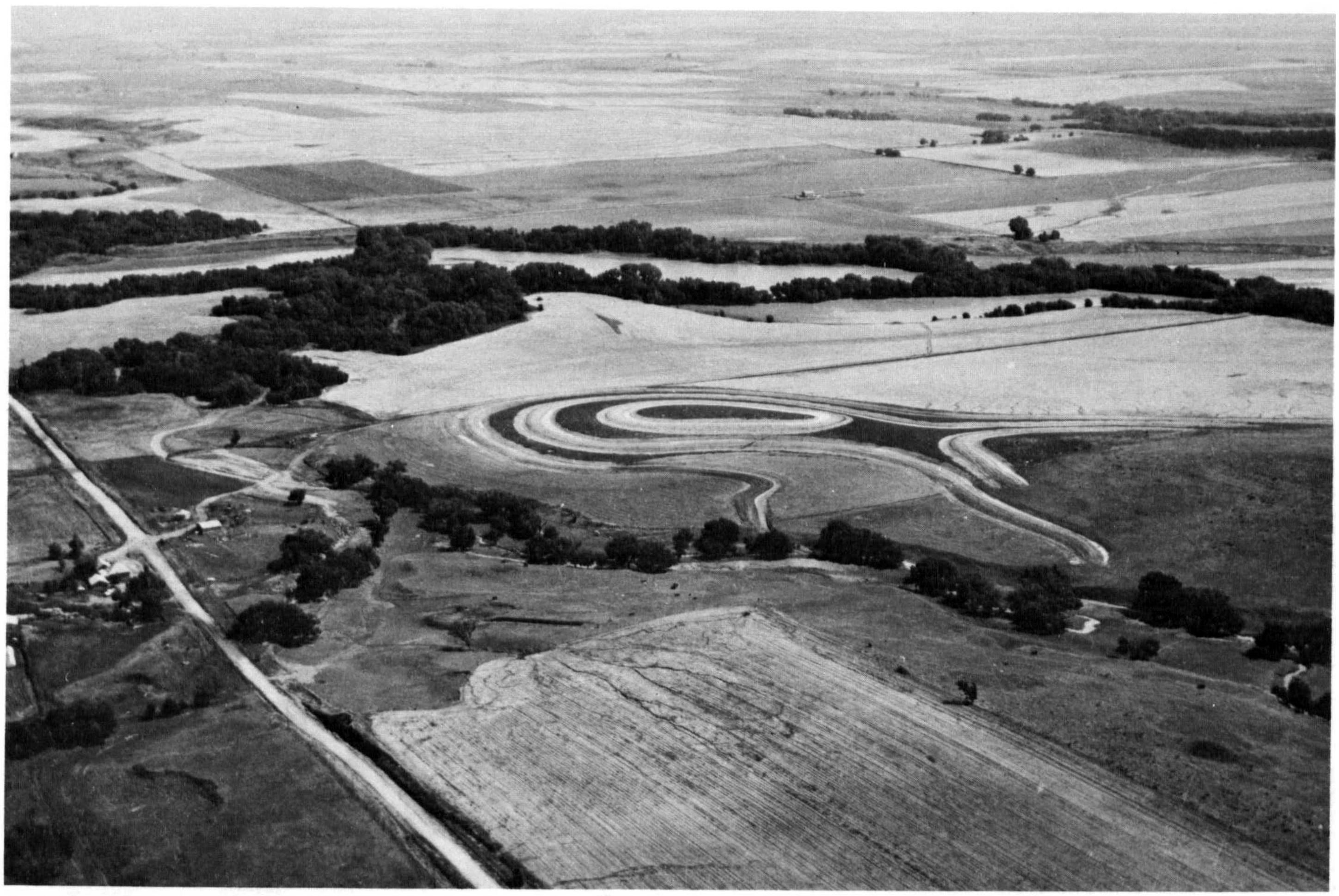
SOIL SURVEY OF

Norton County, Kansas



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1961-72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Norton County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches, in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All of the soils in Norton County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside, and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification and windbreak suitability group of each. It also shows the page where each soil is described and the page for the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the General Soil Map and the information in the text. Translucent material can be used as an overlay over the General Soil Map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the capability units, range sites, and windbreak suitability groups.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range and the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Norton County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: Aerial photograph of level and gradient terraces holding water and slowing runoff on sloping Coly and Uly soils after a heavy rain.

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Issued November 1977

Summary of Tables

SOIL SURVEY OF NORTON COUNTY, KANSAS

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

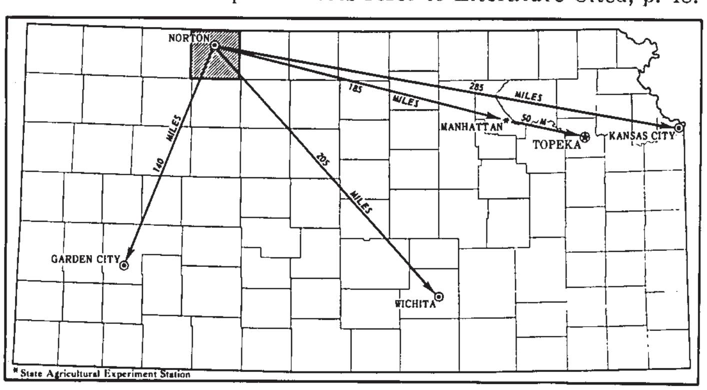
NORTON COUNTY, in the northwestern part of Kansas, covers a total area of 880 square miles, or 558,080 acres. Norton, near the center of the county, is the county seat. The population of the county in 1972 was about 7,652 (*6*).[1] Farming is the most important enterprise in the county, and most of the population makes a living from agriculture or related enterprises. About 94 percent of the county, or 525,000 acres, is in farms and ranches. Wheat, alfalfa, and grain and forage sorghums are the most important dryland crops. Some corn is grown in the valleys, mostly under irrigation. Beef cattle is the main kind of livestock in the county, but some dairy cows, sheep, hogs, and poultry are also raised.

Irrigation is practiced by many farmers in the valley of Prairie Dog Creek. There is also irrigation in the valleys of Sappa Creek and the North Fork Solomon River in areas where an adequate supply of water of good quality is available.

Norton County is in two major land resource areas. Most of the county is in the Rolling Plains and Breaks area. The southwestern part, or about 8 percent, of the county is in the Central High Table Land area.

The elevation above sea level ranges from about 2,012 feet on the North Fork Solomon River in the southeastern part of the county to more than 2,550 feet in the western part near the county line. The rise is about 12 feet to the mile and is in a west-or-northwest direction. Norton, near the center of the county, is at an elevation of 2,278 feet. The elevation is 2,155 feet at Almena and 2,122 feet at Edmond.

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



Location of Norton County in Kansas.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Norton County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock and various 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 the action of plant roots.

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. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles alike or 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. Holdrege and Campus, for example, are the names of two soil series in Norton County. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects their use by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Holdrege silt loam, 1 to 3 percent slopes, is one of several phases within the Holdrege series.

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 help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. 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 phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such mapping units are shown on the soil map of Norton County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Uly-Penden complex, 6 to 20 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant soils represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Coly and Uly silt loams, 6 to 10 percent slopes, eroded, is an undifferentiated group in Norton County.

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

Soil scientists observe how soils behave when used for growing native and cultivated plants and as material, foundations, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a particular kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key or benchmark soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then 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 current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Norton County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts of land that are suitable for a certain use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area; or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the descriptive legends of the associations apply to the texture of the surface layer of the major soils. For example, in the legend of the Uly-Penden-Holdrege association, the words "silt loams" and "loams" refer to the texture of the surface layer of the Uly, Penden, and Holdrege soils.

The soil associations in Norton County are discussed in the following pages.

1. Holdrege-Uly association

Deep, nearly level to strongly sloping, well-drained and somewhat excessively drained silt loams on uplands

This soil association is mainly on broad, loess-covered uplands that are nearly level or gently sloping. Areas along widely spaced upland drainageways are sloping or strongly sloping. The broad, loess-covered ridges are generally long and slope gently toward the drainageways, where slopes are shorter and steeper (fig. 1).

This association makes up about 50 percent of the county. It is about 50 percent Holdrege soils, 25 percent Uly soils, and 25 percent minor soils.

Holdrege soils are on broad, loess-covered uplands. They are nearly level or gently sloping and are well drained. The surface layer is about 11 inches thick. It is grayish-brown silt loam in the upper part and dark grayish-brown silt loam in the lower part. The subsoil is about 17 inches thick. The upper part of the subsoil is grayish-brown silty clay loam, and the lower part is light brownish-gray silty clay loam. The underlying material is calcareous silt loam. It is pale brown

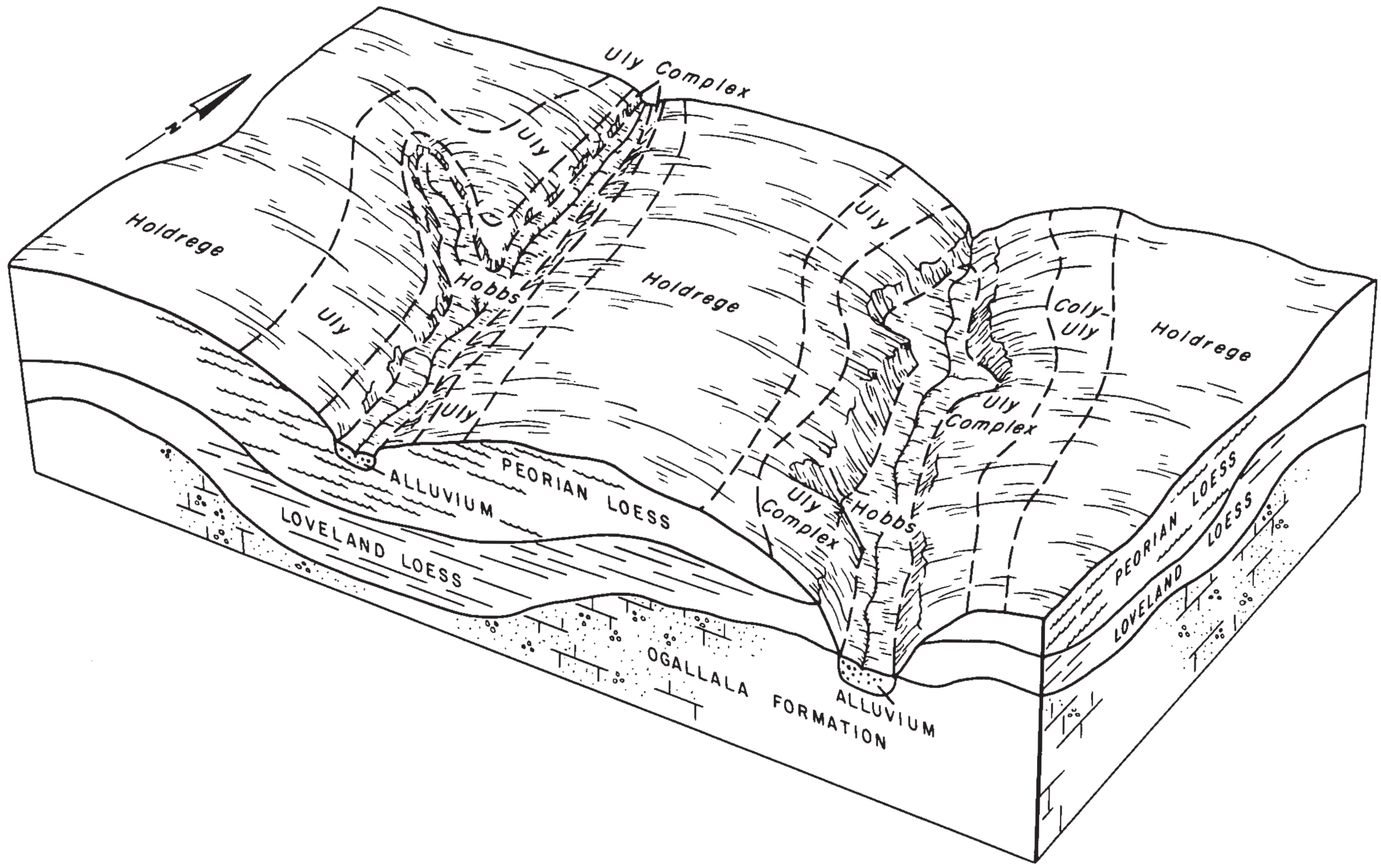


***Figure 1.*—Relationship of topography, soils, and underlying material in the Holdrege-Uly association.**

in the upper part and very pale brown in the lower part.

Uly soils have short slopes that adjoin the drainageways. They are sloping or strongly sloping and are well drained and somewhat excessively drained. The surface layer is dark grayish-brown silt loam about 9 inches thick. The subsoil is 19 inches thick. It is grayish-brown silt loam in the upper 4 inches, light brownish-gray, heavy silt loam in the middle 7 inches, and very pale brown, calcareous silt loam in the lower 8 inches. The underlying material, at a depth of 28 inches, is very pale brown, calcareous silt loam.

Minor soils in this association are Penden, Coly, and Hobbs soils. The Penden soils have short slopes that adjoin the drainageways. The Coly soils are sloping to strongly sloping and are in eroded areas on side slopes and narrow ridges. The Hobbs soils are in narrow areas along alluvial drainageways.

Winter wheat and sorghum grow well on the soils of this association. Some alfalfa is grown, mainly in the eastern part of the county.

The available water capacity is high to very high in the Holdrege soils and very high in the Uly soils. Fertility is high in the Holdrege soils and medium in the Uly soils.

The main management concerns are conserving moisture, controlling water erosion and soil blowing, and maintaining soil tilth and fertility. Most of this association is used for crops, but some sloping and strongly sloping areas along the drainageways are used as range. Growing cash crops and raising beef cattle are the main enterprises.

2. *Uly-Holdrege-Coly association*

Deep, gently sloping to moderately steep, well-drained and somewhat excessively drained silt loams on uplands

This soil association is on loess-covered uplands dissected by intermittent drainageways that have sloping to steep sides. The loess-covered ridges between the valleys are narrow in most areas, and the soils are sloping or gently sloping. The ridges have long slopes down toward the drainageways, where slopes are shorter, steeper, and more irregular. In the lower part of the valleysides are breaks and uneven areas and a few vertical exposures of pale-brown loess (fig. 2).

This association makes up about 21 percent of the county. It is about 40 percent Uly soils, 30 percent Holdrege soils, 20 percent Coly soils, and 10 percent minor soils.

Uly soils are on loess-covered ridges and valley side slopes. They are sloping to moderately steep and are well drained and somewhat excessively drained. The surface layer is dark grayish-brown silt loam about 9

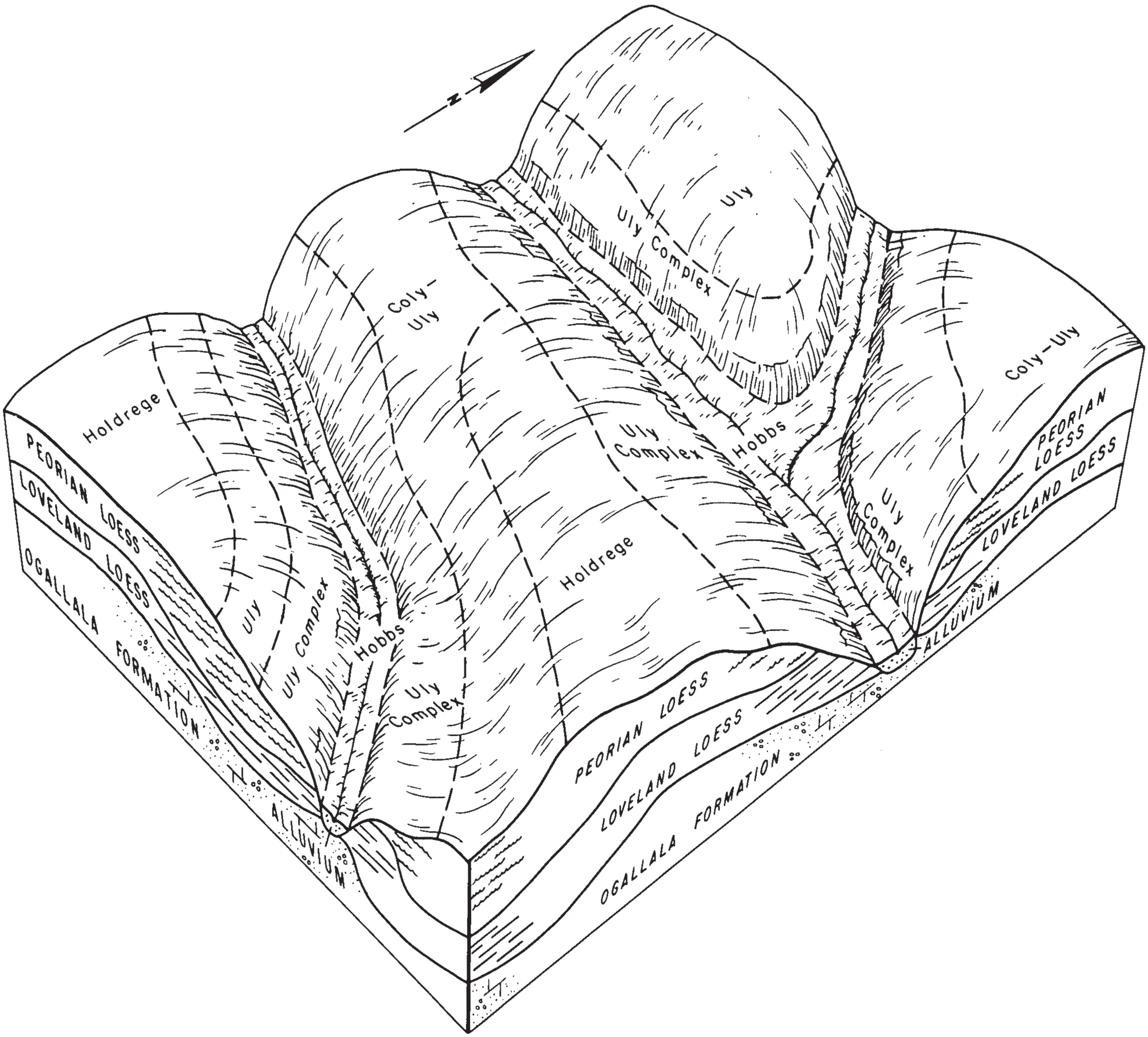


***Figure 2.*—Relationship of topography, soils, and underlying material in the Uly-Holdrege-Coly association.**

inches thick. The subsoil is 19 inches thick. It is grayish-brown silt loam in the upper 4 inches, light brownish-gray heavy silt loam in the middle 7 inches, and very pale brown, calcareous silt loam in the lower 8 inches. The underlying material, at a depth of 28 inches, is very pale brown, calcareous silt loam.

Holdrege soils are on loess-covered uplands. They are gently sloping or sloping and are well drained. The surface layer is about 11 inches thick. It is grayish-brown silt loam in the upper part and dark grayish-brown silt loam in the lower part. The subsoil is about 17 inches thick. The upper part of the subsoil is grayish brown silty clay loam, and the lower part is light brownish-gray silty clay loam. The underlying material, at a depth of 28 inches, is pale-brown, calcareous silt loam.

Coly soils are on loess-covered ridges and valley side slopes. They are sloping to moderately steep and are well drained and somewhat excessively drained. The surface layer is light brownish-gray, calcareous silt loam about 4 inches thick. Below this is light-gray, calcareous silt loam 6 inches thick. The underlying material is very pale brown, strongly calcareous silt loam. Coly soils are intermixed closely with Uly soils.

Minor soils in this association are Penden, Hobbs, and Roxbury soils. The Penden soils are sloping to moderately steep and are underlain by loamy sediment. They have short slopes and adjoin the drainageways. Hobbs soils occupy narrow areas along alluvial drainageways. Roxbury soils are along alluvial drainageways where calcareous silty outwash has accumulated from adjacent uplands.

The sloping to moderately steep soils of this association are better suited to range than to crops. Many areas that were once used for crops have been seeded back to native grass. Some areas of gently sloping or sloping Holdrege, Coly, and Uly soils on ridges and the upper parts of side slopes are suited to and used for crops. Winter wheat and sorghum are the main crops.

The available water capacity is high to very high in the Holdrege soils and very high in the Coly and Uly soils. Fertility is high in the Holdrege soils, medium in the Uly soils, and low in the Coly soils.

The main management needs for crops are conserving moisture, controlling runoff and soil blowing, and maintaining tilth and fertility. The main concern in management of range is maintaining a vigorous stand of desirable grass. Raising beef cattle and growing cash and forage crops are the main enterprises.

3. Uly-Penden-Holdrege association

Deep, gently sloping to moderately steep, well drained and somewhat excessively drained silt loams and loams on uplands

This soil association is on dissected, loess-covered uplands where gravelly and rocky outcrops are along the valley sides. The steeper soils are on the valley slopes, where partly consolidated caliche and sandy or gravelly material are exposed. The loess-covered ridges between the valleys are narrow, and the soils are gently sloping and sloping (fig. 3).

This association makes up about 20 percent of the county. It is about 45 percent Uly soils, 25 percent Penden soils, 20 percent Holdrege soils, and 10 percent minor soils.

Uly soils are on ridgetops and the upper part of side slopes. They are sloping and strongly sloping, deep, and well drained and somewhat excessively drained. The surface layer is dark grayish-brown silt loam about 9 inches thick. The subsoil is 19 inches thick. It is grayish-brown silt loam in the upper part, light-brownish-gray heavy silt loam in the middle part, and very pale brown, calcareous silt loam in the lower part. The underlying material, at a depth of 28 inches, is very pale brown, calcareous silt loam.

