SOIL SURVEY OF

Ness 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.

Major fieldwork for this soil survey was completed in the period 1963–70. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. 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 Ness County Soil Conservation District.

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 agriculture, industry, and recreation.

Locating Soils

All the soils of Ness 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 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, range site, 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 soil map and the information in the text. Translucent material can be used as an overlay over the 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 with a moderate limitation can be colored yellow, and those with 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 range sites.

Foresters and others can refer to the section "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees.

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

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

Engineers and builders can find, under "Enginering 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 the Soils."

Newcomers in Ness 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 "Additional Facts About the County."

Cover: Cattle on native grass range in an area of Harney soils. In the background are soils of the Heizer-Wakeen-Uly association.

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SOIL SURVEY OF NESS COUNTY, KANSAS

BY DONALD E. ROTT AND ROGER L. HABERMAN

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

NESS COUNTY, in the west-central part of Kansas, covers a total area of 1,081 square miles, or 691,840 acres (fig. 1). Ness City, near the center of the county, is the county seat.

Farming is the most important enterprise in the county. Wheat and grain and forage sorghum are the main dryland crops. Some corn and alfalfa are grown in the valleys. Beef cattle are the main kind of livestock in the county. Some dairy cows, sheep, hogs, and poultry are also raised.

Most of the soils in the Pawnee River Valley are irrigated. Soils in the Walnut Creek Valley, in areas where an adequate supply of good quality water is available, are also irrigated.

Ness County is in two major land resource areas. The western part is in the Central High Table Land area, and the eastern part is in the Rolling Plains and Breaks area (*11*).[1]

Elevation ranges from about 2,060 feet above sea level on Walnut Creek near the east county line to 2,665 feet near Utica in the northwest corner of the county. The rise is about 10 feet to the mile in a west-to-northwest direction. Brownell, in the northeastern part of the county, and Beeler, in the Walnut Creek valley in the west-central part, are at an elevation of 2,500 feet. Ness City, near the center of the county, has an elevation of 2,240 feet.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Ness County, where they are located, and how they can be used. They went into the county knowing that they probably would find many soils they had already seen, and perhaps some unfamiliar ones. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed greatly by leaching or by the action of plant roots.

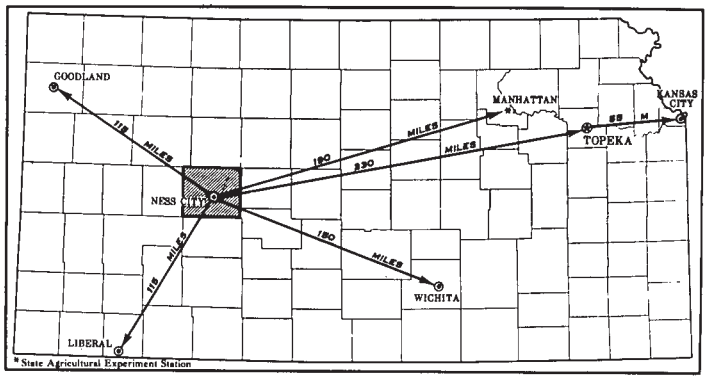

Figure 1.—Location of Ness County in Kansas.

The soil scientists made comparisons among the profiles they studied, and they compared these with others in nearby counties and in more distant places. They classified and named the soils according to 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 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. Many soil series are named for a town or other geographic feature near the place where a soil of that series was first observed and mapped, while the names of some series are coined. Harney and Roxbury, for example, are the names of two soil series. All the soils in the United States that have 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 the use of the soils 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, Harney silt loam, 1 to 3 percent slopes, is one of several phases within the Harney 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 buildings, field borders, trees, and similar details that help in drawing boundaries accurately. The soil map in the back of this survey 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 management of farms and fields, a mapping

[1] Italic numbers in parentheses refer to Literature Cited, p. 50.

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. One such kind of mapping unit, a soil complex, is shown on the soil map of Ness County.

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. Heizer-Wakeen complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names, such as Alluvial land, broken.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, 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 a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named 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 the 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 Ness 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 that are suitable for a certain kind of land 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, recreation 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 or 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 soil associations in Ness County are discussed in the following pages.

1. Roxbury-Bridgeport-Hord association

Deep, nearly level, loamy soils on bottom lands and low terraces

This association consists of areas in the valleys along Pawnee River, Walnut Creek, and their larger tributaries. The areas are broad and nearly level, but in some places they are interrupted by abandoned stream channels.