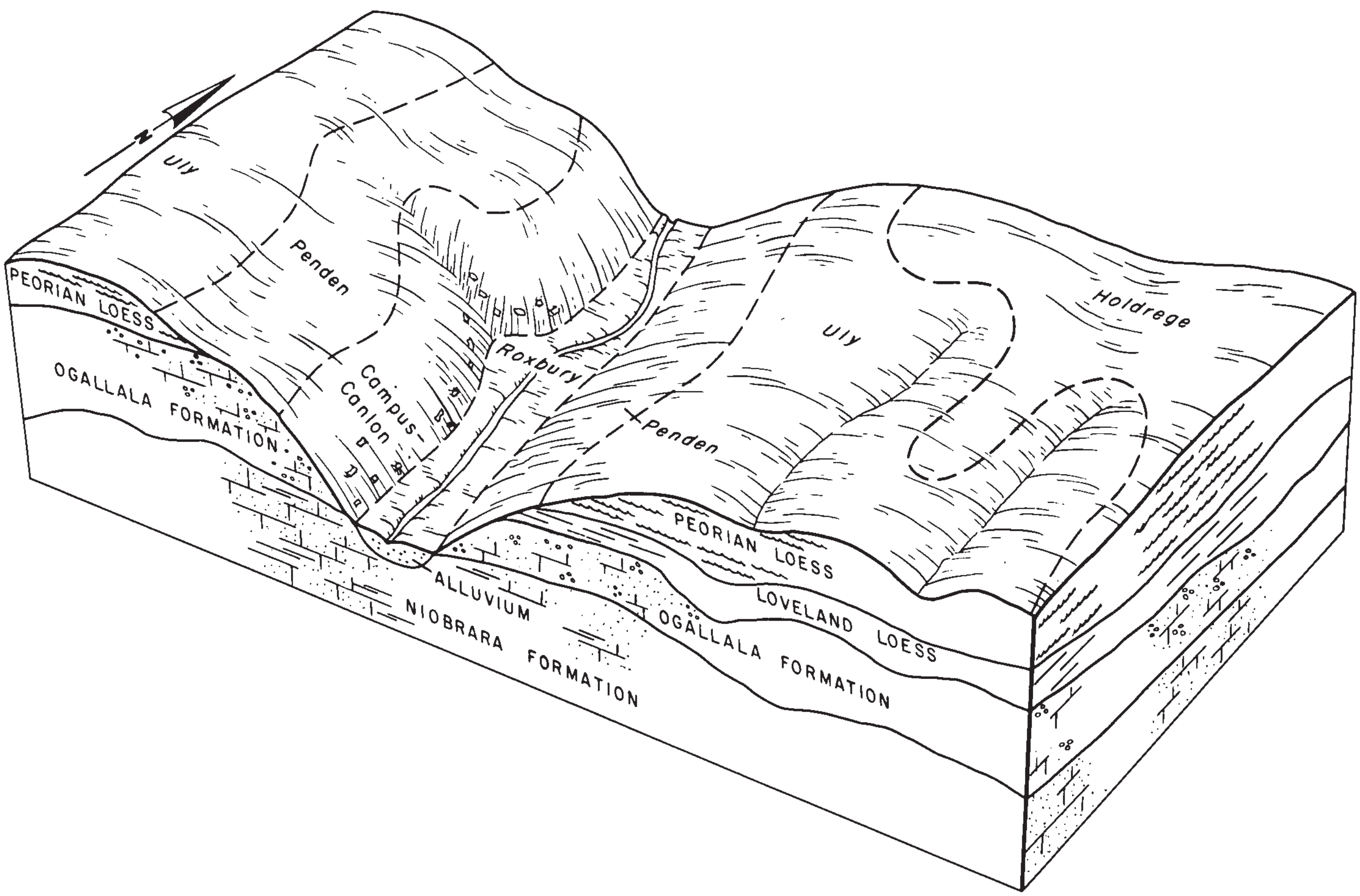


Figure 3.—**Relationship of topography, soils, and underlying material in the Uly-Penden-Holdrege association.**

Penden soils formed in highly calcareous loamy material of valley slopes and gravelly breaks. They are sloping to moderately steep, deep, and well drained. The surface layer is about 15 inches thick. It is dark grayish-brown calcareous loam in the upper part and grayish-brown calcareous loam in the lower part. The subsoil is calcareous, pale-brown heavy loam about 9 inches thick. The underlying material, at a depth of 24 inches, is very pale brown, strongly calcareous loam.

Holdrege soils are on loess-covered ridgetops. They are gently sloping and sloping, deep, and well drained. The surface layer is about 11 inches thick. It is grayish-brown silt loam in the upper part and dark grayish-brown silt loam in the lower part. The subsoil is about 17 inches thick. The upper part of the subsoil is grayish-brown silty clay loam, and the lower part is light brownish-gray silty clay loam. The underlying material is calcareous silt loam. It is pale brown in the upper part and very pale brown in the lower part.

Minor soils in this association are Campus, Canlon, Coly, Roxbury, Munjor, and Hobbs soils. The Campus and Canlon soils are strongly sloping to steep and are on gravelly breaks and rocky outcrops of the entrenched valleys. The Coly soils are sloping and strongly sloping and are on narrow ridges and side slopes. The Munjor, Roxbury, and Hobbs soils are in narrow areas along alluvial drainageways.

Because of the slope and the rocky outcrops, the soils in this association are better suited to range than to farming. In some areas the gravelly and sandy material on the steeper slopes is a fair source of sand, gravel, and road-surfacing material. Some areas of gently sloping soils along ridges are cultivated and used for wheat and sorghum.

The available water capacity is very high in the Uly soils, moderate to high in the Penden soils, and high to very high in the Holdrege soils. Uly and Penden soils have medium fertility, and Holdrege soils have high fertility.

The main management concerns for crops are conserving moisture and controlling runoff and soil blowing. The main concern in management of range is maintaining a vigorous stand of desirable grass.

4. *Hord-Roxbury-Munjor association*

Deep, nearly level, well drained and moderately well drained, silt loams and sandy loams on terraces and bottom lands

This soil association is made up of soils in the valleys along Prairie Dog Creek, Sappa Creek, North Fork Solomon River, and their larger tributaries. These are areas of alluvium and high terraces along the three major perennial streams that flow east and northeast through the county. The valleys are generally ½ to 1 mile wide. The terraces and flood plains are nearly level, but there is a definite drop in elevation from the terrace to the flood plain, which is along the stream channel.

This association makes up about 9 percent of the county. It is about 42 percent Hord soils, 23 percent Roxbury soils, 16 percent Munjor soils, and 19 percent minor soils (fig. 4).

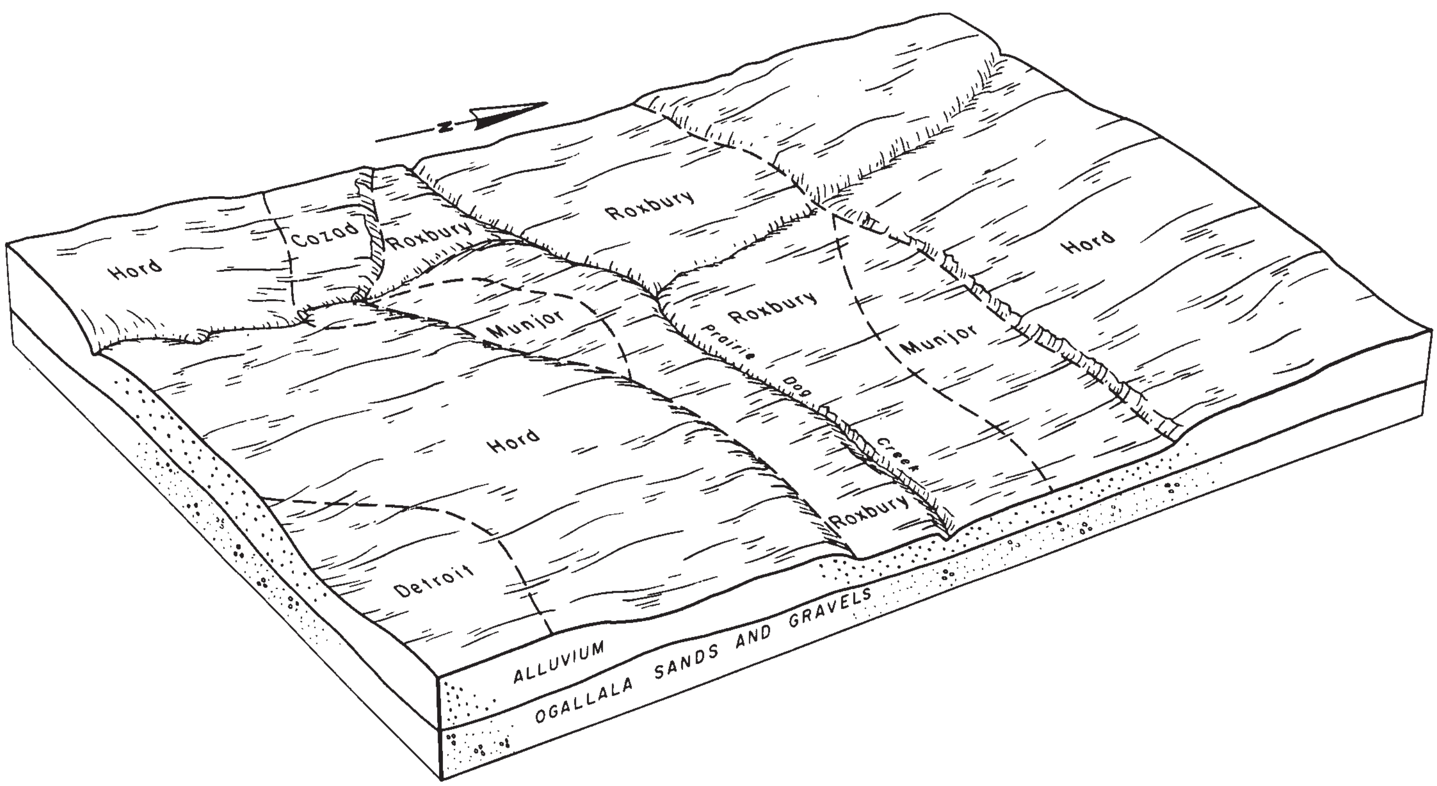


***Figure 4.*—Relationship of topography, soils, and underlying material in the Hord-Roxbury-Munjor association.**

Hord soils are on terraces. They are nearly level and are well drained and seldom flooded. They do receive some runoff, however, from adjacent uplands. These soils formed in alluvium that is thinly mantled with loess in some areas. The surface layer is silt loam about 16 inches thick. It is grayish brown in the upper part and dark grayish brown in the lower part. The subsoil is grayish-brown silt loam about 30 inches thick. The underlying material is light-gray, calcareous silt loam.

Roxbury soils are on low stream terraces and flood plains. They are nearly level and are well drained and moderately well drained. Areas of these soils along the major streams and tributaries are flooded after heavy rains. The surface layer is grayish-brown, calcareous silt loam 19 inches thick. The subsoil is grayish-brown, calcareous silt loam about 17 inches thick. The underlying material is light brownish-gray, calcareous silt loam.

Munjor soils are on flood plains and are subject to flooding. They are nearly level and are well drained. The surface layer is light brownish-gray, calcareous sandy loam about 6 inches thick. Below this is light-gray, calcareous sandy loam 9 inches thick. The underlying material is very pale brown, calcareous, and is sandy loam and loamy sand in thin stratified layers.

Minor soils in this association are Cozad, Detroit, and Holdrege soils. The Cozad soils formed in recent light-colored alluvium or wind-deposited silt on terraces and foot slopes along streams, drainageways, and alluvial fans that have received recent deposition. The Cozad soils are nearly level or gently sloping and are well drained. The Detroit soils are on stream terraces, are nearly level, and are well drained to moderately well drained. Holdrege soils are on high terraces adjoining the stream valleys, are nearly level to sloping, and are well drained.

Most of this association is cultivated, and where adequate water is available, it is irrigated. Corn, sorghum, wheat, and alfalfa grow well on the soils of this association. Most of the corn is grown under irrigation.

The available water capacity is very high in the Hord and Roxbury soils and moderate in the Munjor soils. Fertility is high in the Hord and Roxbury soils and low in the Munjor soils.

Deciduous trees grow along most of the stream channels of this association and some areas along the streams are used for wildlife habitat and as range. Most of the trees are green ash, hackberry, and cottonwood. The main management concerns for crops are controlling flooding from adjacent uplands, managing crop residue, distributing irrigation water properly, and maintaining tilth and fertility. Growing cash and forage crops and raising beef cattle and hogs are the main farm enterprises.

Descriptions of the Soils

In the following pages, each soil series is described in detail, and then, briefly, the mapping units in that series. Unless stated otherwise, what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the soil series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are either stated in the description of the mapping unit or are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated. The description of each mapping unit contains suggestions on how the soil can be managed. The general management of soils in this county is discussed in the section "Use and Management of the Soils."

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page where each range site is described is listed in the "Guide to Mapping Units" at the back of this survey.

The names, descriptions, and delineations of soils in this soil survey do not always agree fully with soil maps of adjoining counties published at a different date. Differences are brought about by better knowledge about soils or by modifications and refinements of soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include soils of minor extent with similar soils if management and response are much the same, rather than set them apart as individual soils. Other differences are brought about by the predominance of different soils in taxonomic units made up of two or three series or may be caused by the range in slope that is allowed within the mapping unit for each survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*9*).

Campus Series

The Campus series consists of moderately deep, well-drained, sloping to steep soils that are underlain by beds of caliche. These soils formed on uplands in residuum weathered from the caliche. Depth to the caliche bedrock ranges from 20 to 40 inches. Slopes are about 6 to 30 percent. The native vegetation is mostly grass. The dominant plants are side-oats grama, blue grama, hairy grama, little bluestem, and big bluestem. These soils are mapped only in a complex with the Canlon soils.

In a representative profile the surface layer is dark grayish-brown loam about 11 inches thick. The subsoil is friable, grayish-brown heavy loam about 8 inches thick. The underlying material is light-gray clay loam, about 11 inches thick, that contains many soft lumps and masses of calcium carbonate. Very pale brown, partly consolidated beds of caliche are at a depth of 30 inches (fig. 5).

Permeability is moderate, the available water capacity is low, and runoff is medium to rapid. Fertility is medium.

***Figure 5.*—Profile of Campus loam under a cover of big and little bluestem. This soil has fragments of caliche and calcium carbonate in the lower part of the profile.**

Because the soils are sloping to steep, they are better suited to grazing than to farming. Most areas are in native grass and are used for grazing. These soils are well suited to wildlife that use range as habitat. Limitations for many nonfarm uses are moderate or severe.

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

Soil	Area	Extent
	Acres	*Percent*
Campus-Canlon complex, 6 to 30 percent slopes	7,250	1.3
Coly and Uly silt loams, 6 to 10 percent slopes, eroded	95,430	17.1
Coly and Uly silt loams, 10 to 20 percent slopes, eroded	3,900	.7
Cozad silt loam, 0 to 2 percent slopes	2,230	.4
Cozad silt loam, 2 to 5 percent slopes	2,790	.5
Detroit silty clay loam	1,110	.2
Hobbs silt loam	10,040	1.8
Holdrege silt loam, 0 to 1 percent slopes	15,070	2.7
Holdrege silt loam, 1 to 3 percent slopes	163,920	29.4
Holdrege silt loam, 1 to 3 percent slopes, eroded	16,740	3.0
Holdrege silt loam, 3 to 6 percent slopes	5,580	1.0
Holdrege silt loam, 3 to 6 percent slopes, eroded	9,490	1.7
Hord silt loam	22,320	4.0
Munjor complex	8,370	1.5
Roxbury silt loam	11,720	2.1
Uly silt loam, 6 to 10 percent slopes	64,180	11.5
Uly complex, 10 to 20 percent slopes	68,090	12.2
Uly-Penden complex, 6 to 20 percent slopes	47,990	8.6
Wakeen complex, 6 to 20 percent slopes	1,670	.3
Gravel pits	80	(1)
Fill and borrow areas	110	(1)
TOTAL	558,080	100.0

[1] Less than 0.05 percent.

Representative profile of Campus loam, in an area of Campus-Canlon complex, 6 to 30 percent slopes, in range, 1,450 feet north and 170 feet west of the southeast corner of sec. 26, T. 5 S., R. 22 W.

A1—0 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable; many worm casts; few, small, hard fragments of caliche; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B2—11 to 19 inches, grayish-brown (10YR 5/2) heavy loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; slightly hard, friable; many worm casts; many, small, hard fragments of caliche; violently effervescent; moderately alkaline; clear, smooth boundary.

C1ca—19 to 30 inches, light-gray (10YR 7/2) light clay loam, grayish brown (10YR 5/2) when moist; weak, fine, granular structure; soft, very friable; about 40 percent soft lumps and masses of calcium carbonate; many, small, hard fragments and concretions of caliche; violently effervescent; moderately alkaline; clear smooth boundary.

C2—30 to 40 inches, very pale brown (10YR 8/3) semiconsolidated caliche.

The solum is mildly or moderately alkaline throughout. The A1 horizon ranges from grayish brown to dark grayish brown and is loam or silt loam 7 to 12 inches thick. The B2 horizon is light grayish brown or grayish brown and is loam or light clay loam 7 to 10 inches thick. The Cca horizon ranges from light gray to light brownish gray and is loam or light clay loam. Calcium carbonate occurs in the form of soft masses and small fragments of caliche and makes up about 25 to 50 percent of this horizon.

Campus soils are near Canlon, Penden, and Wakeen soils. They are deeper and have a thicker, darker colored A1 horizon than the Canlon soils. They are not so deep as the Penden soils, which formed in calcareous outwash. They are in areas similar to those occupied by the Wakeen soils, which are underlain by chalky limestone.

Cc—Campus-Canlon complex, 6 to 30 percent slopes. This mapping unit is on uplands and consists of sloping to steep soils that are underlain by caliche. It is about 45 percent Campus soil, 35 percent Canlon soil, 10 percent Penden soil, and 10 percent Uly soil and caliche outcrops. The Campus and Canlon soils have the profiles described as representative of their series.

Runoff is medium to rapid, and the hazard of erosion is severe.

The soils of this complex are better suited to range than to other uses because they have variable slopes, limited depth of root zone, and low available water capacity. In some places there are rock outcrops. Most of the acreage is used as range. The dominant vegetation is mid and short grasses. Deferred grazing, rotation grazing, proper stocking rates, water development, range seeding, and other range management practices help maintain a vigorous stand of desirable native grasses. Dryland capability unit VIe–3; Campus soil in Limy Upland range site, Canlon soil in Shallow Limy range site; windbreak suitability group not assigned.

Canlon Series

The Canlon series consists of shallow, well drained to somewhat excessively drained, sloping to steep soils that are underlain by caliche beds. These soils are on uplands. Depth to underlying caliche ranges from 10 to 20 inches (fig. 6). Slopes are about 6 to 30 percent The native vegetation is mid grasses. The dominant plants are little bluestem and side-oats grama. These soils are mapped only in a complex with the Campus soils.

In a representative profile the surface layer is grayish-brown loam about 5 inches thick. The next layer is light brownish-gray, friable fine sandy loam about 5 inches thick. The underlying material is white loam about 3 inches thick. Hard caliche is at a depth of 13 inches.

Permeability is moderate, the available water capacity is very low, and runoff is medium to rapid. Fertility is low.

Because the soils are sloping to steep, they are better suited to grazing than to farming. Most areas are in native grass and are used for grazing. These soils are well suited to wildlife that use range as habitat. Limitations for many nonfarm uses are severe.

Representative profile of Canlon loam, in an area of Campus-Canlon complex, in range, 1,450 feet north and 120 feet west of the southeast corner of sec. 26, T. 5 S., R. 22 W.

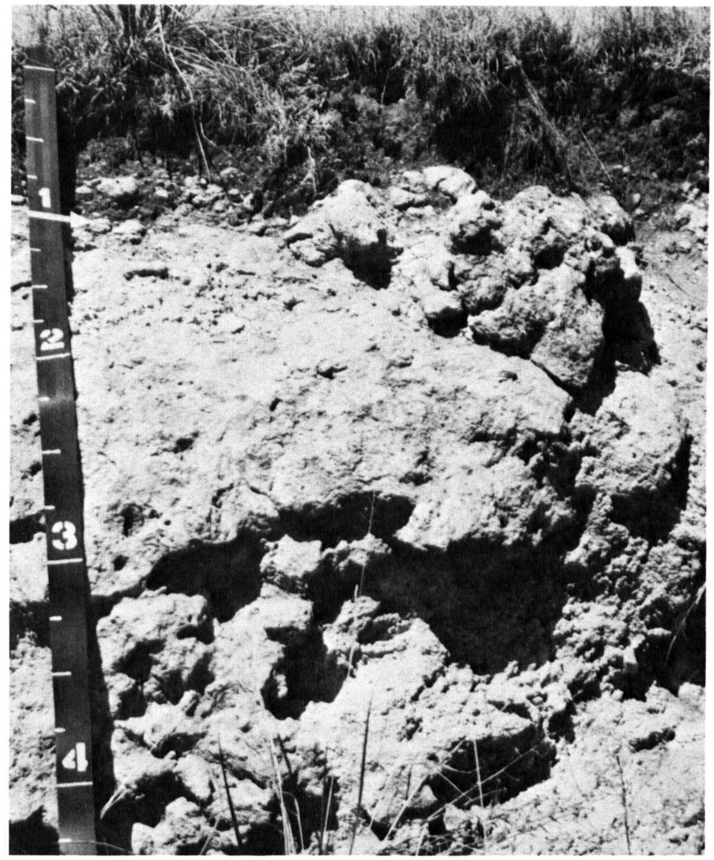


Figure 6.—**Profile of Canlon loam. This soil is underlain by caliche at a shallow depth.**

A1—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many fine and medium roots; many small fragments of caliche; violently effervescent; moderately alkaline; clear, smooth boundary.

AC—5 to 10 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; slightly hard, friable; common fine roots; many fragments of caliche, 1/4 to 1 inch in diameter; violently effervescent; moderately alkaline; clear, smooth boundary.

C—10 to 13 inches, white (10YR 8/2) loam, light gray (10YR 7/2) when moist; massive; hard, friable; about 50 percent, by volume, small to large fragments of caliche; violently effervescent; moderately alkaline; clear, smooth boundary.

R—13 inches, white, hard caliche.

The A1 horizon ranges from light brownish gray to grayish brown or light gray. Although loam in most places, it is silt loam or fine sandy loam in some places. It is 3 to about 6 inches thick.

The AC horizon ranges from light brownish gray to pale brown and it is loam or fine sandy loam about 4 to 8 inches thick.

The C horizon ranges from white to light brownish gray or very pale brown and is loam or fine sandy loam. Fragments of caliche are common throughout the profile. White, hard caliche is at a depth of 10 to 20 inches.

Canlon soils are near Campus, Wakeen, and Penden soils. They are not so deep as those soils and do not have so thick a dark-colored surface layer. The Canlon soils are underlain by caliche, but the Wakeen soils are underlain by chalky limestone. They formed in material weathered from caliche, but the Penden soils formed in loamy sediment.

Coly Series

The Coly series consists of deep, well drained to somewhat excessively drained, sloping to moderately steep soils on uplands. These soils formed in loess. Slopes range from 6 to 20 percent. The native vegetation is mainly short, mid, and tall grasses. The dominant grasses are big bluestem, little bluestem, side-oats grama, blue grama, and hairy grama. These soils are mapped only in an undifferentiated unit with the Uly soils.

In a representative profile the surface layer is light brownish-gray silt loam about 4 inches thick. Below that is light-gray, friable silt loam about 6 inches thick. The underlying material is very pale brown silt loam. The upper 15 inches of this material has common threads and soft masses of lime.

Permeability is moderate, the available water capacity is very high, and runoff is medium to rapid. Fertility is low.

Most areas of Coly soils are cultivated, but these soils are not well suited to crops because of the slope and the hazard of erosion. Many areas have been seeded back to native grass.

Representative profile of Coly silt loam, in an area of Coly and Uly silt loams, 6 to 10 percent slopes, eroded, in a cultivated field, 500 feet west and 250 feet north of the southeast corner of the southwest quarter of sec. 5, T. 2 S., R. 23 W.

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; soft, friable; strongly effervescent; mildly alkaline; abrupt, smooth boundary.

AC—4 to 10 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; moderate, fine, granular structure; slightly hard, friable; many worm casts; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C1ca—10 to 25 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, medium, granular structure; slightly hard, very friable; common worm casts; many root channels; common threads and soft masses of lime; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C2—25 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; soft, very friable; porous; few threads and small masses of lime; strongly effervescent; moderately alkaline.

The solum is mildly or moderately alkaline throughout. The Ap horizon ranges from light gray to grayish brown and is silt loam or loam 3 to 6 inches thick. The AC horizon ranges from light gray to very pale brown, light brownish gray, or pale brown, and although loam in some places, it is typically silt loam. It is 5 to 14 inches thick. The C1ca horizon is very pale brown or pale brown silt loam or loam 13 to 20 inches thick. The C 2 horizon is very pale brown or pale brown silt loam or loam.

Coly soils are near Uly, Holdrege, and Penden soils. They have a lighter-colored A horizon than those soils. They lack the texture of loam throughout the profile, whereas Penden soils do have the texture of loam throughout, and they also contain more than 15 percent sand that is coarser than very fine sand. The Coly soils lack a Bt horizon, but Holdrege soils have one.

Co—Coly and Uly silt loams, 6 to 10 percent slopes, eroded. This mapping unit consists of sloping soils that are on uplands. The soils could be mapped individually but are shown as a differentiated group because, for the purpose of this survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of both. This Coly soil has the profile described as representative of the series. The Uly soil has a profile similar to the one described as representative of the Uly series, but in some places the surface layer is thinner because the soil is eroded.

Included with these soils in mapping are areas of Holdrege silt loam which make up about 8 percent of the mapping unit, and small, narrow areas of alluvial soil material in drainageways.

Runoff is medium to rapid, and the hazard of erosion is severe. The main concerns of management are conserving moisture, controlling water erosion and soil blowing, and maintaining tilth and fertility.

Much of the acreage is cultivated, but the soils are not well suited to crops because of the slope and the hazard of erosion. The main crops are wheat and sorghum. In most cultivated areas, water erosion has removed part of the surface layer, and tillage has mixed the lighter-colored subsoil with the remaining surface layer. Rills and shallow gullies have formed near the bottom of some slopes. Careful management of crop residue, terracing, contour farming, and stubble-mulch tillage help control further water erosion or soil blowing. Range seeding and proper grazing are needed in grassed areas. Dryland capability unit IVe–1; Coly soil in Limy Upland range site, Uly soil in Loamy Upland range site; windbreak suitability group 3.

Cs—Coly and Uly silt loams, 10 to 20 percent slopes, eroded. This mapping unit consists of strongly sloping to moderately steep soils that are on uplands. These soils could be mapped separately but are shown as one undifferentiated group because, for the purpose of this survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or both. The Coly soil has a profile similar to the one described as representative of the Coly series, but in places the surface layer is darker colored. The Uly soil has a profile similar to the one described as representative of the Uly series, but in some places, the surface layer is thinner because of erosion.

Included with these soils in mapping are areas of Penden loam and alluvial soil material. The Penden soil makes up about 8 percent of the acreage and the alluvial material about 6 percent. Also included, on the lower slopes, are areas of soils where erosion has exposed underlying material of yellowish-brown silt loam.

Runoff is rapid, not only because of the slope but also because the surface seals over and becomes slick during rainstorms. The hazard of erosion is severe.

These soils are better suited to range than to farming, because of the slope and the hazard of erosion. A few areas are cultivated, but farming contributes to further loss of soil material. Erosion impairs fertility and damages plants that do not have a well-established root system. Those areas now cultivated should be seeded to suitable native grass. Among the range management practices needed to produce adequate forage for livestock are proper stocking rates, water development, fencing, deferred grazing, and rotation of grazing. Dryland capability unit VIe–1; Coly soil in Limy Upland range site, Uly soil in Loamy Upland range site; windbreak suitability group 3.

Cozad Series

The Cozad series consists of deep, well-drained, nearly level to gently sloping soils on stream terraces and alluvial fans. These soils formed in silty alluvium or loess. Slopes are mainly 0 to 5 percent. The native vegetation is mid and tall grasses. The dominant species are big bluestem, switchgrass, little bluestem, and western wheatgrass.

In a representative profile the surface layer is silt loam about 13 inches thick. The upper part of the surface layer is dark grayish brown, and the lower part is grayish brown. The subsoil is grayish-brown, friable silt loam 6 inches thick. The underlying material extends to a depth of about 60 inches. The upper part of this layer is light-gray silt loam, the middle part is grayish-brown light silty clay loam, and the lower part is light brownish-gray silt loam.

Permeability is moderate, the available water capacity is very high, and surface runoff is slow to medium. Fertility is medium.

Cozad soils are well suited to farming, and many areas are irrigated. These soils are well suited to openland wildlife. Limitations for many nonfarm uses are slight.

Representative profile of Cozad silt loam, 0 to 2 percent slopes, in a cultivated field, 1,050 feet north and 250 feet east of the southwest corner of sec. 20, T. 3 S., R. 24 W.

Ap—0 to 7 inches, dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; massive but parting to weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B2—13 to 19 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; slightly effervescent; mildly alkaline; gradual, smooth boundary.

C1—19 to 40 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; massive but porous; slightly hard, friable; few soft masses of lime; strongly effervescent; moderately alkaline; clear, smooth boundary.

ACcab—40 to 54 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; hard, firm; many soft threads and masses of lime; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C2—54 to 60 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive, slightly hard, friable; strongly effervescent; moderately alkaline.

The solum ranges from 15 to 26 inches in thickness. The depth to free carbonates ranges from 0 to about 15 inches and averages about 13 inches.

The Ap horizon ranges from dark gray or dark grayish brown to gray or grayish brown. It is silt loam or loam about 6 to 8 inches thick. The A12 horizon ranges from dark gray or grayish brown to very dark gray or very dark grayish brown. It is silt loam or silty clay loam about 3 to 6 inches thick.

The B2 horizon ranges from gray to light brownish gray or grayish brown. It is silt loam to silty clay loam 6 to 9 inches thick.

The C1, ACcab, and C2 horizons all range from light gray or pale brown to light brownish gray or grayish brown and from silt loam to silty clay loam. A buried A1 horizon is in many profiles.

Cozad soils are near Hord, Detroit, and Roxbury soils. They are not so deeply leached of lime as the Hord and Detroit soils. Cozad soils are less clayey throughout than the Detroit soils. Dark colors do not extend so deep as in the Hord, Detroit and Roxbury soils.

Cu—Cozad silt loam, 0 to 2 percent slopes. This nearly level soil is on broad stream terraces. Most areas are along the larger streams in positions high enough that they are not subject to frequent flooding. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Hord silt loam. Also included are a few small areas of similar soils that have a surface layer of sandy loam or loam.

Runoff is slow to medium, and the hazard of erosion is slight.

Most areas of this soil are used for crops. Some areas are irrigated. The main crops are corn, wheat, alfalfa, and sorghum. The soil is well suited to cultivation if tilth is maintained. The main concerns of management are controlling soil blowing and conserving moisture. The soil blows when dry if it lacks an adequate cover of crop residue or vegetation. Stubble-mulch tillage helps conserve moisture and control soil blowing. Dryland capability unit IIc–2, irrigated capability unit I–2; Loamy Terrace range site; windbreak suitability group 1.

Cz—Cozad silt loam, 2 to 5 percent slopes. This gently sloping soil is on colluvial slopes and terraces. It formed in recent, light-colored alluvium or wind-deposited silt on terraces and high bottoms along the major streams. The soil is undulating in some places.

Included in mapping are a few small areas of Hord soils and a few areas of soils that have a surface layer of loam or sandy loam.

Runoff is medium, and the hazard of erosion is moderate. Permeability is moderate.

Most areas of this soil are cultivated. Wheat, sorghum, and alfalfa are the main crops. The main concerns of management are conserving moisture, controlling water erosion and soil blowing, and maintaining fertility and tilth. Terraces are needed in some places to divert excess water received from uplands. Contour farming and crop residue management help conserve soil moisture and control soil blowing and water erosion. Dryland capability unit IIe–2, irrigated capability unit IIe-2; Loamy Terrace range site; windbreak suitability group 1.

Detroit Series

The Detroit series consists of deep, well drained to moderately well drained, nearly level soils on stream terraces. These soils formed in silty alluvium modified by loess. Slopes are 0 to 1 percent. The native vegetation is mid and tall grasses.

In a representative profile the surface layer is dark grayish-brown and very dark grayish-brown light silty clay loam about 14 inches thick. The subsoil is about 24 inches thick. The upper 12 inches of the subsoil is very dark grayish-brown, very firm heavy silty clay loam, and the lower 12 inches is grayish-brown and light brownish-gray, firm silty clay loam. The underlying material is light brownish-gray, light silty clay loam.

Permeability is slow, the available water capacity is high, and runoff is slow to medium. Fertility is high.

Detroit soils are well suited to cultivation, and many areas are irrigated. They are well suited to wildlife that use open land as habitat.

Representative profile of Detroit silty clay loam, in a cultivated field, 1,030 feet north and 220 feet west of the southeast corner of the northeast quarter of sec. 26, T. 2 S., R. 22 W.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, granular structure; slightly hard, firm; neutral; clear, smooth boundary.

A12—8 to 14 inches, very dark grayish-brown (10YR 3/3) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; hard, firm; neutral; gradual, smooth boundary.

B2t—14 to 26 inches, very dark grayish-brown (10YR 3/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, angular blocky structure; hard, very firm; mildly alkaline; gradual, smooth boundary.

B31ca—26 to 31 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, angular blocky structure; hard, firm; slight mixing with darker colors from the B2t horizon; calcareous in part of soil mass in which seams of segregated lime are visible; strongly effervescent; moderately alkaline; clear, smooth boundary.

B32ca—31 to 38 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; slightly hard, firm; segregated lime in veins and soft masses; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—38 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam grading to silt loam as depth increases, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, firm; few, medium, faint, strong-brown mottles; few small masses of lime; strongly effervescent; moderately alkaline.

The solum is neutral in the upper part and neutral to moderately alkaline in the lower part.

The Ap horizon is dark grayish-brown or very dark grayish brown silt loam to silty clay loam 6 to 10 inches thick.

The B1 horizon is very dark grayish-brown, or grayish-brown light to heavy silty clay loam 4 to 8 inches thick. The B2t horizon ranges from very dark grayish brown or dark brown to grayish brown or brown. It is silty clay loam to silty clay and has a clay content of 35 to 45 percent. It is 8 to 20 inches thick. The B3ca horizon is grayish-brown, light brownish-gray, or pale brown light to heavy silty clay loam about 10 to 12 inches thick

The C horizon is light brownish-gray, grayish-brown, or pale-brown silty clay loam to silt loam.

Detroit soils are near Hord, Roxbury, and Cozad soils. They are more clayey throughout than those soils. Detroit soils are leached of lime to a greater depth than the Roxbury and Cozad soils, and their dark colors extend to a greater depth than in the Cozad soils.

Dt—Detroit silty clay loam. This nearly level soil is on stream terraces. It has slopes of 0 to 1 percent.

Included with this soil in mapping are a few areas of Hord silt loam. Also included are a few areas of soils that have lime nearer the surface.

Runoff is slow to medium, and the hazard of erosion is slight.

Most areas of this soil are cultivated. The main dryland crops are wheat and sorghum. Much corn is grown under irrigation. The main concerns of management in dryfarmed areas are conserving moisture and controlling soil blowing. Stubble-mulch tillage helps to conserve moisture and control soil blowing. The main concern of management in irrigated areas is proper distribution of water. Land leveling is needed in many areas. Dryland capability unit IIc-3; irrigated capability unit I-3; Loamy Terrace range site; windbreak suitability group 1.

Hobbs Series

The Hobbs series consists of deep, well drained to moderately well drained, nearly level soils on flood plains and along upland drainageways. These soils formed in noncalcareous silty alluvium. Slopes are dominantly 0 to 1 percent. The native vegetation is tall grasses, mostly big bluestem, switchgrass, and indiangrass.

In a representative profile the surface layer is silt loam about 25 inches thick. The upper part of the surface layer is grayish brown, and the lower part is dark grayish brown. The underlying material is grayish-brown and light brownish-gray silt loam.

Permeability is moderate, the available water capacity is very high, and runoff is medium. Fertility is high.

Hobbs soils are well suited to farming. Because of flooding, limitations for many nonfarm uses are severe. Most areas of these soils are used for crops. In a few areas trees grow along the stream channels.

Representative profile of Hobbs silt loam, in a cultivated field, 1,600 feet east and 100 feet north of the southwest corner of sec. 24, T. 1 S., R. 22 W.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, friable; mildly alkaline; abrupt, smooth boundary.

A12—7 to 25 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable; many worm casts; neutral; gradual, smooth boundary.

C1—25 to 55 inches, grayish-brown (10YR 5/2) silt loam, stratified very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

C2—55 to 75 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, friable; mildly alkaline.

The solum is mildly alkaline or neutral throughout. The upper 40 inches of the soil do not contain free carbonates, except in some places where an upper layer 6 to 15 inches thick of recent deposition is calcareous. In most profiles stratification is evident from small discernible variations in color and clay content.

The Ap horizon is gray, grayish-brown, or dark grayish-brown silt loam or light silty clay loam 5 to 18 inches thick. The A12 horizon is grayish-brown or dark grayish-brown silt loam or light silty clay loam 15 to 25 inches thick.

The C horizon is light-gray, light brownish-gray, or grayish-brown silt loam or light silty clay loam. In some places it is mildly or moderately alkaline and slightly effervescent.

Hobbs soils are near Hord and Roxbury soils. They are leached of lime to a greater depth, are more stratified, and are in a lower position on the landscape than the Hord soils. They are leached of lime to a greater depth than the Roxbury soils.

Hb—Hobbs silt loam. This nearly level soil is on flood plains and along upland drainageways. The areas are long and narrow and are dissected by a stream channel in some places.

Included with this soil in mapping are small areas of Roxbury soils. Also included are areas of entrenched stream channels that are not arable and are bordered by deciduous trees in many places.

Runoff is medium, and the hazard of erosion is slight.

The main crops are wheat, sorghum, and alfalfa. In some years flooding delays planting or harvesting, and in other years it damages crops. Proper management of crop residue helps control soil blowing and maintain tilth. Dryland capability unit IIw–1; irrigated capability unit IIw–1; Loamy Lowland range site; windbreak suitability group 1.

Holdrege Series

The Holdrege series consists of deep, well-drained, nearly level to sloping soils on uplands. These soils formed in loess. Slopes are about 0 to 6 percent. The native vegetation is mixed tall and mid grasses, mostly big bluestem, little bluestem, side-oats grama, switchgrass, blue grama, buffalograss, and western wheatgrass.

In a representative profile the surface layer is about 11 inches thick. The upper 6 inches of the surface layer is grayish-brown silt loam, and the lower 5 inches is dark grayish-brown silt loam. The subsoil is about 17 inches thick. The upper 11 inches of the subsoil is grayish-brown, firm silty clay loam and the lower 6 inches is light brownish-gray, friable silty clay loam. The underlying material is pale-brown and very pale brown, calcareous silt loam.

Permeability is moderate, the available water capacity is high to very high, and runoff is slow to medium. Fertility is high.

Holdrege soils are well suited to farming if they are protected from erosion. Some gently sloping to sloping areas are in native grass and are used for grazing. These soils have slight to moderate limitations for many nonfarm uses. They are well suited to wildlife that use open land as habitat.

Representative profile of Holdrege silt loam, 1 to 3 percent slopes, in a cultivated field, 246 feet east and 432 feet south of the northwest corner of the northeast quarter of sec. 34, T. 2 S., R. 24 W.

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and fine, granular structure; slightly hard, friable; many fine roots; slightly acid; abrupt, smooth boundary.

A3—6 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable; many fine roots; slightly acid; clear, smooth boundary.

B21t—11 to 15 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, very fine, subangular blocky structure; hard, firm; few fine roots and pores; neutral; clear, smooth boundary.

B22t—15 to 22 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, subangular blocky structure; very hard, firm; few small worm casts; shiny coatings on peds; neutral; clear, smooth boundary.

B3—22 to 28 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine to medium, subangular blocky structure; hard, friable; many fine pores; mildly alkaline; clear, smooth boundary.

C1ca—28 to 42 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable; many fine threads and soft masses of lime; strongly effervescent; moderately alkaline; diffuse boundary.

C2—42 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure; soft, very friable; many fine threads and soft masses of lime; strongly effervescent, moderately alkaline.

The Ap horizon is grayish brown or dark grayish brown and is 4 to 7 inches thick. It ranges from medium acid to neutral. The A3 horizon is grayish-brown or dark grayish-brown silt loam or light silty clay loam 4 to 8 inches thick. It is slightly acid or neutral.

The Bt horizon ranges from dark grayish brown or brown to light brownish gray or pale brown and is light to heavy silty clay loam 8 to 16 inches thick. It is neutral or mildly alkaline. The B3 horizon is light brownish-gray or pale-brown silty clay loam or light silty clay loam.

The C horizon is pale-brown or very pale brown silt loam or light silty clay loam. The Cca horizon contains some visible free carbonates. Depth to free carbonates ranges from about 20 to 36 inches but averages about 28 inches.

Holdrege soils are near Uly, Coly, Penden, and Hord soils. They have a thicker solum and are leached of lime to a greater depth than the Uly, Coly, and Penden soils, and they have a Bt horizon. Holdrege soils have a darker colored A horizon than the Coly soils. They differ from Hord soils in having a Bt horizon and dark colors that do not extend so deep.

Ho—Holdrege silt loam, 0 to 1 percent slopes. This nearly level soil occupies large areas that are broad and smooth. It formed on broad, flat loessal ridges on uplands. A few areas are on high terraces along the streams. This Holdrege soil has a profile similar to the one described as representative of the series, but the combined surface layer and subsoil is thicker and the subsoil is more clayey.

Included with this soil in mapping are areas of soils that have a more clayey subsoil, mainly in the eastern part of the county. A few small, round depressions that are 5 acres or less in size are shown on the detailed soil map by a spot symbol.

Runoff is slow to medium, and the hazard of erosion is slight. The soil blows when it is dry if it lacks a protective cover of residue or vegetation. Permeability is moderate.

The main crops are wheat and sorghum. A few areas are irrigated and used for corn. The main concern of management is the maintenance of soil tilth and fertility. Contour farming, stubble-mulch tillage, and stripcropping can be used to conserve moisture and control soil blowing. Land leveling is desirable if the soil is irrigated. Dryland capability unit IIc–1; irrigated capability unit I–1; Loamy Upland range site; windbreak suitability group 2.

Hp—Holdrege silt loam, 1 to 3 percent slopes. This gently sloping soil is in large broad areas that are dissected by upland drainageways. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of soils that have a more clayey subsoil, mainly in the eastern part of the county. Eroded soils in which the surface layer is thinner and lime is near the surface and a few depressions that are 5 acres or less in size are shown on the detailed soil map by the appropriate spot symbols.

Runoff is medium, and the hazard of erosion is moderate.

Most areas of this soil are used for crops. A few areas are in native grass. The main dryland crops are wheat, grain sorghum, forage sorghum, and alfalfa. Corn and grain sorghum are grown under irrigation.