This association occupies about 9 percent of the county. It is about 45 percent Roxbury soils, 20 percent Bridgeport soils, 20 percent Hord soils, and 15 percent minor soils (fig. 2).

Roxbury soils are well drained to moderately well drained. In a typical profile the surface layer is grayish-brown heavy silt loam about 21 inches thick. The subsoil is dark grayish-brown silty clay loam about 13 inches thick. The underlying material is grayish-brown and light brownish-gray silty clay loam.

Bridgeport soils are well drained. In a typical profile the surface layer is dark grayish-brown silt loam about 12 inches thick. The next layer is grayish-brown silt loam about 10 inches thick. The underlying material is light brownish-gray light silt loam.

Hord soils are well drained. In a typical profile the surface layer is dark grayish-brown silty clay loam about 12 inches thick. The subsoil is dark grayish-brown and grayish-brown silty clay loam about 23 inches thick. The underlying material is brown silty clay loam.

The minor soils in this association are in the Detroit and Ness series. Areas of Alluvial land, broken, are also included. Detroit soils are nearly level and are well drained to moderately well drained. Ness soils occupy ponded, enclosed depressions. Alluvial land, broken, consists of steep, broken banks of stream channels and small, disconnected areas of low bottom land that are subject to frequent flooding.

The major farm enterprises in this association are the growing of cash crops and feeding of beef cattle. Most of this association is cultivated; areas where adequate water is available are irrigated. The major