The main concern of management is controlling erosion. The soil blows when dry if it lacks a protective residue or vegetative cover. Terracing, contour farming, grassed waterways, and stubble-mulch tillage help conserve moisture and control soil blowing and water erosion. Land leveling is desirable if the soil is irrigated. Dryland capability unit IIe–1; irrigated capability unit IIe–1; Loamy Upland range site; windbreak suitability group 2.

Hr—Holdrege silt loam, 1 to 3 percent slopes, eroded. This gently sloping soil has short slopes and is in moderately eroded areas, mainly along the sloping crests of ridges. The areas are small to large and irregularly shaped. This soil has a profile similar to the one described as representative of the series, but the surface layer has been thinned by erosion.

Included with this soil in mapping are areas of soils that have a surface layer of silty clay loam. These soils have been eroded to the extent that the upper part of the subsoil is mixed with the plow layer.

Most areas of this soil are used for crops. A few areas have been reseeded to native grass. The main dryland crops are wheat and sorghum.

The hazard of erosion is moderate. The main concern of management is controlling water erosion and soil blowing. As a result of erosion this soil is slightly more difficult to cultivate, and because of reduced tilth and soil structure, the permeability of the surface layer is somewhat slower. Terracing, contour farming, grassed waterways, and stubble-mulch tillage help conserve moisture and control soil blowing and water erosion. Dryland capability unit IIe–1; irrigated capability unit IIe–1; Loamy Upland range site; windbreak suitability group 2.

Hs—Holdrege silt loam, 3 to 6 percent slopes. This sloping soil is on narrow ridges adjacent to the more sloping uplands. Most areas are relatively narrow. This soil has a profile similar to the one described as representative of the series, but the subsoil is less clayey, the combined surface layer and subsoil are generally thinner, and lime has not been so deeply leached.

Included with this soil in mapping are small areas of Uly soils along the crests of ridges and on the lower parts of slopes. Small areas of eroded soils, in which the surface layer is thinner and lime is nearer the surface, are shown on the detailed soil map by a spot symbol.

The hazard of erosion is moderate to severe.

Some areas of this soil are cultivated, but many areas are in native grass and are used for grazing. The main crops are wheat and sorghum. The main concern in managing cropped areas is controlling erosion and soil blowing. Terracing, contour farming, grassed waterways, and stubble-mulch tillage help conserve moisture and control soil blowing and water erosion. In areas used for range, deferred grazing, rotation grazing, water development, and proper stocking rates help maintain a desirable stand of native grass. Dryland capability unit IIIe–1; Loamy Upland range site; windbreak suitability group 2.

Ht—Holdrege silt loam, 3 to 6 percent slopes, eroded. This sloping soil is on narrow ridges adjacent to the more sloping uplands. Most areas are relatively narrow. This soil has a profile similar to the one described as representative of the series, but the surface layer has been thinned by erosion. In many areas the surface layer is lighter-colored than the original surface layer because it has been mixed with the subsoil.

Included with this soil in mapping are small areas of Uly soils. Also included are a few small areas of soils where severe erosion has exposed the underlying material and the surface layer is now pale-brown, calcareous silt loam.

The hazard of erosion is moderate to severe.

Most areas of this soil are cultivated, but some areas have been reseeded to native grass and are used for grazing. The main crops are wheat and sorghum. The main concern in managing cropped areas is controlling erosion and soil blowing. Terracing, contour farming, grassed waterways, and stubble-mulch tillage help conserve moisture and control soil blowing and water erosion. In areas used for range, deferred grazing, rotation grazing, and proper stocking rates help maintain a desirable stand of native grass. Dryland capability unit IIIe–1; Loamy Upland range site; windbreak suitability group 2.

Hord Series

The Hord series consists of deep, well-drained, nearly level soils on stream terraces. These soils formed in silty alluvium modified by loess. Slopes are 0 to 1 percent. The native vegetation is mid and tall prairie grasses.

In a representative profile the surface layer is silt loam about 16 inches thick. The upper part of the surface layer is grayish brown, and the lower part is dark grayish brown (fig. 7). The subsoil is grayish-brown, friable silt loam about 30 inches thick. The underlying material is light-gray silt loam.

Permeability is moderate, the available water capacity is very high, and runoff is slow. Fertility is high.

Hord soils are well suited to farming and are well suited to wildlife that use open land as habitat. Limitations for many nonfarm uses are slight.

Representative profile of Hord silt loam, in a cultivated field, 1,000 feet east and 150 feet north of the center of sec. 4, T. 3 S., R. 23 W.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable; many fine roots; neutral; gradual, smooth boundary.

A12—7 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

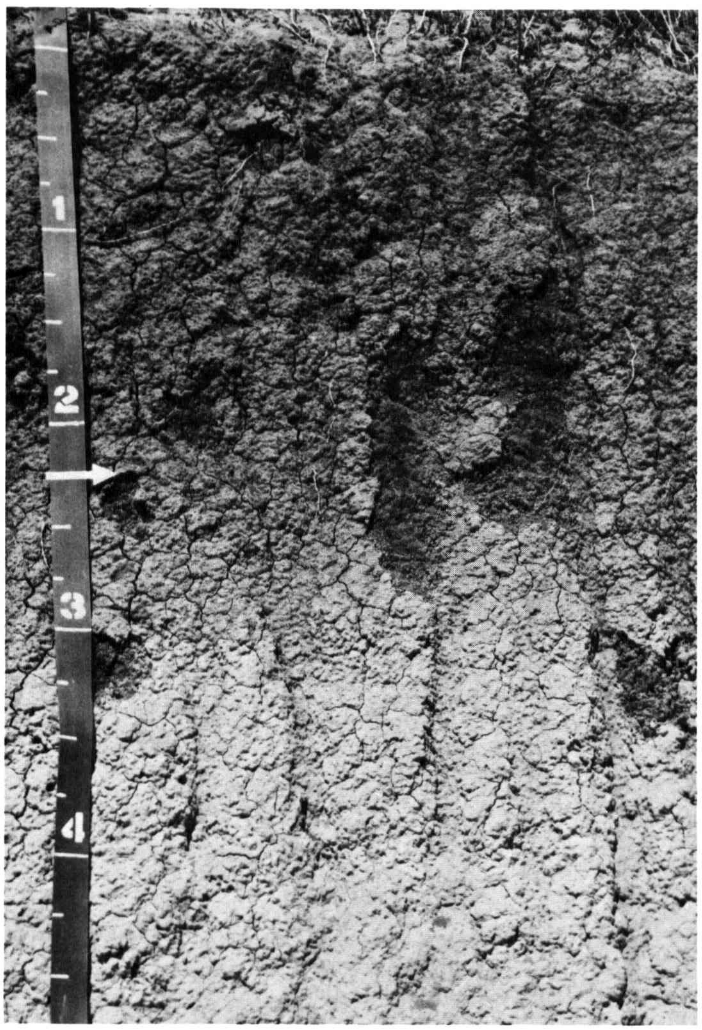


Figure 7.—**Soil profile of Hord silt loam. This soil has a dark-colored surface layer and subsoil.**

B2—16 to 30 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish-brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable; common worm casts; neutral; clear, smooth boundary.

B3—30 to 46 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

C—46 to 60 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; massive; slightly hard, friable; strongly effervescent; moderately alkaline.

The solum is neutral in the upper part and neutral or mildly alkaline in the lower part. The A horizon ranges from dark gray or dark grayish brown to gray or grayish brown and is about 10 to 18 inches thick. It is generally silt loam but is silty clay loam in a few places. The B horizon ranges from dark grayish-brown to light brownish-gray silt loam or silty clay loam. The B2 horizon is 10 to 15 inches thick, and the B3 horizon is 10 to 18 inches thick. The depth of free lime ranges from about 22 to 48 inches, but it averages 32 inches. In some places lime occurs in the B3 horizon. The C horizon is mainly light gray, light brownish gray, or pale brown.

Hord soils are near Cozad, Detroit, Hobbs, Munjor, Roxbury, and in some places, Holdrege soils. Hord soils are leached of lime to a greater depth than Cozad soils, and their dark colors extend to a greater depth. They differ from Detroit soils in that they lack a Bt horizon. They are less stratified than Hobbs soils, and they occupy higher areas. Hord soils are finer textured throughout and have dark colors that extend to a greater depth than Munjor soils. They are leached of lime to a greater depth than Munjor and Roxbury soils, and they lack a Bt horizon.

Hz—Hord silt loam. This nearly level soil is on stream terraces. The areas are large and run parallel to and higher than the flood plains along the larger streams in the county and are high enough that they are not flooded in most years.

Included with this soil in mapping are a few small areas of Cozad and Detroit soils. Also included are some terrace escarpments or short steep side slopes where the terraces grade to the flood plains. These areas are generally long and narrow and less than 100 feet wide. Also included are narrow areas of broken alluvium soils. A few depressions that are 5 acres or less in size are shown on the detailed soil map by a spot symbol.

The hazard of erosion is slight.

The main crops are wheat, corn, sorghum, and alfalfa. A large acreage of this soil is irrigated, and is used for corn, sorghum, and alfalfa. The main concern of management is the maintenance of tilth and fertility. Use of crop residue, proper distribution of water, and the use of fertilizer are desirable management practices in irrigated areas. Land leveling is generally necessary for the most efficient application of water. Dryland capability unit IIc–2; irrigated capability unit I–2; Loamy Terrace range site; windbreak suitability group 1.

Munjor Series

The Munjor series consists of deep, well-drained, nearly level soils on flood plains or bottom lands. These soils formed in calcareous, moderately coarse textured alluvium. The native vegetation is tall grasses, dominantly sand bluestem, switchgrass, and indiangrass.

Scattered deciduous trees grow in some areas but are not native.

In a representative profile the surface layer is light brownish-gray sandy loam about 6 inches thick. The next layer is light-gray, very friable, sandy loam about 9 inches thick. The underlying material is very pale brown sandy loam.

Permeability is moderately rapid, the available water capacity is moderate, and runoff is slow. Fertility is low.

Munjor soils are well suited to farming. Limitations for many nonfarm uses are moderate to severe because the soils are subject to flooding.

Representative profile of Munjor sandy loam, in a cultivated field, 1,000 feet east and 700 feet south of the northwest corner of sec. 9, T. 3 S., R. 23 W.

A1—0 to 6 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; many fibrous roots; slightly effervescent; mildly alkaline; clear, smooth boundary.

AC—6 to 15 inches, light-gray (10YR 7/2) sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; few fibrous roots; slightly effervescent; mildly alkaline; gradual, smooth boundary.

C—15 to 60 inches, very pale brown (10YR 7/3) stratified layers of sandy loam and loamy sand that have an average texture of sandy loam, brown (10YR 5/3) when moist; single grained; soft, very friable; few fibrous roots; strongly effervescent; moderately alkaline.

The depth to free carbonates is less than 10 inches. In many places, at a depth of 20 inches or more, evidence of stratification is shown by small, discernible variations in color and content of sand.

The A1 horizon is dark grayish brown, grayish brown, or light brownish gray. It is typically sandy loam but is loamy sand or loam in some places. It is 3 to 15 inches thick and is mildly alkaline.

The AC horizon ranges from light gray or very pale brown to grayish-brown or brown loam to sandy loam 8 to 20 inches thick. It is mildly or moderately alkaline.

The C horizon ranges from very pale brown or pale brown to grayish brown or light gray. It is stratified with sandy loam, silt loam, loamy sand, and loam but has an average texture of fine sandy loam. It is moderately alkaline. In some profiles faint mottles are below a depth of 30 inches.

Munjor soils are near the Roxbury and Hord soils. Munjor soils have a lighter-colored A horizon than the Roxbury and Hord soils and are sandy loam throughout. They are not leached of lime to so great a depth as the Hord soils.

Mu—Munjor complex. These nearly level soils are on flood plains along the major streams of the county. Most areas are long and narrow and are dissected by a stream channel in some places. The slopes are 0 to 1 percent.

Included with these soils in mapping are small areas of Roxbury soils. Also included are long, narrow areas of entrenched stream channels that are not arable and that are bordered by deciduous trees in many places.

The hazard of erosion is slight to moderate.

Most areas are used for crops, mainly wheat, sorghum, and alfalfa. The main concerns of management are maintaining moisture and tilth and controlling soil blowing. In some years flooding delays planting or harvesting, and in other years it damages crops. This soil blows if it lacks a protective cover of residue or vegetation. Stubble-mulch tillage helps conserve moisture and control soil blowing. Dryland capability unit IIIw–1; irrigated capability unit IIw–2; Sandy Lowland range site; windbreak suitability group 1.

Penden Series

The Penden series consists of deep, well-drained, sloping to moderately steep soils on uplands. These soils formed in calcareous loamy sediment that is modified in the upper part by loess that is more silty. Slopes are 6 to 20 percent. Penden soils are on eroded, dissected uplands that are adjacent to the more deeply entrenched streams in the county. The dominant native vegetation is side-oats grama, little bluestem, western wheatgrass, and forbs, but there are lesser amounts of big bluestem and switchgrass. In this county Penden soils are mapped only in a complex with the Uly soils.

In a representative profile the surface layer is loam about 15 inches thick. The upper 10 inches of the surface layer is dark grayish brown, and the lower 5 inches is grayish brown. The subsoil is pale-brown, friable heavy loam about 9 inches thick. The underlying material, to a depth of 60 inches, is very pale brown loam.

Permeability is moderate and moderately slow, the available water capacity is moderate to high, and runoff is medium to rapid. Fertility is medium.

Because the soils are sloping to moderately steep, they are better suited to grazing than to farming. Most areas are in native grass. Because the soils are sloping to moderately steep, they have moderate to severe limitations for many nonfarm uses.

Representative profile of Penden loam, in an area of Uly-Penden complex, 6 to 20 percent slopes, in range, 600 feet east and 120 feet north of the southwest corner of sec. 1, T. 3 S., R. 22 W.

A11—0 to 10 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard, friable; many fibrous roots; slightly effervescent; mildly alkaline; gradual, smooth boundary.

A12—10 to 15 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable; many fibrous roots; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B2—15 to 24 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 5/3) when moist; weak, medium, granular structure; hard, friable; few fibrous roots, few fine threads and soft bodies of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1ca—24 to 43 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard, friable; many soft bodies of lime; violently effervescent; moderately alkaline; diffuse boundary.

C2—43 to 60 inches, very pale brown (10YR 8/3) loam, pale brown (10YR 6/3) when moist; massive; common soft bodies of lime; violently effervescent; moderately alkaline.

Free carbonates are within 10 inches of the surface and, in most places, occur in the A1 horizon. The A horizon is brown, dark grayish brown, or grayish brown and is about 8 to 20 inches thick. It is typically loam but is silt loam in some places. The B2 horizon is pale-brown, light brownish-gray, or grayish-brown loam to clay loam 5 to 10 inches thick. The C1ca horizon ranges from about 15 to 22 percent free carbonates.

Penden soils are near Campus, Wakeen, Canlon, Coly, Holdrege, and Uly soils. Penden soils are deeper than Campus and Wakeen soils, in which the depth to beds of caliche or chalky limestone is 20 to 40 inches. They are deeper than Canlon soils, in which the depth to caliche bedrock is less than 20 inches. Penden soils have a darker colored surface layer than Coly soils and contain more sand. They are typically calcareous nearer the surface and contain more sand than Holdrege and Uly soils, which formed in loess, and they have a less clayey B horizon than Holdrege soils.

Roxbury Series

The Roxbury series consists of deep, well drained to moderately well drained, nearly level soils on flood plains and stream terraces. These soils formed in calcareous silty alluvium. Slopes are mainly 0 to 1 percent. The native vegetation is mid and tall prairie grasses.

In a representative profile the surface layer is grayish-brown silt loam about 19 inches thick. The subsoil is grayish-brown, friable silt loam about 17 inches thick. The underlying material is light brownish-gray silt loam.

Permeability is moderate, the available water capacity is very high, and runoff is medium to low. Fertility is high.

Roxbury soils are well suited to farming. Limitations for many nonfarm uses are severe because the soils are subject to flooding.

Representative profile of Roxbury silt loam, in a cultivated field, 700 feet north and 200 feet west of the southeast corner of sec. 36, T. 2 S., R. 23 W.

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard, friable; few fine roots; slightly effervescent; mildly alkaline; clear, smooth boundary.

A12—6 to 19 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many fine pores; common worm casts; slightly effervescent; mildly alkaline; gradual, smooth boundary.

B21—19 to 29 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard, friable; strongly effervescent; moderately alkaline; gradual, smooth boundary.

B22—29 to 36 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; slightly hard, friable; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—36 to 60 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard, friable; strongly effervescent; moderately alkaline.

The depth to free carbonates is less than 15 inches. This soil is mildly or moderately alkaline throughout. In many places, at a depth of 25 inches or more, evidence of stratification is shown by small but discernible variations in color and content of clay.

The A horizon is grayish-brown or dark grayish-brown silt loam or light silty clay loam 10 to 24 inches thick.

The B2 horizon is light-gray, light brownish-gray, or grayish-brown silt loam or light silty clay loam 12 to 20 inches thick.

The C horizon ranges from grayish-brown or brown to light-gray or very pale brown silt loam to loam. In some places the C horizon has strata of fine sandy loam below a depth of 40 inches.

Roxbury soils are near Hord, Hobbs, Cozad, Munjor, and Detroit soils. Roxbury soils are not leached of lime at so great a depth as the Hord and Hobbs soils. They have dark colors that extend to a greater depth than those in the Cozad and Munjor soils, and they have a lower content of sand throughout than the Munjor soils. Roxbury soils do not have so clayey a B horizon and are not leached of lime to so great a depth as Detroit soils.

Rx—Roxbury silt loam. This nearly level soil is on broad flood plains and low terraces along the major streams of the county. Most areas are long and narrow and are dissected by the stream channel. Slopes are 0 to 1 percent.

Included with this soil in mapping are small areas of Munjor soils. Also included are long, narrow areas of entrenched stream channels that are not arable and that are bordered by deciduous trees in most places.

The hazard of erosion is slight.

Most areas of this soil are used for crops, mainly wheat, sorghum, alfalfa, and corn. A few areas are irrigated. This soil has slight limitations for crops because it is occasionally flooded. In some years flooding delays planting or harvesting, and in other years it is beneficial because it provides extra water for crop growth. In some places this soil blows when dry if it lacks a protective cover of vegetation or crop residue. Stubble-mulch tillage and proper crop residue management help control soil blowing and conserve moisture. Limitations to the use of this soil for many nonfarm purposes are severe because of the flooding. Dryland capability unit IIc-2; irrigated capability unit I-2; Loamy Terrace range site; windbreak suitability group 1.

Uly Series

The Uly series consists of deep, well drained to somewhat excessively drained, sloping to moderately steep soils on uplands. These soils formed in thick, calcareous loess. Slopes are mainly 6 to 20 percent. The native vegetation is big and little bluestem, buffalograss, sideoats grama, blue grama, and western wheatgrass.

In a representative profile the surface layer is dark grayish-brown silt loam about 9 inches thick. The subsoil is grayish-brown, light brownish-gray, and very pale brown, friable silt loam about 19 inches thick. The underlying material is very pale brown silt loam (fig. 8).

Permeability is moderate, the available water capacity is very high, and runoff is medium to rapid. Fertility is medium.

Some areas of Uly soils are cultivated, but these soils are not well suited to crops because of the slope and the hazard of erosion. Many areas that were once cultivated have been seeded back to native grass. Because the soils are sloping to moderately steep, they have moderate to severe limitations for many nonfarm uses. Uly soils are well suited to wildlife that use open land and range as habitat.

Representative profile of Uly silt loam, 6 to 10 percent slopes, in native grass, 850 feet west and 640 feet

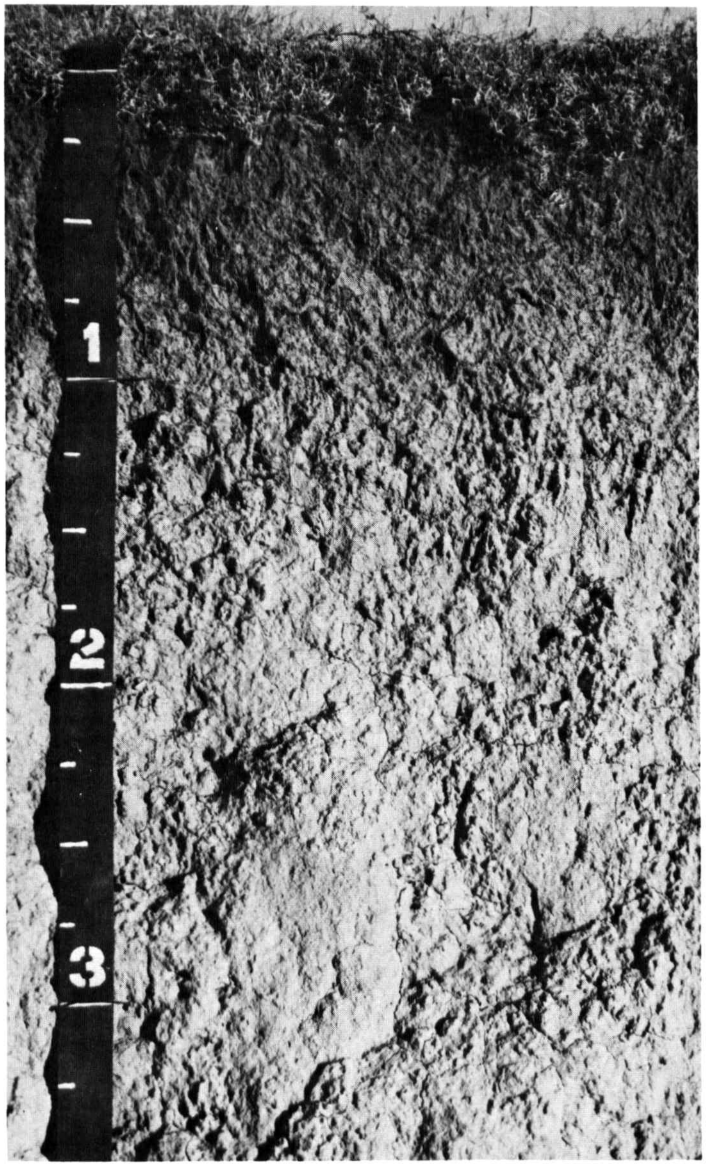


Figure 8.—**Profile of Uly silt loam under a cover of buffalograss.**

north of the southeast corner of the northeast quarter of sec. 3, T. 1 S., R. 23 W.

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard, friable; common fibrous roots; neutral; gradual, smooth boundary.

B1—9 to 13 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard, friable; common fibrous roots; neutral; gradual, smooth boundary.

B2—13 to 20 inches, light brownish-gray (10YR 6/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, granular structure; hard, friable; common fibrous roots; mildly alkaline; clear, wavy boundary.

B3—20 to 28 inches, very pale brown (10YR 7/3) silt loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; common coatings and threads of lime; strongly effervescent; moderately alkaline; gradual, wavy boundary.

C—28 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; massive; slightly hard, friable; few large roots and root channels; common coatings and threads of lime; strongly effervescent; moderately alkaline.

The depth to free carbonates is typically more than 8 inches. The A horizon is grayish-brown or dark grayish-brown silt loam or light silty clay loam and is 6 to 12 inches thick. It ranges from slightly acid to mildly alkaline.

The B horizon ranges from very pale brown or light gray to dark grayish brown. It is silt loam to silty clay loam 6 to 24 inches thick.

The C horizon ranges from light brown to light gray or very pale brown. Free carbonates in the form of threads, coatings, and soft masses are common in the C horizon.

Uly soils are near Coly, Penden, Wakeen, and Holdrege soils. They have a darker A horizon than the Coly soils. They contain less sand and are typically leached of lime to a greater depth than the Penden soils. Uly soils are deeper than the Wakeen soils, which are underlain by chalky limestone. They have free carbonates nearer the surface than the Holdrege soils and do not have a developed Bt horizon.

Ub—Uly silt loam, 6 to 10 percent slopes. This sloping soil is on uplands. Areas are small to large and are narrow. Most areas are adjacent to intermittent upland drainageways and are along perennial streams where they are dissected and rolling. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Coly and Holdrege soils. Severely eroded soils that have a thinner surface layer and have lime nearer the surface, generally 5 acres or less, are shown on the detailed soil map by a spot symbol.

Runoff is medium to rapid, and the hazard of erosion is severe.

Some areas are cultivated, but the soil is not well suited to crops because of the slope and the hazard of erosion. The main crops are wheat and sorghum. The main concern of management is controlling erosion. In most cultivated areas, water erosion has removed part of the original surface layer, and tillage has mixed part of the lighter colored subsoil material with the remaining surface layer. Terracing, contour farming, and stubble-mulch tillage help conserve moisture and control soil blowing and runoff.

Most areas of this soil are in native grass and are used for grazing. The dominant vegetation is mid and short grasses. Range management practices, such as deferred grazing, rotation grazing, and proper stocking rates, help maintain a desirable stand of native grass. Dryland capability unit IVe–1; Loamy Upland range site; windbreak suitability group 3.

Uc—Uly complex, 10 to 20 percent slopes. This mapping unit consists of strongly sloping to moderately steep soils on uplands. It is in wide, nonarable valleys along upland drainageways in the more dissected areas of deep loess. The sides of the drainageways have slopes of 10 to 20 percent. Loess breaks, alluvial soils, and soils similar to Uly soils are on the lower parts of the side slopes.

Included with this complex in mapping are areas of Penden soils. Areas of rock outcrops, generally 5 acres or less in size, are shown on the soil map by a spot symbol.

Runoff is rapid, and the hazard of erosion is severe.

The soils in this complex are better suited to range than to other uses because of the variable slopes and, in some places, rock outcrops. The dominant vegetation is mid and short grasses. The main concern of management is controlling erosion. Range management practices, such as deferred grazing, rotation grazing, water development, and proper stocking rates, help maintain a desirable stand of native grass. A few small areas are cultivated with adjoining larger areas of arable soils. Dryland capability unit VIe–1; Loamy Upland range site; windbreak suitability group 3.

Up—Uly-Penden complex, 6 to 20 percent slopes. This mapping unit consists of sloping to moderately steep soils on uplands. It is about 44 percent Uly soils, 40 percent Penden soils, 10 percent Campus soils, and 6 percent Canlon soils. The soils formed in three different kinds of parent material. The Uly soils formed in relatively thin silty loess, and the Penden soils formed in calcareous loamy sediment. The Campus and Canlon soils formed in material weathered from underlying caliche. A Penden soil in this mapping unit has the profile described as representative of the Penden series.

Rock outcrops, generally 5 acres or less in size, are shown on the detailed soil map by a spot symbol.

Runoff is rapid, and the hazard of erosion is severe. The main concern of management is controlling erosion.

The soils in this complex are better suited to range than to other uses because of the variable slopes and, in some places, rock outcrops. The dominant vegetation is mid and short grasses. The main concern of management is controlling erosion. Range management practices, such as deferred grazing, rotation grazing, water development, and proper stocking rates, help maintain a desirable stand of native grass. A few small areas are cultivated with adjoining larger areas of arable soils. Dryland capability unit VIe–1; Uly soil in Loamy Upland range site, Penden soil in Limy Upland range site; windbreak suitability group 3.

Wakeen Series

The Wakeen series consists of moderately deep, well-drained, sloping to moderately steep soils on uplands. These soils formed in material weathered from chalky limestone. Slopes are mainly 6 to 20 percent. The native vegetation is mid and tall prairie grasses.

In a representative profile the surface layer is grayish-brown silt loam about 8 inches thick. The subsoil is about 30 inches thick. It is pale-brown, friable light silty clay loam in the upper part of the subsoil and very pale brown, friable silt loam in the lower part. Chalky limestone is at a depth of 38 inches.

Permeability is moderate, the available water capacity is moderate, and runoff is medium to rapid. Fertility is medium.

Because the soils are sloping to moderately steep, they are better suited to grazing than farming. Most areas are in native grass. Because the soils are sloping and moderately deep, they have moderate to severe limitations for many nonfarm uses.

Representative profile of Wakeen silt loam, in range, 1,600 feet south and 250 feet east of the northwest corner of sec. 21, T. 4 S., R. 21 W.

A1—0 to 8 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard, friable; many fibrous roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

B2—8 to 20 inches, pale-brown (10YR 6/3) light silty clay loam, dark brown (10YR 4/3) when moist; moderate, fine, subangular blocky structure parting to moderate, fine, granular; slightly hard, friable; many fine roots; few, small, weathered fragments of chalk; violently effervescent; moderately alkaline; gradual, smooth boundary.

B3—20 to 38 inches, very pale brown (10YR 8/4) silt loam, light yellowish brown (10YR 6/4) when moist; weak, coarse, prismatic structure; slightly hard, friable; few soft lumps and fragments of chalk in lower part; few roots; violently effervescent; strongly alkaline; clear, smooth boundary.

C—38 inches, yellow (10YR 7/6) semi-indurated chalk.

The depth to chalky limestone ranges from 20 to 40 inches. The depth to carbonates is less than 12 inches.

The A horizon ranges from very dark grayish brown or dark brown to grayish brown or brown. It is silt loam or light silty clay loam 7 to 18 inches thick.

The B horizon ranges from grayish brown or brown to light gray or very pale brown. It is silt loam or silty clay loam about 6 to 15 inches thick. The B3 horizon ranges from light brownish gray or pale brown to nearly white or very pale brown. It is silt loam or loam that contains common soft chalk fragments and is 8 to 20 inches thick.

Wakeen soils are near Campus, Canlon, Penden, and Uly soils. Wakeen soils are in areas similar to those in which the Campus and Canlon soils occur, but they are underlain by semi-indurated chalk instead of caliche. They are deeper than the Canlon soils. They are not so deep as the Penden and Uly soils and are underlain by chalky limestone.

Wa—Wakeen complex, 6 to 20 percent slopes. This mapping unit consists of sloping to moderately steep soils on uplands. It is mainly in nonarable upland valleys where geologic erosion has exposed outcrops of chalky limestone.

Four major soils make up this mapping unit. Wakeen is the dominant soil and makes up 50 percent of the unit. Uly soils make up 20 percent of the unit. Shallow soils that are similar to Wakeen soils but have chalky limestone at a depth of less than 20 inches make up 20 percent of the unit. Penden soils make up 10 percent of the unit.

Runoff is rapid, and the hazard of erosion is severe. The main concern of management is controlling erosion.

The soils in this complex are better suited to range than to other uses because of the variable slopes and the limited depth of the root zone. In some places the available water capacity is restricted because of the depth to limestone. The dominant vegetation is mid and short grasses. In areas used for range, planned grazing systems, water development, fencing, and proper stocking rates, and other practices help maintain a desirable stand of native grass. Dryland capability unit VIe–3; Limy Upland range site; windbreak suitability group 3.

Use and Management of the Soils

The soils of Norton County are used mainly for growing crops and, to a lesser extent, for grazing. According to the Conservation Needs Inventory of 1967 (*8*), about 56 percent of the county is dryfarmed and about 2 percent is irrigated.

In this section, the use of soils for both dryland and irrigated crops is discussed. The section includes an outline of the capability groups of the soils in the county and a table of predicted yields for both dryland and irrigated crops. Use of the soils for windbreaks, range, habitat, recreation, and engineering is also discussed.

Management of Soils for Dryfarmed Crops [2]

In Norton County the management of soils for dryland crops consists of a combination of practices that reduce water erosion and soil blowing, help maintain good soil structure and an adequate organic-matter content, and conserve as much rainfall as possible. Erosion control and water conservation are most successful if a proper combination of practices is used.

Terracing and contour farming help reduce water erosion and conserve rainfall on all of the sloping soils in the county. These practices, alone or in combination, are also beneficial on some nearly level soils that have long slopes. Each row planted on the contour acts as a miniature terrace; it holds the water back and lets it soak into the soil. The water that is saved by terracing and contour farming increases crop growth, which in turn adds to the amount of residue available to protect the soil.

Proper management of crop residue is necessary on all of the soils in Norton County. This practice helps maintain good soil structure, improves the infiltration of water, and helps control both water erosion and soil blowing. A cover of residue on the surface helps hold the soil in place and reduces the puddling effect of beating raindrops.

Minimum or reduced tillage helps prevent the breakdown of soil aggregates and maintains more residue on the surface. Tilling when the soil is too wet causes a tillage pan to form, particularly in the loam and silt loam soils.

Stripcropping is another measure that helps control soil blowing (fig. 9). This practice is generally used in combination with a good crop residue management program, minimum tillage, and a good fertility program. Stripcropping is especially beneficial on some of the nearly level soils that have a surface layer of sandy loam or loam.

Wheat and grain sorghum are the major crops grown in Norton County. Some alfalfa is grown in the county. It is grown mainly on bottom lands, but some is grown on uplands. Forage sorghum is also grown. The sequence of crops grown affects the combination of

[2] EARL BONDY, conservation agronomist, Soil Conservation Service, helped prepare this section.

Figure 9.—**Contour farming with strips of newly seeded wheat and wheat stubble on Holdrege silt loam.**

management practices needed on a particular soil. Wheat and other close-growing crops provide more protection for the soil than row crops, and the residue from wheat provides more protection than the residue from grain sorghum.

Management of Soils for Irrigated Crops [3]

The factors to be considered in planning an irrigation system are the characteristics and properties of the soil, the quality and quantity of irrigation water available, the crops to be irrigated, and the type of irrigation system to be used. It is especially important to know the quality of the irrigation water so that the longtime effect of irrigation on the soil can be evaluated. All natural water used for irrigation contains some soluble salts. If water of poor quality is used on a soil that has slow permeability, harmful salts are likely to accumulate in the soil unless some leaching is done. This requires an application of water in excess of the need of the crop so that some of the water passes through the root zone, carrying the salts with it.

Some of the soil factors that are important to irrigation are depth, available water capacity, permeability, drainage, slope, and susceptibility to stream overflow. All of these must be considered in designing the irrigation system. (fig. *10*). The frequency of irrigation depends on the requirements of the crop and the available water capacity of the soil. The available water capacity is determined mainly by the depth and texture of the soil. Permeability affects the rate at which water enters the soil, as well as the internal drainage. The rate of water intake is also affected by the condition of the surface layer.

The soil survey has determined the characteristics of each soil in the county. Permeability and available water capacity are listed for each soil in table 6 in the section "Engineering Uses of the Soils." Soil features affecting irrigation of the soils are given in table 7 in the engineering section.

Corn, grain sorghum, and alfalfa are the main irrigated crops grown in Norton County.

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage in the same manner some of the different kinds of soil on their farms. These readers can make good use of the capability classification system, a grouping that shows, in

[3] Earl Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

Figure 10.—**Irrigation water management for corn on Hord silt loam in the Prairie Dog Valley.**

a general way, the suitability of soils for most kinds of field crops.

The grouping is based on permanent limitations of soils when they are used for field crops, the risk of damage when they are farmed, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range or for engineering.

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

The subclass indicates major kinds of limitations within the classes. The subclasses are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes 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, or stony; and *c* shows 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 are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, or wildlife habitat.

Subclasses are further divided into capability units. These are groups of soils that are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Capability units are generally designated by numbers assigned locally, for example, IIc-2 and IIIe-1.

The eight classes in the capability system and the subclasses and units in Norton County are described in the lists that follow. The capability unit for each soil in the county is given in the "Guide to Mapping Units."

Irrigated capability units

Class I. Soils that have few limitations that restrict their use.
- (No subclasses.)
  - Unit I-1. Deep, nearly level, well-drained silt loams that have a subsoil of silty clay loam; on uplands.
  - Unit I-2. Deep, nearly level, well drained to moderately well drained silt loams that have a subsoil of silt loam; on stream terraces.
  - Unit I-3. Deep, nearly level, well drained to moderately well drained silty clay loams that have a subsoil of silty clay loam; on stream terraces.

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils that are subject to moderate erosion unless they are protected.
  - Unit IIe-1. Deep, gently sloping, well-drained silt loams that have a subsoil of silty clay loam; on uplands.
  - Unit IIe-2. Deep, gently sloping, well-drained silt loams that have a subsoil of silt loam; on stream terraces.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Unit IIw-1. Deep, nearly level, well drained to moderately well drained, frequently flooded silt loams; on flood plains.
  - Unit IIw-2. Deep, nearly level, well drained to moderately well drained, frequently flooded sandy loams; on flood plains.

Dryland capability units

Class I. Soils that have few limitations that restrict their use. (None in Norton County.)

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils that are subject to moderate erosion unless they are protected.
  - Unit IIe-1. Deep, gently sloping, well-drained silt loams that have a subsoil of silty clay loam; on uplands.
  - Unit IIe-2. Deep, gently sloping, well-drained silt loams that have a subsoil of silt loam; on stream terraces.
- Subclass IIc. Soils that are subject to climatic limitations of temperature or lack of moisture.
  - Unit IIc-1. Deep, nearly level, well-drained silt loams that have a subsoil of silty clay loam; on uplands and high terraces.
  - Unit IIc-2. Deep, nearly level, well-drained silt loams that have a subsoil of silt loam; on stream terraces.
  - Unit IIc-3. Deep, nearly level, well drained to moderately well drained silty clay loams that have a subsoil of silty clay loam; on stream terraces.
- Subclass IIw. Soils that are moderately limited because of excess water.
  - Unit IIw-1. Deep, nearly level, well drained to moderately well drained, frequently flooded silt loams; on flood plains.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe. Soils that are subject to severe erosion if they are cultivated and not protected.

Unit IIIe–1. Deep, sloping, well-drained silt loams that have a subsoil of silty clay loam; on uplands.

Subclass IIIw. Soils that are severely limited for cultivation because of excess water.

Unit IIIw–1. Deep, nearly level, well drained to moderately well drained, frequently flooded sandy loams; on flood plains.

Class IV. Soils that have very severe limitations that reduce the choice of plants, require very careful management, or both.

Subclass IVe. Soils that are subject to very severe erosion if they are cultivated and not protected.

Unit IVe–1. Deep, sloping, well-drained to somewhat excessively drained soils that are silt loam throughout; on uplands.

Class V. Soils that are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat. (None in Norton County.)

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe. Soils that are severely limited, chiefly by risk of erosion, unless protective cover is maintained.

Unit VIe–1. Deep, strongly sloping to moderately steep, well-drained to somewhat excessively drained soils that are silt loam throughout; on uplands.

Unit VIe–2. Deep and moderately deep, strongly sloping to moderately steep, well-drained to somewhat excessively drained loams and silt loams; on uplands.

Unit VIe–3. Moderately deep and shallow, sloping to steep, well-drained to somewhat excessively drained loams and silt loams; on uplands.

Class VII. Soils that have very severe limitations that make them unsuited to cultivation and restrict their use largely to range, woodland, or wildlife habitat. (None in Norton County.)

Class VIII. Soils and landforms that have limitations that preclude their use for commercial crops and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (None in Norton County.)

Predicted Yields

The predicted average yields per acre that can be expected for the principal crops grown in the county are shown in table 2. These yields do not apply to any specific field in any particular year. Rather, they indicate what can be expected as an average yield over a period of years. The estimates in the table were made on the basis of information obtained from local farmers, various agricultural agencies, demonstration plots, and research data.

Only the soils commonly used for crops are listed in table 2. The predicted yields are for a high level of management that includes the following:

1. Crop varieties are suited to the area.
2. Proper seeding rates are used. Methods of planting and harvesting are suitable and timely.
3. Full and timely practices are used for controlling weeds, diseases, and insects.
4. Tillage is timely.
5. A fertility program is used that is based on the

TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*

[Only the soils suitable for cultivation are listed. Dashes indicate that the soil is not suited to the crop or is not irrigated]

Name	Dryland				Irrigated			
	Wheat	Forage sorghum	Grain sorghum	Alfalfa	Grain sorghum	Corn (silage)	Alfalfa	Corn
	Bu	*Tons*	*Bu*	*Tons*	*Bu*	*Tons*	*Tons*	*Bu*
Coly and Uly silt loams, 6 to 10 percent slopes, eroded	22	2.4	24	1.8	------	------	------	------
Cozad silt loam, 0 to 2 percent slopes	34	4.0	48	2.8	120	20	6.0	130
Cozad silt loam, 2 to 5 percent slopes	32	3.6	44	2.6	105	19	5.0	120
Detroit silty clay loam	36	4.0	52	3.2	120	21	6.4	140
Hobbs silt loam	32	4.0	48	3.5	105	19	5.5	130
Holdrege silt loam, 0 to 1 percent slopes	36	3.4	50	2.5	122	20	6.0	140
Holdrege silt loam, 1 to 3 percent slopes	35	3.2	46	2.2	120	19	6.0	130
Holdrege silt loam, 1 to 3 percent slopes, eroded	32	3.2	42	2.0	115	18	5.8	120
Holdrege silt loam, 3 to 6 percent slopes	30	3.0	40	1.9	------	------	------	------
Holdrege silt loam, 3 to 6 percent slopes, eroded	28	2.8	36	1.8	------	------	------	------
Hord silt loam	35	4.0	52	3.1	130	21	6.4	140
Munjor complex	28	3.0	40	2.5	105	18	5.0	110
Roxbury silt loam	32	4.0	56	3.4	110	19	6.0	130
Uly silt loam, 6 to 10 percent slopes	24	2.4	30	1.8	------	------	------	------

requirements for optimum efficiency in crop production.

6. Terraces, contour farming, grassed waterways, stubble-mulch tillage, and summer fallow are used to conserve moisture and control runoff.
7. Cropping systems and crop residue management are used to control water erosion and soil blowing and to help maintain the condition of the soil.

Windbreaks

A well-placed windbreak, properly spaced and cared for, is a practical and esthetic improvement to the farmstead. Windbreaks prevent snow from drifting into yards, protect livestock, reduce the cost of feeding livestock and of heating homes, protect gardens, and attract insect-eating birds and other wildlife, such as quail, pheasant, and rabbit.

There are no native forests or woodlands in Norton County. Cottonwood, willow, red elm, American elm, green ash, wild plum, boxelder, and hackberry grow along most of the streams and drainageways, but no large areas are wooded. In Norton County trees have been planted to protect and beautify the farmsteads since early settlement. A few plantings and timber claims were established in the 1880's, and some of these still grow. Currently, the only tree plantings in the county are for windbreaks, for shade or ornamental purposes on farmsteads, or in yards in urban areas.

Windbreaks should be carefully designed and laid out before the trees are planted. Species of trees and shrubs that are best suited to the soils of the area should be selected. A weak establishment or low survival rate of windbreak plantings is generally caused by insufficient moisture conservation and inadequate seedbed preparation. It is essential that a firm, weed-free seedbed be prepared before the trees are planted. On most soils in Norton County, areas to be planted should be prepared in the same way as for field crops. Trees should be planted early in spring. The seedlings should be protected from drying out while they are being planted. As tree and shrub seedlings are planted, soil should be firmly tamped around the roots. Areas between tree rows of newly planted windbreaks should be seeded to a cover crop to protect seedlings from winter wind and to hold snow.

For protecting farmsteads or livestock, windbreaks should be at least five rows wide, or wide enough to trap most of the blowing snow. A good wind barrier is provided by planting low shrubs, tall shrubs or trees of medium height, and tall trees. At least a third of the rows should be planted to redcedar, pine, or other suitable evergreens. Redcedars have dense growth near the ground, and pines add height to the windbreaks as they grow older. Because evergreens live longer, they greatly extend the life of the windbreak.