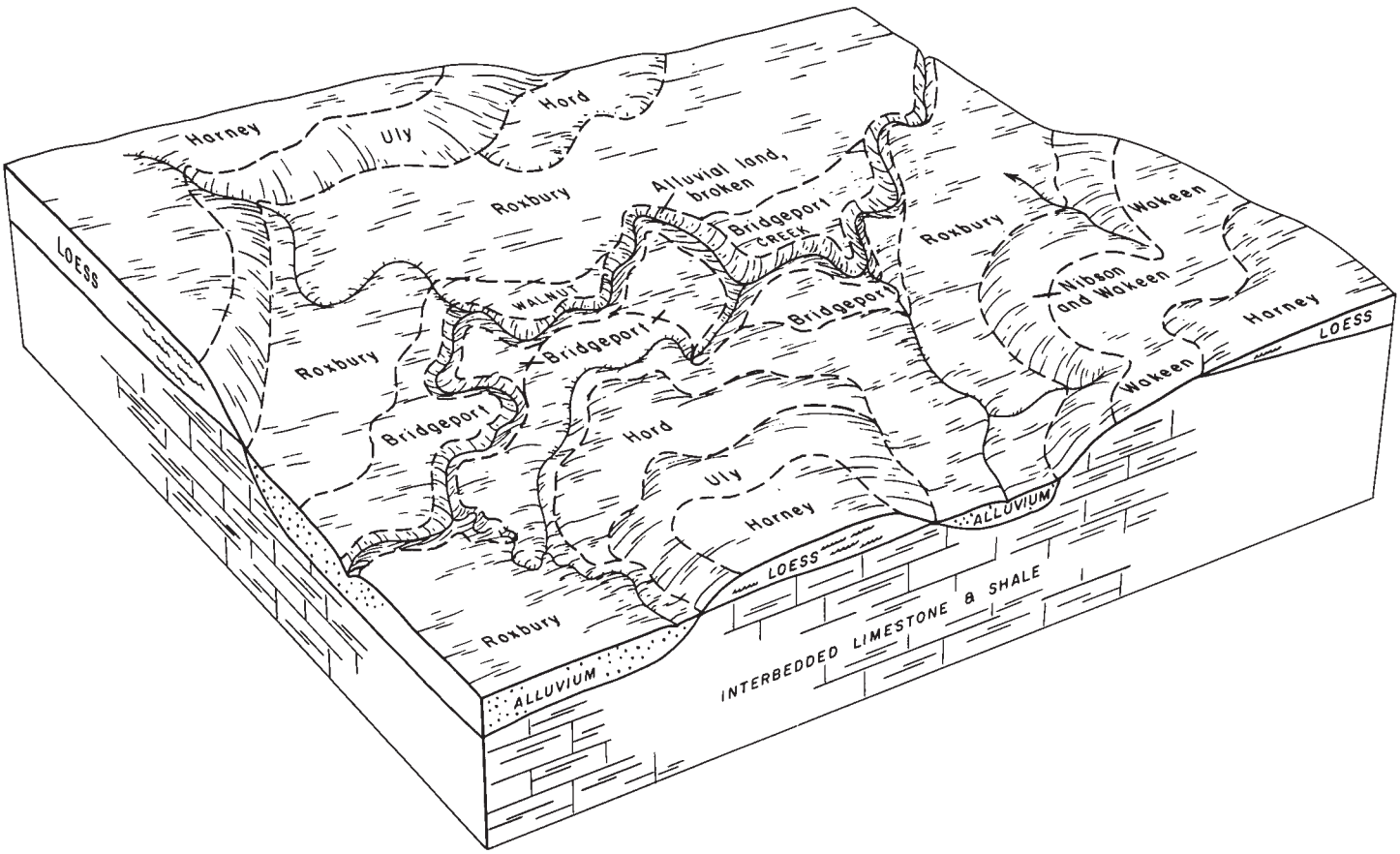

Figure 2.—**Parent material and position of soils in association 1 in relationship to nearby soils.**

soils are well suited to all crops commonly grown in the county. Alluvial land, broken, is used for range. In some places deciduous trees grow near the stream channel. The major soils have a high available water capacity. Roxbury and Hord soils have high fertility, and Bridgeport soils have moderate fertility. The main concerns of management are controlling soil blowing and keeping the soils in good tilth.

This association joins the Roxbury-Bridgeport association in Hodgeman County, where the Hord soils are not so large a component of the association.

2. *Harney-Uly association*

Deep, nearly level to sloping, loamy soils on uplands

This association consists mainly of broad, nearly level areas. Narrow, gently sloping to sloping areas are along small, widely spaced, upland drainageways.

This association occupies about 8 percent of the county. It is about 80 percent Harney soils, 15 percent Uly soils, and 5 percent minor soils.

Harney soils are in broad areas. They are nearly level and well drained. In a typical profile the surface layer is about 11 inches thick. The upper part of this layer is grayish-brown silt loam, and the lower part is dark grayish-brown light silty clay loam. The subsoil is about 22 inches thick. The upper part of the subsoil is grayish-brown heavy silty clay loam, and the lower part is very pale brown silty clay loam. The underlying material is very pale brown light silty clay loam.

Uly soils are gently sloping and sloping and are well drained. In a typical profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is grayish-brown heavy silt loam about 8 inches thick. The underlying material is pale-brown and light-brown light silty clay loam.

The minor soils in this association are in the Coly and Ness series. Coly soils are on short slopes adjoining the drainageways. Ness soils occupy small, ponded, enclosed depressions.