Among the practices needed for proper care of windbreaks are controlling grass and weeds to reduce competition for available moisture. Cultivation controls weeds and also permits water and air to enter the soil more readily. New plantings benefit from extra moisture during the first few days. This moisture can be provided by diverting runoff from other areas, by hauling irrigation water from wells, or by using diversion terraces. Livestock should be excluded from the windbreaks. Practices other than burning are needed to remove the accumulation of loose weeds and trash that is occasionally blown into the windbreaks. Snow or rain usually packs the weeds into mats, which decay and disappear. Protection from fire is important and can be achieved by continuous cultivation for weed control on the isolation strip surrounding the windbreak.

The windbreak suitability group for each soil is listed at the end of the mapping unit description and in the "Guide to Mapping Units." Group 1 consists of deep, well drained to moderately well drained, loamy soils on lowlands. Group 2 consists of deep, well-drained, loamy soils on uplands. Group 3 consists of deep and moderately deep, well drained to somewhat excessively drained, loamy and limy soils on uplands. The soils in group 3 are generally not so well suited to trees, but if they are along the drainageways and areas of alluvium, they may be rated the same as the soils on lowlands.

In table 3 estimated tree heights for the three windbreak suitability groups are shown. The suitability of the soils in each group is rated for particular trees and shrubs. The ratings are *excellent, good, fair,* and *poor*.

The vigor rating of *excellent* indicates that trees grow well, leaves have good color, there are no dead branches in the upper part of the crown, and there is no indication of damage by fungi or disease.

A rating of *good* indicates that trees grow moderately well, there are a few dead branches and some dieback in the upper part of the crown, and there is slight damage by fungi or insects.

A rating of *fair* indicates that tree growth is slow, at least one-half of the trees have a significant number of dead branches in the upper part of the crown, about one-fourth of the trees are dead, and moderate damage by fungi or insects can be expected.

A rating of *poor* indicates that less than three-fourths of the trees planted will survive, the surviving trees have severe dieback, and severe damage by fungi and insects can be expected.

Use of the Soils for Range [4]

In Norton County much of the agricultural income is from the sale of livestock and livestock products. According to the 1971 Farm Facts, Farm Crop and Livestock Information (*6*), about 51 percent of the annual gross income from farms and ranches in the county was from the sale of beef cattle, sheep, and dairy products. The number of cattle, including calves, in the county usually ranges from 42,000 to 60,000.

The major source of livestock forage is native range, but a large amount of crops and their by-products is used for supplemental feed. Approximately

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[4] By HARLAND E. DIETZ, range conservationist, Soil Conservation Service, Salina, Kansas.

TABLE 3.—*Suitability of trees and shrubs for windbreaks*

[The windbreak suitability group for each soil in Norton County is listed at the end of the mapping unit description and in the "Guide to Mapping Units." The estimated height is for trees and shrubs at 20 years of age. The estimated height is not given if the rating is poor]

Trees and shrubs	Windbreak suitability groups					
	Group 1		Group 2		Group 3	
	Vigor	Height	Vigor	Height	Vigor	Height
		Feet		*Feet*		*Feet*
Conifers:						
Eastern redcedar	Excellent	25	Excellent	23	Good	18
Rocky Mountain juniper	Good	30	Good	25	Poor.	
Ponderosa pine	Excellent	30	Fair to good	24	Fair	20
Austrian pine	Excellent	30	Excellent	30	Fair	15
Tall trees:						
Cottonwood	Excellent	45	Fair	30	Poor.	
Siberian elm	Excellent	45	Good	35	Fair	30
Medium trees:						
Green ash	Fair	30	Fair	26	Poor.	
Hackberry	Excellent	30	Fair	21	Fair	19
Bur oak	Excellent	30	Fair	25	Fair	20
Honeylocust	Good	30	Good	25	Fair	20
Short trees:						
Russian-olive	Good	20	Good	15	Fair	15
Russian mulberry	Excellent	17	Good	15	Good	15
Osageorange	Excellent	20	Excellent	18	Good	15
Shrubs:						
American plum	Excellent	8	Excellent	8	Good	5
Tamarack	Excellent	10	Good	10	Poor.	
Common lilac	Excellent	8	Excellent	8	Poor.	
Skunkbush sumac	Excellent	6	Excellent	6	Excellent	6
Cotoneaster	Excellent	7	Good	7	Good	6

38 percent of the land area in the county, or 203,640 acres, is range.

In addition to producing pasture and hay for livestock, range supplies food and cover for wildlife. Well-managed range contributes to flood control when a large amount of precipitation soaks into the root zone.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kind and amount of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of range that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind of climax vegetation. Climax vegetation is the stabilized plant community; it reproduces itself and does not change as long as the environment remains unchanged. Throughout the prairie and the plains, the climax vegetation consists of the plants that were growing there when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation that could grow there.

A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in good condition if the percentage is 51 to 75; in fair condition if the percentage is 26 to 50; and in poor condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. Important changes in the kind of cover on a range site must be recognized. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of the range sites

In the following pages the range sites in Norton County are described and the climax plants and the plants most likely to invade the sites are named. Also given is an estimate of the potential annual yield of air dry herbage for each site when it is in excellent condition. The range site for each soil in the county is listed in the "Guide to Mapping Units" at the back of this soil survey.

LIMY UPLAND RANGE SITE

This site consists of deep and moderately deep, gently sloping to sloping soils of the Campus, Coly, Penden, and Wakeen series. These soils are on uplands. Their surface layer is generally calcareous and well granulated. They take in water well, and the plant-moisture relationship is good.

Big bluestem makes up about 30 percent, by weight, of the climax plant community; little bluestem makes up 20 percent; side-oats grama makes up 10 percent; blue grama and hairy grama together make up 8 percent; indiangrass, switchgrass, western wheatgrass, leadplant, and Louisiana sagewort each make up 5 percent; prairieclover makes up 3 percent; and black sampson and western ragweed each make up 2 percent.

Big bluestem, little bluestem, indiangrass, switchgrass, and leadplant decrease if the site is overgrazed. Side-oats grama, blue grama, buffalograss, western ragweed, and Louisiana sagewort increase. If the site is overgrazed for many years, the vegetation degenerates to predominantly blue grama, buffalograss, silver bluestem, western ragweed, and broomweed.

If this site is in excellent condition, the average annual production of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

LOAMY LOWLAND RANGE SITE

This site consists of deep, level to sloping soils of the Hobbs series on bottom lands along upland drainageways. These soils have a loamy or silty surface layer. The root zone is not restricted, and the available water capacity is very high.

Big bluestem makes up about 30 percent, by weight, of the climax plant community; switchgrass makes up 15 percent; indiangrass and western wheatgrass each make up 10 percent; and little bluestem, side-oats grama, tall dropseed, maximillian sunflower, wholeleaf rosinweed, carex, and woody plants each make up 5 percent. Among the common woody plants are cottonwood, elm, bur oak, and buckbrush.

Big bluestem, indiangrass, switchgrass, and little bluestem decrease if the site is overgrazed. Palatable forbs, maximillian sunflower, and wholeleaf rosinweed also decrease. Western wheatgrass, side-oats grama, blue grama, and tall dropseed increase. Heath aster, baldwin ironweed, and Missouri goldenrod make up a very small part of the climax plant community, but they increase rapidly. Woody plants, common along stream channels, also increase.

If this site is in excellent condition, the average annual production of air-dry herbage is 6,000 pounds per acre in years of favorable moisture and 3,500 pounds per acre in years of unfavorable moisture.

LOAMY TERRACE RANGE SITE

This site consists of deep, nearly level to gently sloping soils of the Detroit, Roxbury, Hord, and Cozad series. These soils are on alluvial benches or terraces. Flooding is infrequent, but additional moisture is received as runoff from nearby uplands. The soils have a surface layer and subsoil of silt loam to silty clay loam. They are permeable, and the root zone is deep.

Big bluestem makes up about 25 percent, by weight, of the climax plant community; switchgrass makes up 15 percent; indiangrass and western wheatgrass each make up 10 percent; little bluestem, side-oats grama, blue grama, tall dropseed, maximillian sunflower, and carex each make up 5 percent; Canada wildrye and slimflower scurfpea each make up 3 percent; and Illinois bundleflower and western ragweed each make up 2 percent.

Big bluestem, indiangrass, switchgrass, and little bluestem decrease if the site is overgrazed. Palatable forbs, maximillian sunflower, and Illinois bundleflower also decrease. Western wheatgrass, side-oats grama, blue grama, and tall dropseed increase. Western ragweed, heath aster, baldwin ironweed, and tall goldenrod make up a very small part of the climax plant community, but they increase rapidly.

If this site is in excellent condition, the average annual production of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 2,500 pounds per acre in years of unfavorable moisture.

LOAMY UPLAND RANGE SITE

This site consists of deep, nearly level to moderately steep soils of the Holdrege and Uly series. These soils are on uplands. They have a loamy surface layer and a loamy to clayey subsoil. Permeability is moderate to slow, and the available water capacity is high. The root zone is not restricted.

Big bluestem makes up about 30 percent, by weight, of the climax plant community; little bluestem, side-oats grama, blue grama, and western wheatgrass each make up 10 percent; switchgrass, buffalograss, tall dropseed, and slimflower scurfpea each make up 5 percent; indiangrass and western ragweed each make up 3 percent; and prairie coneflower and Louisiana sagewort each make up 2 percent.

Big bluestem, little bluestem, and switchgrass decrease if the site is overgrazed. Side-oats grama, blue grama, buffalograss, western wheatgrass, western ragweed, and Louisiana sagewort increase. If the site is overgrazed for many years, the vegetation degenerates to predominantly blue grama, buffalograss, windmillgrass, and western ragweed.

If this site is in excellent condition, the average annual production of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

SANDY LOWLAND RANGE SITE

This site consists of deep, nearly level to gently undulating soils of the Munjor series on flood plains adjacent to the North Fork Solomon River. They have a sandy loam surface layer and a coarse-textured subsoil. Permeability is rapid. If not protected, these soils are highly susceptible to soil blowing.

Sand bluestem makes up about 35 percent, by weight, of the climax plant community; switchgrass and little bluestem each make up 15 percent; indiangrass makes up 10 percent; western wheatgrass, Illinois bundleflower, and woody plants each make up 5 percent; side-oats grama and maximillian sunflower each make up 3 percent; and sand dropseed and roundhead lespedeza each make up 2 percent.

Sand bluestem, indiangrass, switchgrass, and little bluestem decrease if the site is overgrazed. Palatable forbs, maximillian sunflower, roundhead lespedeza, and Illinois bundleflower also decrease. Western wheatgrass, side-oats grama, blue grama, and sand dropseed increase. Louisiana sagewort, baldwin ironweed, western ragweed, and tall goldenrod make up a very small part of the climax plant community, but they increase rapidly. Woody plants also increase.

Woody plants, mainly cottonwood and willow, are common along stream channels. Sand plum is in small, scattered mottles over the site and is not confined to stream banks.

If the site is in excellent condition, the average annual production of air-dry herbage is 4,500 pounds per acre in years of favorable moisture and 3,000 pounds per acre in years of unfavorable moisture.

SHALLOW LIMY RANGE SITE

This site consists of sloping to steep soils of the Canlon series on uplands. They have a loamy surface layer that is 4 to 20 inches thick and is underlain by limestone. Permeability is moderate to slow, and the available water capacity is high. Because of the rough and broken topography and the many vertical ledges, travel is difficult for livestock.

Little bluestem makes up about 25 percent, by weight, of the climax plant community; big bluestem makes up 20 percent; side-oats grama makes up 15 percent; plains muhly makes up 10 percent; blue grama and hairy grama together make up 10 percent; switchgrass and leadplant each make up 5 percent; and resinous skullcap, black sampson, prairieclover, western ragweed, and smooth sumac each make up 2 percent.

Big bluestem, little bluestem, plains muhly, switchgrass, and leadplant decrease if the site is overgrazed. Side-oats grama, blue grama, hairy grama, buffalograss, and western ragweed increase. If the site is overgrazed for many years, the vegetation degenerates to predominantly blue grama, hairy grama, buffalograss, silver bluestem, western ragweed, and broom snakeweed.

If this site is in excellent condition, the average annual production of air-dry herbage is 2,500 pounds per acre in years of favorable moisture and 800 pounds per acre in years of unfavorable moisture.

Wildlife [5]

Farms and cultivated areas are a major habitat for many different kinds of wildlife (fig. 11). Cottontail rabbit, fox squirrel, mourning dove, songbirds, and bobwhite quail are typical of wildlife that inhabit farmed areas or open land in Norton County. The mixed areas of range and cultivated fields in the county provide habitat for good populations of birds and mammals.

Proper pasture and range management is essential to optimum livestock and wildlife populations. In judging pasture or range, all factors that affect streamflow, siltation, available water, wildlife, and recreation must be evaluated.

The effect of livestock grazing on wildlife may be competitive, beneficial, or neutral, depending on such factors as the type of vegetation, kind and combination of livestock, topography, soils, and availability of water.

Wildlife populations increase where animals can find food, water, and cover within a small area. More kinds of wildlife can survive where different cover types are broken up and mixed together.

Many farm ponds are scattered throughout the county; most serve both livestock and wildlife. The major lake in the county is Norton Reservoir, and the major rivers and creeks are North Fork Solomon River, Sappa Creek, and Prairie Dog Creek. Fishing is good in Norton County.

In table 4, the soils in Norton County are rated for eight elements of wildlife habitat and for three kinds of wildlife. The kinds of wildlife are defined in the following paragraphs.

Openland wildlife are animals that inhabit cultivated areas, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck are examples of openland wildlife.

Wetland wildlife are animals that inhabit swampy,

[5] By JACK W. WALSTROM, biologist, Soil Conservation Service.

Figure 11.—Wildlife planting of redcedar on Coly and Uly soils. When fully grown, these trees will be excellent habitat for openland wildlife.

TABLE 4.—*Suitability of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees
Campus: Cc For the Canlon part, see the Canlon series.	Fair	Fair	Good	Fair
Canlon Mapped only in a complex with Campus soils.	Poor	Fair	Fair	Poor
Coly: Co, Cs For the Uly part, see the Uly series.	Fair where slopes are less than 10 percent. Poor where slopes are more than 10 percent.	Good where slopes are less than 10 percent. Poor where slopes are more than 10 percent.	Fair	Poor
Cozad: Cu, Cz	Good	Good	Good	Good
Detroit: Dt	Good	Good	Good	Good
Hobbs: Hb	Good	Good	Good	Good
Holdrege: Ho, Hp, Hr, Hs, Ht	Good where slopes are less than 3 percent. Fair where slopes are more than 3 percent.	Good	Good	Good
Hord: Hz	Good	Good	Good	Good
Munjor: Mu	Good	Good	Good	Good
Penden Mapped only in a complex with Uly soils.	Fair where slopes are less than 7 percent. Poor where slopes are more than 7 percent.	Fair	Good	Fair
Roxbury: Rx	Good	Good	Good	Good
Uly: Ub, Uc, Up For the Penden part of Up, see the Penden series.	Fair where slopes are less than 10 percent. Poor where slopes are more than 10 percent.	Good where slopes are less than 10 percent. Fair where slopes are more than 10 percent.	Good	Fair
Wakeen: Wa	Fair	Good	Fair	Fair

marshy, or open water areas. Duck, geese, heron, shorebirds, rail, kingfisher, muskrat, and beaver are examples of wetland wildlife.

Rangeland wildlife are animals that inhabit natural range. Antelope, mule deer, bison, prairie chicken, coyote, jackrabbit, prairie dog, and lark bunting are examples of rangeland wildlife.

Further information and assistance in planning and developing wildlife habitat can be obtained at the local office of the Soil Conservation Service; the Kansas Forestry, Fish and Game Commission; the Fish and Wildlife Service; and the County Agricultural Extension Agent.

Use of the Soils for Recreation [6]

Prairie Dog State Park, which is 5 miles southwest of Norton, is an area of 1,578 acres adjacent to Norton Reservoir. The reservoir has a surface area of 2,330 acres. Fishing, hunting, camping, picnicking, boating, water skiing, hiking, and swimming are some of the activities provided by this facility.

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 5 the limitations to the use of soils in Norton County are shown for camp areas, picnic areas, playgrounds, and paths and trails.

[6] By JACK W. WALSTROM, biologist, Soil Conservation Service.

of wildlife habitat and kinds of wildlife

Elements of wildlife habitat—Continued						
Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Good	Good	Poor	Poor	Good	Poor	Good.
Good	Good	Poor	Poor	Good	Poor	Good.
Good	Good	Poor	Poor	Good	Poor	Good.
Good	Good	Very poor	Very poor	Good	Very poor	Good.
Good	Good	Poor	Very poor	Good	Very poor	Good.
Good	Good	Poor	Poor	Good	Poor	Good.
Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Good	Good	Poor	Poor	Good	Poor	Good.
Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Fair	Fair	Poor	Very poor	Fair	Very poor	Fair.

In table 5 terms used for degree of limitation are *slight, moderate,* or *severe.* For all of these degrees of limitation, it is assumed that a good cover of vegetation can be established and maintained. *Slight* means that soil properties are generally favorable and that limitations are so minor that they can easily be overcome. *Moderate* means that limitations can be overcome or modified by planning, design, or special maintenance. *Severe* means that costly soil reclamation, special design, intensive maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The soils that are best suited to camp areas have mild slopes, good drainage, a surface that is free of rocks and coarse fragments, and a surface that is firm when wet but not dusty when dry. Also, flooding does not occur during periods of heavy use.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The soils that are best suited to picnic areas are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or

TABLE 5.—*Degree and kind of limitations of the soils for recreation development*

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Campus: Cc. For the Canlon part, see the Canlon series.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent; caliche beds at a depth of 20 to 40 inches.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.
Canlon. Mapped only in a complex with Campus soils.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent; hard caliche at a depth of 10 to 20 inches.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.
Coly: Co, Cs. For the Uly part, see the Uly series.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.
Cozad: Cu, Cz	None to slight	None to slight	Moderate where slopes are more than 2 percent.	None to slight.
Detroit: Dt	Moderate: surface layer too clayey.	Moderate: surface layer too clayey.	Moderate: surface layer too clayey.	Moderate: surface layer too clayey.
Hobbs: Hb	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Holdrege: Ho, Hp, Hr, Hs, Ht.	None to slight	None to slight	None to slight where slopes are less than 2 percent. Moderate where slopes are 2 to 6 percent.	None to slight.
Hord: Hz	None to slight	None to slight	None to slight	None to slight.
Munjor: Mu	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	None to slight.
Penden. Mapped only in a complex with Uly soils.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.
Roxbury: Rx	Severe: subject to flooding.	Moderate: Subject to flooding.	Moderate: subject to flooding	Moderate: subject to flooding.
Uly: Ub, Uc, Up. For the Penden part of Up, see the Penden series.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.
Wakeen: Wa	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Severe: slopes are more than 6 percent.	None to slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.

stones or boulders that greatly increase the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The soils that are best suited to playgrounds have a nearly level surface that is free of coarse fragments and rock outcrops, good drainage, and a surface that is firm when wet but not dusty when dry. Also, flooding does not occur during periods of heavy use. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The soils that are best suited to paths and trails are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils [7]

This section is useful to those who need information about soils used as structural material or as foundation on which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties that are highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreation areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

[7] ARTHUR H. HOLSTE, civil engineer, Soil Conservation Service, helped prepare this section.

Most of the information in this section is presented in tables. Table 6 shows several estimated soil properties significant in engineering; table 7 shows interpretations for various engineering uses; table 8 shows suitability of the soils as a source of construction material; and table 9 gives the results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6, 7, and 8 and also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavation to a depth greater than those shown in the tables, generally a depth greater than 6 feet. Also, inspection of sites, especially small ones, is needed because many areas of a given mapping unit may contain small areas of other kinds of soils that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have a special meaning to soil scientists. Many of these terms are defined in the Glossary at the back of this survey.