Nearly all of this association is cultivated, mainly to wheat and sorghum. Some of the more sloping soils on drainageways are in grass and are used as range. Harney soils have high fertility, and Uly soils have moderate fertility. Both Harney and Uly soils have a high available water capacity. The main concerns of management are conserving moisture, controlling water erosion and soil blowing, and keeping the soils in good tilth.

3. *Harney-Uly-Coly association*

Deep, gently sloping and sloping, loamy soils on uplands

This association consists of broad, gently sloping and sloping areas that are dissected by intermittent upland drainageways. Slopes along the drainageways

are short in most places and are steeper than in other parts of the association.

This association occupies about 70 percent of the county. It is about 61 percent Harney soils, 20 percent Uly soils, 9 percent Coly soils, and 10 percent minor soils (fig. 3).

Harney soils are gently sloping and are in broad areas. They are well drained. In a typical profile the surface layer is about 11 inches thick. The upper part of this layer is grayish-brown silt loam, and the lower part is dark grayish-brown light silty clay loam. The subsoil is about 22 inches thick. The upper part of the subsoil is grayish-brown heavy silty clay loam, and the lower part is very pale brown silty clay loam. The underlying material is very pale brown light silty clay loam.

Uly soils are gently sloping and sloping and are well drained. In a typical profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is grayish-brown heavy silt loam about 8 inches thick. The underlying material is pale-brown and light-brown light silty clay loam.

Coly soils are gently sloping and sloping and are well drained to somewhat excessively drained. In a typical profile the surface layer is grayish-brown silt loam about 3 inches thick. The next layer is pale-brown silt loam about 11 inches thick. The underlying material is a very pale brown silt loam.

The minor soils in this association are in the Bridgeport, Corinth, Heizer, Penden, Roxbury, Timken, and Wakeen series. Bridgeport and Roxbury soils occupy narrow, low flood plains that are subject to frequent flooding and, in some places, are interrupted by old abandoned stream channels. Heizer and Timken soils are mainly on the short, steep breaks adjoining deeply incised drainageways or valley floors. Corinth soils are mainly on narrow side slopes and are underlain by calcareous shale. Penden soils are sloping and are underlain by loamy sediment. Wakeen soils are gently sloping and sloping and are underlain by chalky limestone.

The major enterprises on this association are the growing of cash crops and raising of beef cattle. A large part of the association is cultivated, mainly to wheat and sorghum. The strongly sloping to steep soils are in grass and are used as range. The major soils have a high available water capacity. Harney soils have high fertility, and Uly and Coly soils have moderate fertility. The main concerns in managing cultivated fields are conserving moisture, controlling water erosion and soil blowing, and keeping the soils in good tilth.

4. Heizer-Wakeen-Uly association

Shallow to deep, sloping to steep, loamy soils on uplands

This association is dissected by drainageways.

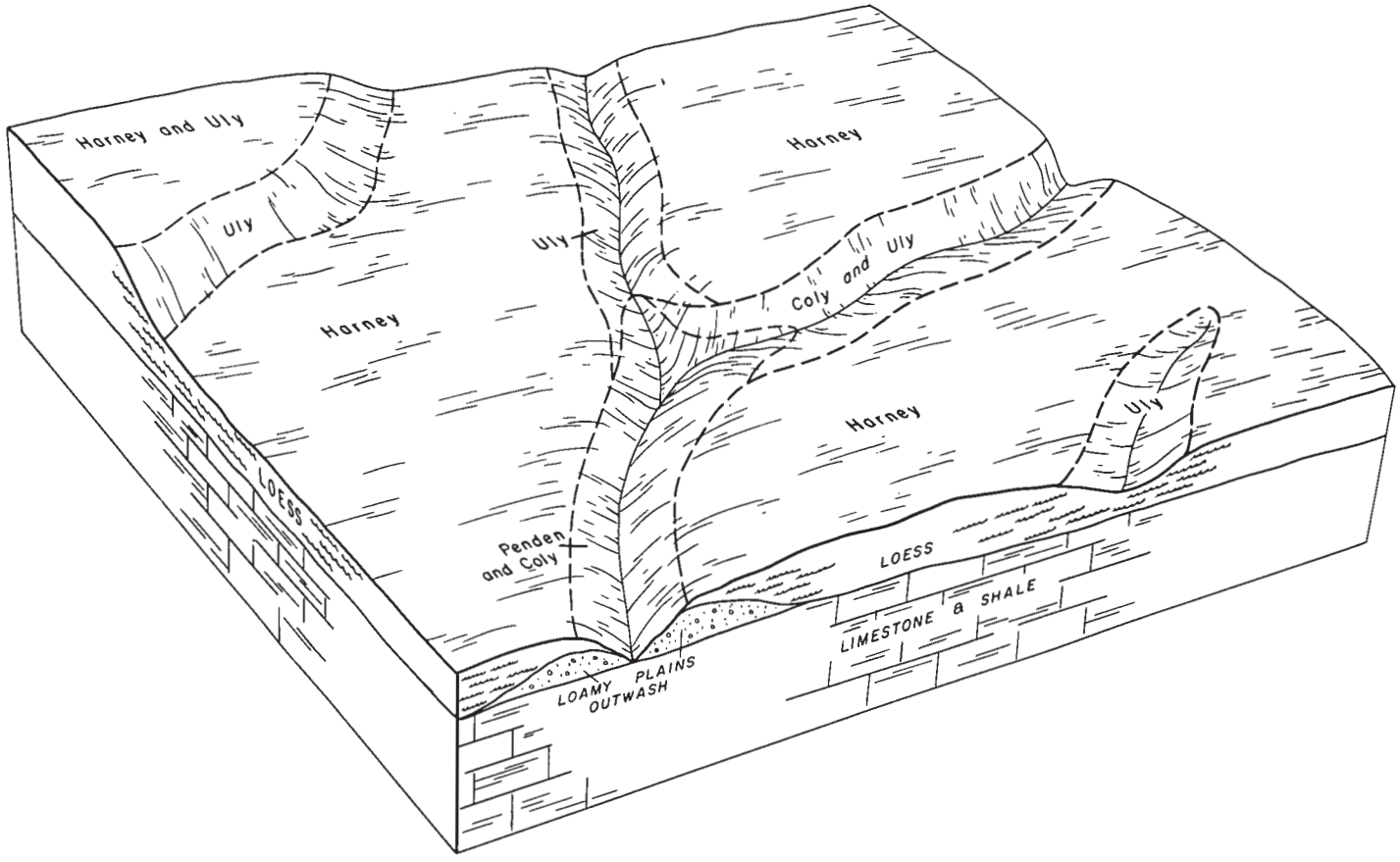

Figure 3.—**Parent material and position of soils in association 3.**

Slopes are irregular, and the elevation varies considerably over short distances. Bands of rock outcrop are common in most places.

This association occupies about 10 percent of the county. It is about 30 percent Heizer soils, 30 percent Wakeen soils, 20 percent Uly soils, and 20 percent minor soils (fig. 4).

Heizer soils are sloping to steep and are well drained. In a typical profile the surface layer is grayish-brown loam about 6 inches thick. The next layer is gray gravelly loam about 3 inches thick. The underlying material is light brownish-gray channery loam. Chalky limestone is at a depth of about 13 inches.

Wakeen soils are gently sloping to moderately steep and are well drained. In a typical profile the surface layer is grayish-brown heavy silt loam about 13 inches thick. The subsoil is pale-brown silty clay loam about 10 inches thick. The underlying material is very pale brown silty clay loam. Chalky limestone is at a depth of about 32 inches.

Uly soils are gently sloping to sloping and are well drained. In a typical profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is grayish-brown heavy silt loam about 8 inches thick. The underlying material is pale-brown and light-brown silty clay loam.

The minor soils in this association are dominantly in the Coly, Harney, Penden, Nibson, and Timken series. Coly and Penden soils are sloping and have short slopes. Harney soils are gently sloping and have longer slopes. Nibson soils are gently rolling to steep and are underlain by chalky shale. Timken soils occupy rough, hilly slope breaks and areas adjacent to deeply incised drainageways. Rock outcrops are common in areas of Heizer and Wakeen soils.

Nearly all of this association is in grass and is used as range. A few large areas of the gently sloping and sloping Wakeen and Uly soils are cultivated to wheat and sorghum. Heizer soils have a very low available water capacity. Wakeen and Uly soils have a high available water capacity. Heizer soils have low fertility, and Wakeen and Uly soils have moderate fertility. The main concern in managing grassland is maintaining an adequate and vigorous stand of grass. Controlling runoff and erosion and conserving moisture are the main concerns in managing cultivated fields.