Engineering soil classification systems

The two systems most commonly used in classifying soils for engineering are the Unified system (*12*) used by Soil Conservation Service engineers, the Department of Defense, and others, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. Eight classes of coarse-grained soils are divided on the basis of content of gravel and sand and identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are divided on the basis of plasticity and organic-matter content. Nonplastic classes are identified as ML and MH, plastic classes are CL and CH, and slightly organic classes are OL and OH. There is one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the engineering value of soil material can be indicated by a group

TABLE 6.—*Estimated soil properties*

[An asterisk in the first column means that at least one mapping unit in this series is made up of two or more kinds of soil. The
The symbol >

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHTO
	Inches	*Feet*	*Inches*			
*Campus: Cc. For the Canlon part, see the Canlon series.	20–40	> 6	0–11	Loam	ML or CL	A–6 or A–7–6
			11–30	Loam, clay loam.	CL, SC	A–6 or A–7–6
			30	Caliche.		
Canlon. Mapped only in a complex with Campus soils.	10–20	> 6	0–13	Loam, fine sandy loam.	CL	A–4 or A–6
			13	Hard caliche.		
*Coly: Co, Cs. For the Uly part, see the Uly series.	> 60	> 10	0–10	Silt loam	ML or CL	A–4 or A–6
			10–60	Silt loam	ML or CL	A–4 or A–6
Cozad: Cu, Cz	> 60	> 6	0–13	Silt loam	ML or CL	A–4 or A–6
			13–60	Silt loam, silty clay loam.	ML or CL	A–6 or A–4
Detroit: Dt	> 60	> 6	0–14	Silty clay loam	CL	A–6 or A–7
			14–26	Heavy silty clay loam.	CH or CL	A–7
			26–60	Silty clay loam	CL	A–4 or A–6
Hobbs: Hb	> 60	> 6	0–25	Silt loam	ML or CL	A–4 or A–6
			25–60	Silt loam	ML or CL	A–6 or A–4
Holdrege: Ho, Hp, Hr, Hs, Ht	> 60	> 6	0–11	Silt loam	ML or CL	A–4 or A–6
			11–22	Silty clay loam	CL or CH	A–6 or A–7–6
			22–60	Silt loam	CL or ML	A–4, A–6, or A–7
Hord: Hz	> 60	> 6	0–16	Silt loam	ML or CL	A–4 or A–6
			16–30	Silt loam or light silty clay loam.	ML or CL	A–4, A–6, or A–7
			30–60	Silt loam	ML or CL	A–4 or A–6
Munjor: Mu	> 60	> 5	0–15	Sandy loam	SM	A–2–4
			15–60	Sandy loam	SM	A–2–4
Penden. Mapped only in a complex with Uly soils.	> 60	> 5	0–10	Loam	CL	A–6 or A–7–6
			10–24	Loam	CL	A–6
			24–60	Loam	CL	A–6
Roxbury: Rx	> 60	> 5	0–36	Silt loam	ML-CL or CL	A–4 or A–6
			36–60	Silt loam	CL or ML	A–4 or A–6

significant in engineering

soils in such mapping units can have different properties, and for this reason it is necessary to refer to other series as indicated. means more than]

Percentage of material smaller than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea- bility	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*			
90–100	90–100	75–95	50–80	35–45	11–20	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
90–100	85–100	65–85	40–80	35–45	15–20	0.6–2.0	0.15–0.19	7.4–8.4	Low	Low	Low.
90–100	85–100	85–100	65–85	25–40	8–20	0.6–2.0	0.12–0.16	7.4–8.4	Low	Low	Low.
100	100	95–100	90–100	25–40	4–20	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
100	100	100	95–100	25–40	4–20	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
100	100	90–100	90–100	20–35	8–18	0.6–2.0	0.22–0.24	6.6–8.4	Low	Low	Low.
100	100	100	95–100	25–40	8–20	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
100	100	95–100	85–95	30–45	11–24	0.2–0.6	0.21–0.23	6.1–7.3	Low to moderate.	Moderate	Low.
100	100	95–100	90–100	40–55	20–30	0.06–0.2	0.11–0.13	6.1–7.3	Moderate to high.	Moderate to high.	Low.
100	100	95–100	85–95	35–45	18–24	0.2–0.6	0.18–0.20	6.6–8.4	Moderate	Moderate	Low.
100	100	95–100	90–100	30–40	8–15	0.6–2.0	0.22–0.24	6.1–7.3	Low	Low	Low.
100	100	95–100	90–100	30–40	8–15	0.6–2.0	0.20–0.22	6.6–7.8	Low	Low	Low.
100	100	98–100	90–100	24–40	2–14	0.6–2.0	0.22–0.24	6.1–7.0	Low	Low	Low.
100	100	98–100	95–100	30–55	20–35	0.6–2.0	0.18–0.20	6.1–7.3	Low to moderate.	Low	Low.
100	100	98–100	95–100	30–45	5–20	0.6–2.0	0.20–0.22	7.3–8.4	Low to moderate.	Low	Low.
100	100	98–100	90–100	20–40	6–15	0.6–2.0	0.22–0.24	6.6–7.3	Low	Low	Low.
100	100	100	95–100	25–45	8–25	0.6–2.0	0.20–0.22	6.6–7.3	Low to moderate.	Low	Low.
100	100	100	95–100	20–40	6–15	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
100	95–100	60–70	20–35	20–35	3–7	2.0–6.0	0.13–0.15	7.4–8.4	Low	Low	Low.
95–100	90–95	55–70	15–35	20–35	3–7	6.0–20	0.11–0.13	7.4–8.4	Low	Low	Low.
100	100	90–100	70–95	35–45	15–25	0.2–2.0	0.20–0.22	7.4–8.4	Low to moderate.	Low to moderate.	Low.
100	100	90–100	70–85	30–40	15–25	0.2–2.0	0.17–0.19	7.4–8.4	Low	Low to moderate.	Low.
100	100	90–100	70–85	30–40	15–25	0.2–2.0	0.14–0.16	7.9–8.4	Low	Low to moderate.	Low.
100	100	96–100	75–95	25–40	5–20	0.6–2.0	0.22–0.24	7.4–8.4	Low	Low	Low.
100	100	96–100	65–90	25–40	2–15	0.6–2.0	0.17–0.22	7.4–8.4	Low	Low	Low.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	USDA texture	Classification Unified	Classification AASHTO
	Inches	*Feet*	*Inches*			
*Uly: Ub, Uc, Up	> 60	> 10	0–13	Silt loam	ML or CL	A–4 or A–6
For the Penden part of Up, see the Penden series.			13–20	Silt loam	ML-CL or CL	A–4 or A–6
			20–60	Silt loam	ML-CL or CL	A–4 or A–6
Wakeen: Wa	20–40	> 6	0–8	Silt loam	CL	A–6 or A–7
			8–20	Silt loam	CL	A–4, A–6, or A–7
			20–38	Silt loam	CL	A–6, A–4, or A–7–6
			38	Chalky limestone.		

index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 9; the estimated classification, without group index numbers, is given in table 6 for all soils mapped in the survey area.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 6. These estimates are made for representative soil profiles, by layers having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 6 in the standard terms used by the Department of Agriculture (*9*). These terms are based on the percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary of this survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil from which the particles coarser than 0.42 millimeter have been removed is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state, and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which soil material is plastic. Liquid limit and plasticity index are estimated in table 6, but in table 8 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability, as used here, is an estimate of the rate at which saturated soil transmits water downward under a unit head of pressure. It is estimated on the basis of soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage and transient soil features, such as plowpans and surface crusts, are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed as pH value for a stated soil-solution mixture. The pH value and terms used to describe reaction are explained in the Glossary at the back of this survey.

Shrink-swell potential refers to the relative change in volume to be expected of soil material as the moisture content changes, that is, the extent to which the soil shrinks as it dries out or swells as it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and *significant in engineering*—Continued

Percentage of material smaller than 3 inches passing sieve—				Liquid limit	Plasticity index	Permea- bility	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to—	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*			
100	100	98–100	90–100	25–37	7–15	0.6–2.0	0.22–0.24	6.1–7.8	Low	Low	Low.
100	100	100	90–100	30–40	9–18	0.6–2.0	0.20–0.22	6.1–7.8	Low	Low	Low.
100	100	100	90–100	25–35	6–15	0.6–2.0	0.20–0.22	7.4–8.4	Low	Low	Low.
100	100	90–100	70–90	35–50	15–25	0.6–2.0	0.22–0.24	7.4–8.4	Low	Low	Low.
100	100	95–100	80–95	30–50	10–25	0.6–2.0	0.20–0.22	7.4–8.4	Low to moderate.	Low	Low.
100	100	90–100	75–95	30–45	8–20	0.6–2.0	0.17–0.19	7.4–8.4	Low	Low	Low.

swelling of soils may damage building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Corrosivity pertains to potential soil-induced chemical action that dissolves or weakens steel or concrete. The rate of corrosion of steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one horizon. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate but also by soil texture and acidity. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to reduce damage.

Engineering interpretations of the soils

Table 7 gives estimated interpretations of the soils for various engineering uses, and table 8 rates the suitability of the soils as a source of construction materials. The information in these tables is based on the engineering properties of the soils shown in table 6, on test data for soils in this survey area and in others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Norton County.

Table 7 shows the soil features affecting the use of soils for highway location; pond reservoir areas; embankments, dikes, and levees; terraces, diversions, and waterways; and irrigation. For the other uses listed, the degree and kind of limitations are given.

In table 7 the degree of limitation is expressed as *slight, moderate,* and *severe. Slight* means that the properties are generally favorable for the specified use, or that limitations are minor and easily overcome. *Moderate* means that some properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that the properties are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is needed.

Following are explanations of some of the columns in table 7.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction as well as the risk of erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and has sides, or embankments, of compacted soil material. It is assumed that the embankment is compacted to medium density and the pond is protected from flooding. Properties considered are those that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope and, if the floor needs to be leveled, depth to bedrock. The soil properties that affect embankments are the engineering properties of the embankment material as interpreted from the Unified soil classification, the amount of stones,

TABLE 7.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. series as indicated in the

Soil series and map symbols	Degree and kind of limitations for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Local roads and streets
*Campus: Cc For the Canlon part, see the Canlon series.	Severe: caliche beds at a depth of 20 to 40 inches.	Severe: slopes are more than 7 percent in most places; caliche beds at a depth of 20 to 40 inches.	Moderate: rippable caliche beds at a depth of 20 to 40 inches.	Moderate where slopes are 8 to 15 percent: caliche beds at a depth of 20 to 40 inches. Severe where slopes are more than 15 percent.	Moderate where slopes are 8 to 15 percent: caliche beds at a depth of 20 to 40 inches. Severe where slopes are more than 15 percent.
Canlon Mapped only in a complex with Campus soils.	Severe: caliche at a depth of 10 to 20 inches.	Severe: slopes are more than 7 percent in most places; caliche at a depth of 10 to 20 inches.	Severe: caliche at a depth of 10 to 20 inches.	Severe: caliche at a depth of 10 to 20 inches.	Severe: caliche at a depth of 10 to 20 inches.
*Coly: Co, Cs For the Uly part, see the Uly series.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent: moderate permeability. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent: medium soil support. Severe where slopes are more than 15 percent.
Cozad: Cu, Cz	Slight	Moderate: moderate permeability.	Slight	Slight	Slight
Detroit: Dt	Severe: slow permeability.	Slight	Moderate: silty clay loam.	Moderate to severe: moderate to high shrink-swell potential.	Moderate to severe: moderate to high shrink-swell potential.
Hobbs: Hb	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Severe: subject to frequent flooding.
Holdrege: Ho, Hp, Hr, Hs, Ht	Slight to moderate: moderate permeability.	Moderate: moderate permeability; slopes of 0 to 6 percent.	Slight	Moderate: low to moderate shrink-swell potential.	Moderate: low to moderate shrink-swell potential.
Hord: Hz	Slight	Moderate: moderate permeability.	Slight	Slight	Slight

See footnote at end of table.

properties of the soils

The soils in such mapping units can have different properties and limitations, and for this reason it is necessary to refer to other first column of this table]

Degree and kind of limitations for—Continued		Soil features affecting—				
Sanitary landfill (trench type)[1]	Sanitary landfill (area type)	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Severe: caliche beds at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	High erodibility; slopes of 6 to 30 percent; caliche at a depth of 20 to 40 inches.	Caliche at a depth of 20 to 40 inches; slopes of 6 to 30 percent.	Limited borrow material; fair stability and compaction characteristics.	Caliche at a depth of 20 to 40 inches; slopes of 6 to 30 percent.	Caliche at a depth of 20 to 40 inches; slopes of 6 to 30 percent.
Severe: caliche at a depth of 10 to 20 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	High erodibility; slopes of 6 to 30 percent; caliche at a depth of 10 to 20 inches.	Caliche at a depth of 10 to 20 inches; slopes of 6 to 30 percent.	Shallow soil	Caliche at a depth of 10 to 20 inches; slopes of 6 to 30 percent.	Caliche at a depth of 10 to 20 inches; slopes of 6 to 30 percent.
Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	High erodibility; slopes of 6 to 20 percent.	Slopes of 6 to 20 percent.	Fair stability; high erodibility.	High erodibility; excessive slopes; low fertility.	Generally not irrigated: most slopes are too steep; very high available water capacity; moderate intake rate.
Slight	Slight	No unfavorable features; nearly level.	Low to moderate risk of seepage.	Slopes are erodible; moderate hazard of piping.	Slopes are erodible.	Very high available water capacity; moderate intake rate.
Moderate: silty clay loam.	Slight	No unfavorable features; nearly level.	Slow permeability.	Low shear strength; moderate to high shrink-swell potential.	Nearly level; silty clay loam subsoil.	Nearly level.
Severe: subject to frequent flooding.	Severe: subject to frequent flooding.	Subject to frequent flooding.	Moderate permeability.	Fair to good stability and compaction characteristics; medium compressibility.	Subject to frequent flooding.	Subject to frequent flooding.
Slight	Slight	Slopes of 0 to 6 percent.	Moderate permeability; low to moderate risk of seepage.	Slopes are erodible; subject to piping.	Risk of siltation in channels; few available outlets.	High to very high available water capacity; moderate intake rate.
Slight	Slight	No unfavorable features; nearly level.	Low to moderate risk of seepage.	Slopes are erodible; moderate hazard of piping.	No unfavorable features.	Very high available water capacity; moderate intake rate.

TABLE 7.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitations for—				
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings	Local roads and streets
Munjor: Mu	Severe: subject to flooding.	Severe: subject to flooding; moderately rapid permeability.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
Penden. Mapped only in a complex with Uly soils.	Moderate where slopes are less than 15 percent: moderate permeability. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent: moderate and moderately slow permeability. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent: low to moderate shrink-swell potential. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.
Roxbury: Rx	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate to severe: subject to flooding.
*Uly: Ub, Uc, Up. For the Penden part of Up, see the Penden series.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent: moderate permeability. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.
Wakeen: Wa	Severe: chalky limestone at a depth of 20 to 40 inches.	Severe: chalky limestone at a depth of 20 to 40 inches; slopes of more than 7 percent in most places.	Moderate where slopes are less than 15 percent: rippable bedrock at a depth of 20 to 40 inches. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent: rippable bedrock at a depth of 20 to 40 inches; low soil support. Severe where slopes are more than 15 percent.	Severe: low soil support.

[1] Onsite deep studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

if any, which influences the ease of excavation, and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, for example, excavations for pipelines, sewer lines, telephone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, and gentle slopes. Also, the soils should have no rock outcrops or big stones, should not be subject to flooding, and should not have a high water table.

Dwellings, as rated in table 7, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

properties of the soils—Continued

Degree and kind of limitations for—Continued		Soil features affecting—				
Sanitary landfill (trench type) [1]	Sanitary landfill (area type)	Highway location	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Severe: subject to flooding.	Severe: subject to flooding.	Subject to flooding; nearly level.	Moderately rapid permeability.	Pervious material; good shear strength.	Sandy loam	Sandy loam; rapid intake rate.
Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate erodibility.	Moderate permeability; slopes of 6 to 20 percent.	Low to moderate shrink-swell potential; fair to good stability and compaction characteristics.	Slopes of 6 to 20 percent.	Slopes of 6 to 20 percent.
Severe: subject to flooding.	Severe: subject to flooding.	Nearly level; subject to flooding.	Moderate permeability; subject to flooding.	Fair compaction characteristics; medium to low shear strength.	Moderate permeability; subject to flooding; nearly level.	Very high available water capacity; moderate permeability; subject to flooding.
Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate erodibility; slopes of 6 to 20 percent.	Fair to poor bank stability; slopes of 6 to 20 percent.	Fair bank stability and compaction characteristics; fair resistance to piping.	No unfavorable features; exposed subsoil is erodible and has low fertility; slopes of 6 to 20 percent.	No unfavorable features; severe hazard of erosion on slopes of 6 to 20 percent.
Moderate: rippable bedrock at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate erodibility; limestone at a depth of 20 to 40 inches; slopes of 6 to 20 percent.	Moderate permeability; bedrock at a depth of 20 to 40 inches; slopes of 6 to 20 percent.	Fair stability; good compaction characteristics; fair shear strength.	Moderate permeability; slopes of 6 to 20 percent; bedrock at a depth of 20 to 40 inches.	Slopes of 6 to 20 percent; bedrock at a depth of 20 to 40 inches.

Local roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, usually asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect the design and construction of roads and streets are the load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of soils, as well as the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Sanitary landfill is a method of disposing of refuse either in dug trenches (trench type) or on the soil surface (area type). The waste is spread in thin layers,

TABLE 8.—*Suitability of the soils as a source of construction materials*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units can have different properties and limitations, and for this reason it is necessary to refer to other series a sindicated in the first column of this table]

Soil series and map symbols	Sanitary landfill cover material	Topsoil	Sand and gravel	Road subgrade	Road fill
*Campus: Cc. For the Canlon part, see the Canlon series.	Poor: caliche at a depth of 20 to 40 inches; slopes of 6 to 30 percent; area difficult to reclaim.	Poor: area difficult to reclaim.	Poor except for local pockets.	Poor: low soil support.	Fair: fair shear strength.
Canlon. Mapped only in a complex with Campus soils.	Poor: caliche at a depth of 10 to 20 inches.	Poor: more than 15 percent coarse fragments; caliche at a depth of 10 to 20 inches.	Poor except for local pockets.	Poor: low soil support.	Fair: fair shear strength.
*Coly: Co, Cs. For the Uly part, see the Uly series.	Good where slopes are less than 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are more than 15 percent.	Fair where slopes are less than 15 percent: low organic-matter content; low fertility. Poor where slopes are more than 15 percent.	Unsuited	Fair: medium soil support.	Good.
Cozad: Cu, Cz	Good	Good	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
Detroit: Dt	Fair to poor: silty clay loam.	Fair: surface layer 14 inches thick.	Unsuited	Poor: low soil support.	Fair: fair shear strength.
Hobbs: Hb	Good	Good	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
Holdrege: Ho, Hp, Hr, Hs, Ht.	Fair to good	Good	Unsuited	Fair: medium soil support.	Good.
Hord: Hz	Good	Good	Unsuited	Fair: medium soil support.	Good.
Munjor: Mu	Good	Fair: 8 to 16 inches of suitable material.	Fair: poorly graded sand in substratum.	Good	Good.
Penden. Mapped only in a complex with Uly soils.	Good where slopes are less than 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are more than 15 percent.	Fair where slopes are 6 to 15 percent: 10 inches of suitable material. Poor where slopes are more than 15 percent.	Unsuited	Fair: medium soil support.	Good.
Roxbury: Rx	Good	Good	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
*Uly: Ub, Uc, Up. For the Penden part of Up, see the Penden series.	Good where slopes are less than 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are more than 15 percent.	Good where slopes are less than 8 percent. Fair where slopes are 8 to 15 percent. Poor where slopes are more than 15 percent.	Unsuited	Fair: medium soil support.	Good.
Wakeen: Wa	Poor: area difficult to reclaim.	Poor: area difficult to reclaim.	Unsuited	Poor: low soil support.	Fair: fair shear strength.

compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some properties that affect suitability for landfill are ease of excavation, hazard of pollution of ground water, and trafficability. The soils that are best suited to sanitary landfill have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 7 apply only to a depth of about 6 feet, and therefore ratings of *slight* or *moderate* may not be valid if trenches are deeper. Each possible site should be investigated before one is selected.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. The presence of stones or organic material are among factors that are unfavorable.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope, depth to bedrock or other unfavorable material, presence of stones, permeability, and resistance to water erosion, soil slipping, and soil blowing. A suitable soil for these structures provides outlets for runoff and is not difficult to vegetate.

Irrigation of a soil is affected by such features as slope; susceptibility to flooding, water erosion, or soil blowing; texture; content of stones; accumulation of salts and alkali; depth of the root zone; rate of water intake at the surface; permeability of soil layers below the surface and in fragipans or other layers that restrict movement of water; amount of water available to plants; and need for drainage or depth to water table or bedrock.

In table 8, the ratings *good, fair,* and *poor* are used to summarize the suitability of the soils as a source of construction materials. Following are explanations of some of the columns in table 8.

Topsoil is used for topdressing in an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. The texture of the material and content of stone fragments are characteristics that affect suitability; also considered in the ratings is the damage that results to the area from which the topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance as to about where to look for sources of sand and gravel. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and they do not indicate the quality of the deposit.

The soil support ratings for road subgrade indicate the ability of the soil material to support a load under vehicular traffic. The ratings are based on the liquid limit and plasticity index of the material.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and the relative ease of excavating the material at borrow areas.

Soil test data

Table 9 contains engineering test data for some of the major soil series in Norton County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limit and plastic limit. The mechanical analyses were made by combined sieve and hydrometer method.

Compaction (or moisture-density) data are important in soil engineering. If a soil material is compacted at successively higher levels of moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases as moisture content increases. The highest dry density obtained in the compactive test is termed the *maximum dry density*. As a rule, the maximum strength of soil material is obtained if it is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material, as has been explained for table 6.

Formation and Classification of Soils

This section explains how the factors of soil formation affected the development of soils in Norton County. The current system of soil classification is then explained and the soil series are placed in higher categories of that system.

Factors of Soil Formation

Soil is produced by processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plants and animals on and in the soil, the relief, or lay of the land, and the length of time the forces of soil formation have acted on the soil material.

Climate and plants and animals, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that

TABLE 9.—*Engineering*

[Tests performed by the State Highway Commission of Kansas according to standard procedures of the

Soil name and location	Parent material	Kansas report no. S–71–	Depth	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			Inches	*Pounds per cubic foot*	*Percent*
Holdrege silt loam: 1,425 feet west and 150 feet south of the northeast corner of section 20, T. 2 S., R. 23 W. About 2 miles west and 3 miles north of Norton. (Modal)	Peorian loess.	69–1–1	0–6	101	19
		69–1–2	14–23	101	19
		69–1–3	31–45	103	17
		69–1–4	45–60	104	18
Uly silt loam: 850 feet west and 640 feet north of the southeast corner of the NE¼ of section 3, T. 1 S., R. 23 W. About 10 miles north of Norton. (Modal)	Peorian loess.	69–2–1	0–9	98	19
		69–2–2	13–20	104	18
		69–2–3	28–60	106	16
Hord silt loam: 1,000 feet south and 120 feet west of the northeast corner of the SE¼ of section 22, T. 3 S., R. 24 W. About 6 miles west and 4 miles south of Norton. (Modal)	Loess and alluvium.	69–3–1	0–15	102	18
		69–3–2	15–25	99	19
		69–3–3	40–60	104	18

[1] Based on AASHTO Designation T 99–61, Method A (*1*), with the following variations: (1) all material is ovendried at 230°F. and crushed in a laboratory crusher after drying, and (2) no time is allowed for dispersion of moisture after mixing with soil material.

[2] Mechanical analyses according to AASHTO Designation T 88–70 (*1*), with the following variations: (1) all material is ovendried at 230°F. and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium hexametaphosphate buffered with Na_2Co_3 is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute.

Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method,

has genetically related horizons. The effect of climate and plants and animals are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. Usually, a long time is required for the development of distinct horizons.

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

Parent material

Parent material is the unconsolidated mass from which the soils are formed. It determines the mineralogical and chemical composition of the soil and, to a large extent, the rate at which soil-forming processes take place. It affects the texture, structure, color, natural fertility, and other properties of the soil.

Parent material is formed by the mechanical and chemical weathering of rocks. Among the agents of mechanical weathering are temperature changes, freezing and thawing, plant and animal action, wetting and drying, abrasion, and corrosion (*4*). Chemical weathering is more complex. In most cases it results in the reduction of particle size, the addition of water, oxygen, and carbon dioxide, and the loss of soluble salts of some elements, such as sodium and potassium (*4*).

Most of the soils of Norton County formed in loess, some in alluvium, some in loamy outwash, and some in material weathered from chalky limestone and caliche.

The Niobrara Chalk of the Cretaceous System crops out mainly along the ridges and slope breaks in the southeast part of the county. It is a remnant of a time when Kansas was an inland sea. Wakeen soils formed in material weathered from this chalky limestone.

In some of the strongly sloping, dissected areas, outcrops of caliche hardened by cementation are visible. These outcrops make up the Ogallala Formation in this county. This formation is in areas that have irregular slopes and that are at an elevation that varies greatly over short distances. Campus and Canlon soils formed in material weathered from this caliche.

Outwash is mostly from the Ogallala Formation and was modified in the upper part by loess during Pleistocene and more recent times. Outwash occurs in many places, mainly on eroded, dissected uplands in the southern part of the county. The outwash is limy and contains medium and coarse grains of sand. Penden soils formed in this outwash.

A mantle of loess, probably Peorian Loess of the Wisconsin Stage, which covers most of the uplands, was deposited during the Pleistocene Epoch. In most *test data*

American Association of State Highway and Transportation Officials (AASHTO) (*1*), except as noted]

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage smaller than 3 inches passing sieve—			Percentage smaller than—						AASHTO [3]	Unified [4]
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
							Percent			
100	100	90	75	49	26	18	37	13	A–6(9)	ML–CL
100	100	98	88	57	36	29	43	21	A–7–6(13)	CL
100	100	96	83	50	24	15	35	12	A–6(9)	ML–CL
100	100	97	86	45	20	11	33	9	A–4(8)	ML–CL
100	99	94	79	38	18	14	36	8	A–4(8)	ML
100	100	97	85	43	23	18	36	13	A–6(9)	ML–CL
100	100	98	88	43	18	11	30	7	A–4(8)	ML–CL
100	99	90	78	44	23	17	34	12	A–6(9)	ML–CL
100	100	98	90	59	30	24	41	18	A–7–6(11)	CL
100	100	96	87	50	25	17	35	13	A–6(9)	ML–CL

and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3] Based on AASHTO Designation M 145–49 (*1*).

[4] Based on the Unified Soil Classification System (*12*). SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from the A-line be given a borderline classification. An example of a borderline classification obtained by this use is ML–CL.

places it is pale brown, calcareous, friable, and porous. Holdrege, Coly, and Uly silt loams are the major soils in Norton County that formed in loess. Probably, in some places, a thin mantle of loess has modified the surface characteristics of other soils in the county.

Alluvium of relatively recent age occurs on the bottom lands and terraces along Sappa Creek, North Fork Solomon River, Prairie Dog Creek, and, to a lesser extent, along some of the other streams in the county. These soils range from silt loam to sandy loam and have little or no development. Roxbury, Hobbs, Munjor, Hord, and Cozad soils all formed in alluvium.

Climate

The climate of Norton County is continental and marked by extreme seasonal changes in temperature. Moisture is deficient in most seasons. Temperature varies widely; temperatures of below 0 in winter and of 100°F in summer are not uncommon. Wind velocity is fairly high. The soils formed somewhat more slowly than those in areas of higher rainfall.

Climate affects the physical, chemical, and biological relationships in soil. The downward movement of water is a major factor in changing parent material into a soil that has distinct horizons. The amount of water that percolates through the soil depends partly on rainfall, humidity, and the length of frost-free periods. Water dissolves small amounts of minerals and carries them out of the soil. It moves other minerals, such as clay and calcium carbonate, downward only a short distance into the soil profile.

Because of the limited amount of rainfall in Norton County, the soils have not weathered and are not leached greatly. Calcium carbonate has been leached to a depth of about 20 to 35 inches in Holdrege and other soils. Penden, Uly, and other soils have calcium carbonate near the surface in many places.

Plants and animals

Plants and animals have an important effect on soil formation. Small burrowing animals, earthworms, and insects help to mix the soil, and bacteria, fungi, and other micro-organisms help to weather rock and decompose organic matter. Plants and animals also influence the chemical and biological processes that take place in the soils.

The kind and amount of vegetation are important in soil formation. Vegetation adds organic matter to the soil and thus influences its physical and chemical characteristics. It makes the soil more permeable to water, promotes leaching, and affects soil structure. Burrowing animals, insects, and earthworms move large quantities of soil. Their activity improves aeration, mixes the soil horizons, and helps decompose plant material.

The soils of Norton County formed mainly under grass. The remains of grass roots and leaves add organic matter to the soils over a long period of time. As a result, the soils generally have a dark-colored surface layer.

Man also has had an effect on the soils. Poor cropping and tillage practices have removed the protective cover from soils and have caused the loss of organic matter. If the protective cover of plants is gone, accelerated erosion occurs. As a result, soil material washed from one place is deposited on soils in another place. Man has also changed the soils in many areas through irrigation, drainage, land leveling, and landforming.

Relief

Relief influences soil formation through its effect on drainage, runoff, erosion, and soil temperature. Through its effect on moisture and temperature, relief also affects the kinds of plants and animals that live on and in the soil. If other factors are equal, soil formation is less rapid in more sloping areas because runoff and erosion are greater. In more level areas, erosion is slight, soils are generally deep, and the soil horizons are well developed.

Many of the soils of Norton County are in broad, smooth, nearly level to sloping areas. Holdrege soils, the main soils on uplands, have well-expressed horizons and are among the more strongly developed soils in the county. Soils that formed in parent material similar to that in which Holdrege soils formed but that are in more sloping areas have less horizon development and have a thinner surface layer. Uly and Coly soils are examples.

Many soils have more than one type of relief, but some have only one type. For example, Hord soils are only on nearly level stream terraces, but most Holdrege soils are on gently sloping to sloping upland ridges, and some are on nearly level upland plains.

Time

Time is required for the formation of soils from parent material. The length of time needed depends largely on the kind of parent material and the effect on other factors of soil formation. Water moves through the soil profile and gradually leaches soluble materials and fine particles from the surface layer downward into the subsoil. When the factors of soil formation have not taken place long enough to form definite horizons, the soil is considered young or immature. Soils that have been in place for a long time and have well-expressed horizons are considered mature.

The soils of Norton County range from young soils that show little or no development to soils that have a well-developed subsoil. Examples of young soils are the Hobbs and Roxbury soils that formed in alluvium. These soils have few or weakly expressed horizons because fresh material is continuously deposited on them.

The Holdrege soils are mature enough to show definite horizon development. They have formed since late Pleistocene time, in Peorian Loess.

Road cuts expose pale-brown loess that contains many fossils of calcareous land snails. Many species of these snails are extinct or no longer found in the county. Fossils help geologists and soil scientists determine the age of the modern soil layers.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation (*7*). First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*10*). Because this system is under continual study, readers interested in developments of the current system should search the latest available literature.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 10, the soil series of Norton County are placed in higher categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER. Each order is divided into suborders that are based mainly on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, climate, the accumulation of clay, iron, or organic carbon in the upper part of the solum, cracking of soils caused by a decrease in moisture, and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is Ustoll (*Ust*, meaning dryness, and *oll*, from Mollisol).

TABLE 10.—*Classification of soil series*

Series	Family	Subgroup	Order
Campus	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Canlon	Loamy, mixed (calcareous), mesic	Lithic Ustorthents	Entisols.
Coly	Fine-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Cozad	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Detroit	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Hobbs	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Holdrege	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Hord	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Munjor	Coarse-loamy, mixed (calcareous), mesic	Typic Ustifluvents	Entisols.
Penden	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Roxbury	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Uly	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Wakeen	Fine-silty, carbonatic, mesic	Typic Haplustolls	Mollisols.

GREAT GROUP. Suborders are separated into great groups on the basis of uniformity in the kinds and sequences of major soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are acidity, climate, composition, and color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplustoll (*Hapl,* meaning simple horizons, *ust* for dryness, and *oll,* from Mollisols).

SUBGROUP. Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplustoll (a typical Haplustoll).

FAMILY. Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used to differentiate families. An example is the fine-silty, mixed, mesic family of Typic Haplustolls.

General Nature of the County

When the early settlers first came to what is now Norton County, native grass covered the soil and few trees grew along the major streams and tributaries. Because there was so little timber, the settlers had to seek other building material. Many of the first houses were constructed from sod, but some were constructed from limestone quarried from the Ogallala Formation. A church and adjacent buildings constructed from this material can be seen at New Almelo.

When Kansas became a state in 1861, Norton County was part of a territory but was organized in 1872. Billingsville was the first name of the county seat, but this was later changed to Norton. The population of the county was 7,002 in 1880, and according to reports of the Kansas State Board of Agriculture, it decreased from about 11,551 in 1930 to 7,650 in 1972. The population of Norton, the county seat and largest town in the county, was 3,792 in 1972 (*6*).

Agriculture is the main enterprise in Norton County. According to the 1969 Census of Agriculture, the 696 farms in the county average 753 acres in size. According to the Conservation Needs Inventory of 1967 (*8*) about 56 percent of the county is dryfarmed and about 1 percent is irrigated. The rest, except for towns, roads, and other facilities, is used for pasture and range. The growing of crops and the raising of livestock have about equal importance. For example, in 1971 field crops made up 49 percent and livestock and poultry products 51 percent of the value of farm products sold.

Corn was the most important crop in Norton County until the 1930's. In 1930 Norton County was the leading corn-producing county in Kansas and had 150,682 acres under cultivation. Wheat and grain sorghum are now the most important dryfarmed crops. According to the Kansas State Board of Agriculture, 87,000 acres of wheat, 39,000 acres of grain sorghum, 3,900 acres of corn, 2,000 acres of oats, 11,800 acres of alfalfa, and 8,000 acres of sorghum for forage were harvested in 1971.

The raising of livestock is a growing enterprise, and the number of beef cattle has been increasing steadily. Most farms in the county have a herd of beef cows and calves that are used to consume forage and to supplement income. The number of beef cattle increased from 18,674 in 1930 to 51,600 in 1971, but the number of dairy cattle decreased from 5,949 in 1930 to 1,400 in 1971. The number of hogs increased slightly from 13,600 in 1960 to 17,000 in 1970.

Transportation in Norton County is provided by highways and railroads. U.S. Highway 283 runs in a north-south direction through the county, and U.S. Highways 36 and 383 and State Highway 9 run in a generally east-west direction. Two of the railroads pass through the central part of the county and serve Almena and Norton, and a branch line of another railroad passes through the southern part of the county as far west as Lenora.

Among the farm-related industries in the county are, in most towns, grain elevators where grain is bought and stored. Farm machinery is sold in Norton and Almena. Norton Lake and Prairie Dog State Park, about 4 miles west of Norton, provide facilities for camping, boating, fishing, swimming, and picnicking. There is also a game refuge in the area immediately west and south of Norton Lake.

Climate

Except for a severe deficiency of moisture in some years, the climate of Norton County, which is dry and continental, is generally favorable for the successful growth of many crops. Contributing to the high potential for crops are percentage of possible sunshine received, length of the growing season, monthly distribution of precipitation, and temperatures during the growing season. The freeze-free period is 5½ months long and extends from April 29 to October 11.

Table 11 gives temperature and precipitation data for the county, and table 12 (*2*) shows probabilities for specified low temperatures in spring and fall.

TABLE 11.—*Temperature and precipitation data*

[From records kept at Norton, Kansas]

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have about 4 days with— Maximum temperature equal to or higher than—	Two years in 10 will have about 4 days with— Minimum temperature equal to or lower than—	Average monthly total [2]	One year in 10 will have— Less than—	One year in 10 will have— More than—
	°F	°F	°F	°F	Inches	Inches	Inches
January	39.7	15.6	61	−4	0.50	0.01	0.85
February	44.4	19.5	67	4	.61	.01	1.70
March	53.3	26.6	77	8	1.17	.10	2.66
April	65.2	38.3	84	26	1.99	.40	4.37
May	74.6	48.6	91	36	3.37	.93	5.82
June	85.4	59.1	101	48	4.31	.89	7.61
July	92.1	64.6	104	56	3.70	1.18	6.84
August	90.6	62.9	104	53	2.56	.73	4.50
September	82.0	53.9	98	40	2.06	.38	3.46
October	69.7	41.4	88	29	1.47	.09	3.92
November	53.7	28.0	72	12	.58	.01	1.84
December	41.6	19.0	63	4	.45	.01	1.12
Year	66.0	39.8	[3] 106	[4] −12	22.77	13.52	28.87

[1] For the period 1899–1960.
[2] For the period 1941–1970.
[3] Average annual highest temperature.
[4] Average annual lowest temperature.

TABLE 12.—*Probabilities for specified low temperatures in spring and fall*

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 11	April 15	April 18	May 5	May 14
2 years in 10 later than	April 5	April 9	April 13	April 30	May 9
5 years in 10 later than	March 24	March 30	April 4	April 20	April 29
Fall:					
1 year in 10 earlier than	October 29	October 21	October 17	October 7	September 27
2 years in 10 earlier than	November 4	October 26	October 21	October 12	October 1
5 years in 10 earlier than	November 16	November 6	October 31	October 21	October 11

Although the Gulf of Mexico is the principal source of moisture for precipitation in Kansas (*3*), the western part of the state, including Norton County, is infrequently in the flow of moist air from the Gulf. Norton County is in the rain shadow of the Rocky Mountains, and its annual rainfall is 22.7 inches. The low rainfall is partly offset by the seasonal distribution of precipitation. More then three-fourths of the precipitation is received during the 6-month period April through September. More than 2½ inches of rainfall is received each month during the period May through August, and an average of more than 4 inches is received in June, the wettest month. Winters are dry. On the average, less than 0.75 inch of rain is received in 1 month during the period December through February.

As in most dry climates, precipitation has varied widely from month to month and from year to year. In 1966 at Norton, only 0.39 inch of rain fell in May, but 6.37 inches fell in June. During the period of record, annual precipitation has ranged from 12.48 inches, which fell in 1937, to 34.45 inches, which fell in 1965. Several consecutive months of dry weather are not unusual, and droughts have extended over a period of years at irregular intervals. One of the worst droughts of record lasted from 1934 to 1939, a period when the annual precipitation averaged 8 inches below the long-term mean.

Cold winters and hot summers, both typical of a midlatitude continental climate, prevail in Norton County, and variations in daily and annual temperatures are relatively large. The daily range averages more than 27° and is the most pronounced in October when a daily range of more than 40° occurs occasionally. The mean monthly temperature ranges from 27.5° in January, the coldest month, to 78.5° in July. The change from the warm to the cold season is quite rapid: the monthly mean for October is 55.2° but for November it is 41°.

In most years the annual extremes of temperature range from below 0 to more than 100° above. Except during summer, temperatures are occasionally moderated by warm chinook winds that blow downslope from higher elevations to the west.

Snowfall in Norton County is light to moderate and averages about 24 inches a year. It has ranged from less than 12 inches in some winters to more than 0 in others. March is the month when snowfall is heaviest. Blizzards occur at times and bring high winds and drifting snow.

The annual average wind velocity is about 10 to 12 miles per hour. The highest average wind velocity, about 13 or 14 miles an hour, occurs in the period March through May. During periods of dry weather, particularly during March and April, strong winds may cause soil blowing. The prevailing winds are northerly and northwesterly during the period November through March and southerly during the period April through October.

Relative humidity averages nearly 60 percent for the year and is lowest during hot, dry afternoons in midsummer. Humidity of less than 20 percent occurs occasionally, and humidity of less than 15 percent has been reported.

More than one-third of the days in Norton County are clear; only one-third are cloudy. The mean percentage of possible sunshine is more than 70 but ranges from 65 in winter to about 80 in July.

Physiography, Relief, and Drainage

Most of Norton County is on rolling plains and breaks in the Great Plains physiographic province (*11*). In most of the county, relief consists of nearly level, gently sloping, and sloping ridgetops, which are mantled with loess and separated by the steeper slopes along the drainageways. The areas immediately south of Sappa Creek, Prairie Dog Creek, and the North Fork Solomon River are more mature and dissected. In these areas are narrow ridgetops and steeper, more precipitous south walls. The tributaries that flow north into these streams are shorter, steeper, and more numerous than those that flow south.

Prairie Dog Creek and Sappa Creek, which are the major drainageways for the central and northern parts of the county, flow in a general east-northeast direction and join the Republican River in Nebraska. The North Fork Solomon River flows east across the southern part of the county and flows into the Solomon River to the southeast and then out of the county.

Elevation ranges from 2,012 feet above sea level in the North Fork Solomon River Valley in the southeastern part of the county to more than 2,550 feet near the western edge of the county.

Water Supply

Because Norton County receives a limited amount of rainfall, water is an important resource. For domestic use on farms, it is obtained mainly from wells that have been drilled or dug. For watering livestock on range or pasture, it is also obtained mainly from wells, but some is supplied by farm ponds that have been built on intermittent streams. Most of the wells on uplands obtain all or part of their water from the sand and gravel of the Ogallala Formation, which is the most widespread source of ground water in Norton County (*5*). In the southeastern part of the county where there are not adequate deposits of Ogallala sand and gravel, the supply of water is deficient in many years when the ponds or wells go dry.

On terraces along Sappa Creek, Prairie Dog Creek, and the North Fork Solomon River, the major streams, underground deposits of sand and gravel are the most important source of ground water for irrigation as well as municipalities and industry. Wells into these deposits supply most of the water used for irrigation. A diversion dam and canal system have been constructed near Almena and the water is used for irrigation in Norton County. Water is also available from Norton Lake for use by the city of Norton and for irrigation in Prairie Dog Valley.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

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

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

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

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Ground water (geology). Water that fills all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

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

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil, series, or other unit in the soil 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 series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	Ph		*Ph*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Rotation grazing. Grazing two or more pastures, or parts of a range, in regular order, with definite recovery periods between grazing periods. Contrasts with continuous grazing.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and the description of the soil series to which the mapping unit belongs. An explanation of the capability classification system begins on page 21.

Map symbol	Mapping unit	Described on page	Capability unit Dryland	Capability unit Irrigated	Range site Name	Windbreak suitability group
Cc	Campus-Canlon complex, 6 to 30 percent slopes	9	VIe-3	-----	-------------	--
	Campus	--	-----	-----	Limy Upland	--
	Canlon	--	-----	-----	Shallow Limy	--
Co	Coly and Uly silt loams, 6 to 10 percent slopes, eroded	10	IVe-1	-----	-------------	3
	Coly	--	-----	-----	Limy Upland	--
	Uly	--	-----	-----	Loamy Upland	--
Cs	Coly and Uly silt loams, 10 to 20 percent slopes, eroded	10	VIe-1	-----	-------------	3
	Coly	--	-----	-----	Limy Upland	--
	Uly	--	-----	-----	Loamy Upland	--
Cu	Cozad silt loam, 0 to 2 percent slopes	11	IIc-2	I-2	Loamy Terrace	1
Cz	Cozad silt loam, 2 to 5 percent slopes	11	IIe-2	IIe-2	Loamy Terrace	1
Dt	Detroit silty clay loam	12	IIc-3	I-3	Loamy Terrace	1
Hb	Hobbs silt loam	13	IIw-1	IIw-1	Loamy Lowland	1
Ho	Holdrege silt loam, 0 to 1 percent slopes	13	IIc-1	I-1	Loamy Upland	2
Hp	Holdrege silt loam, 1 to 3 percent slopes	14	IIe-1	IIe-1	Loamy Upland	2
Hr	Holdrege silt loam, 1 to 3 percent slopes, eroded	14	IIe-1	IIe-1	Loamy Upland	2
Hs	Holdrege silt loam, 3 to 6 percent slopes	14	IIIe-1	-----	Loamy Upland	2
Ht	Holdrege silt loam, 3 to 6 percent slopes, eroded	14	IIIe-1	-----	Loamy Upland	2
Hz	Hord silt loam	15	IIc-2	I-2	Loamy Terrace	1
Mu	Munjor complex	16	IIIw-1	IIw-2	Sandy Lowland	1
Rx	Roxbury silt loam	17	IIc-2	I-2	Loamy Terrace	1
Ub	Uly silt loam, 6 to 10 percent slopes	18	IVe-1	-----	Loamy Upland	3
Uc	Uly complex, 10 to 20 percent slopes	18	VIe-1	-----	Loamy Upland	3
Up	Uly-Penden complex, 6 to 20 percent slopes	19	VIe-1	-----	-------------	3
	Uly	--	-----	-----	Loamy Upland	--
	Penden	--	-----	-----	Limy Upland	--
Wa	Wakeen complex, 6 to 20 percent slopes	19	VIe-3	-----	Limy Upland	3

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