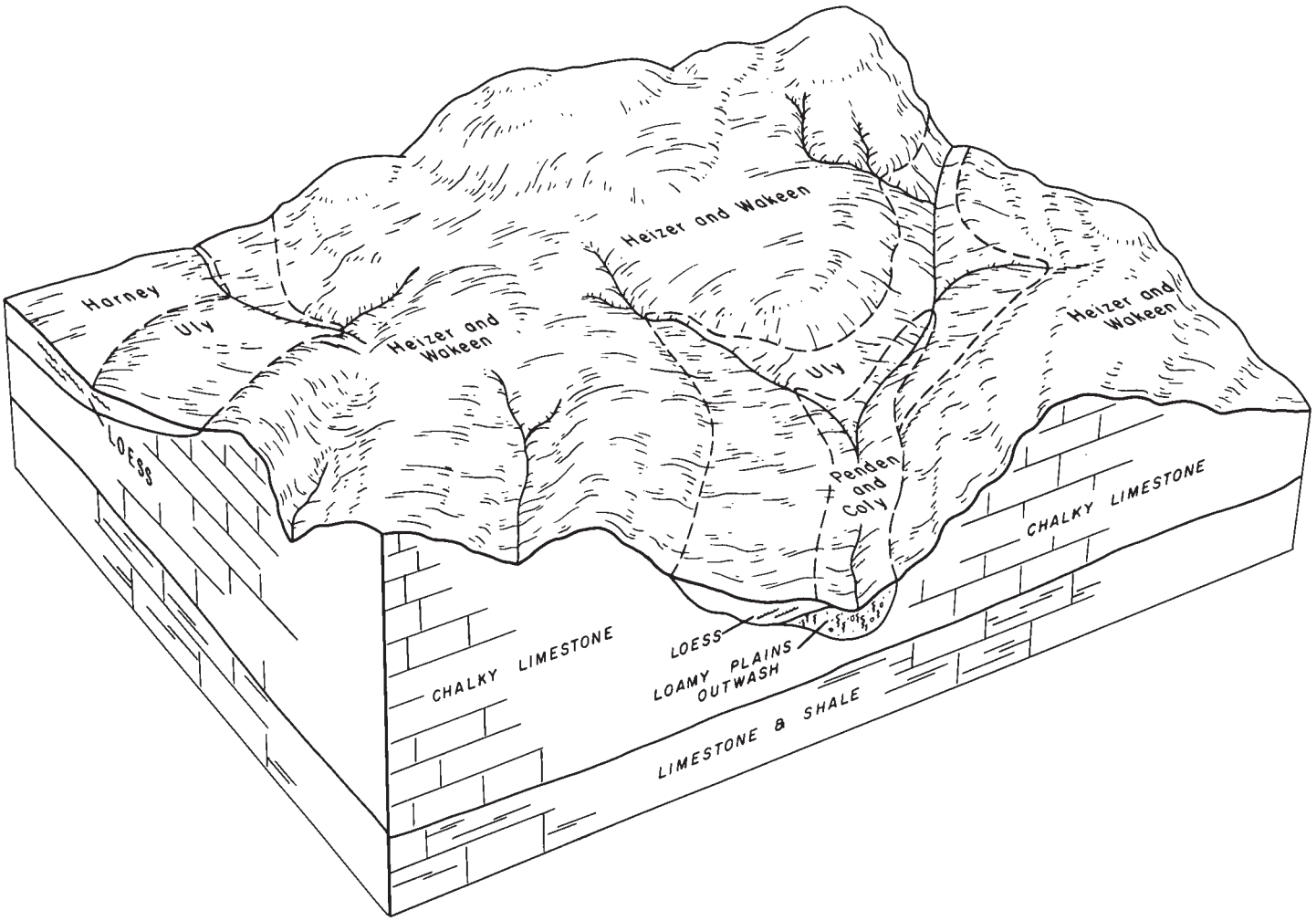

***Figure 4.*—Parent material and position of soils in association 4.**

5. *Campus-Canlon-Penden association*

Shallow to deep, gently sloping to steep, loamy soils on uplands

This association consists of irregularly sloping areas in which the elevation varies greatly over short distances. Bands of rock outcrop are common in most places.

This association occupies about 3 percent of the county. It is about 30 percent Campus soils, 22 percent Canlon soils, 20 percent Penden soils, and 28 percent minor soils (fig. 5).

Campus soils are gently sloping to strongly sloping and are well drained. In a typical profile the surface layer is grayish-brown heavy loam about 7 inches thick. The next layer is light brownish-gray clay loam about 8 inches thick. The underlying material is very pale brown clay loam. Caliche beds are at a depth of about 28 inches.

Canlon soils are sloping to steep and are well drained to somewhat excessively drained. In a typical profile the surface layer is grayish-brown loam about 4 inches thick. The next layer is grayish-brown loam about 5 inches thick. The underlying material is light brownish-gray loam. Hard caliche is at a depth of about 14 inches.

Penden soils are gently sloping to moderately steep and are well drained. In a typical profile the surface layer is about 14 inches thick. The upper 8 inches of this layer is dark grayish-brown light clay loam, and the lower 6 inches is grayish-brown clay loam. The underlying material is pale-brown clay loam.

The minor soils in this association are in the Coly, Heizer, Uly, and Wakeen series. Some small areas of Rock land are also included. Coly and Uly soils are sloping. They are on short hillsides. Heizer soils are on narrow slope breaks and side slopes. Wakeen soils are on short side slopes. Areas of Rock land are along steep slope breaks and dissected areas.

Most of this association is in grass and is used as range. A few of the larger gently sloping and sloping areas are cultivated, mainly to wheat and sorghum. Campus soils are so intermixed with some shallow soils and rocky areas that they are better suited to range than to most other uses. Canlon soils are shallow and are not suited to crops. Campus soils have a low available water capacity, Canlon soils have a very low available water capacity, and Penden soils have a

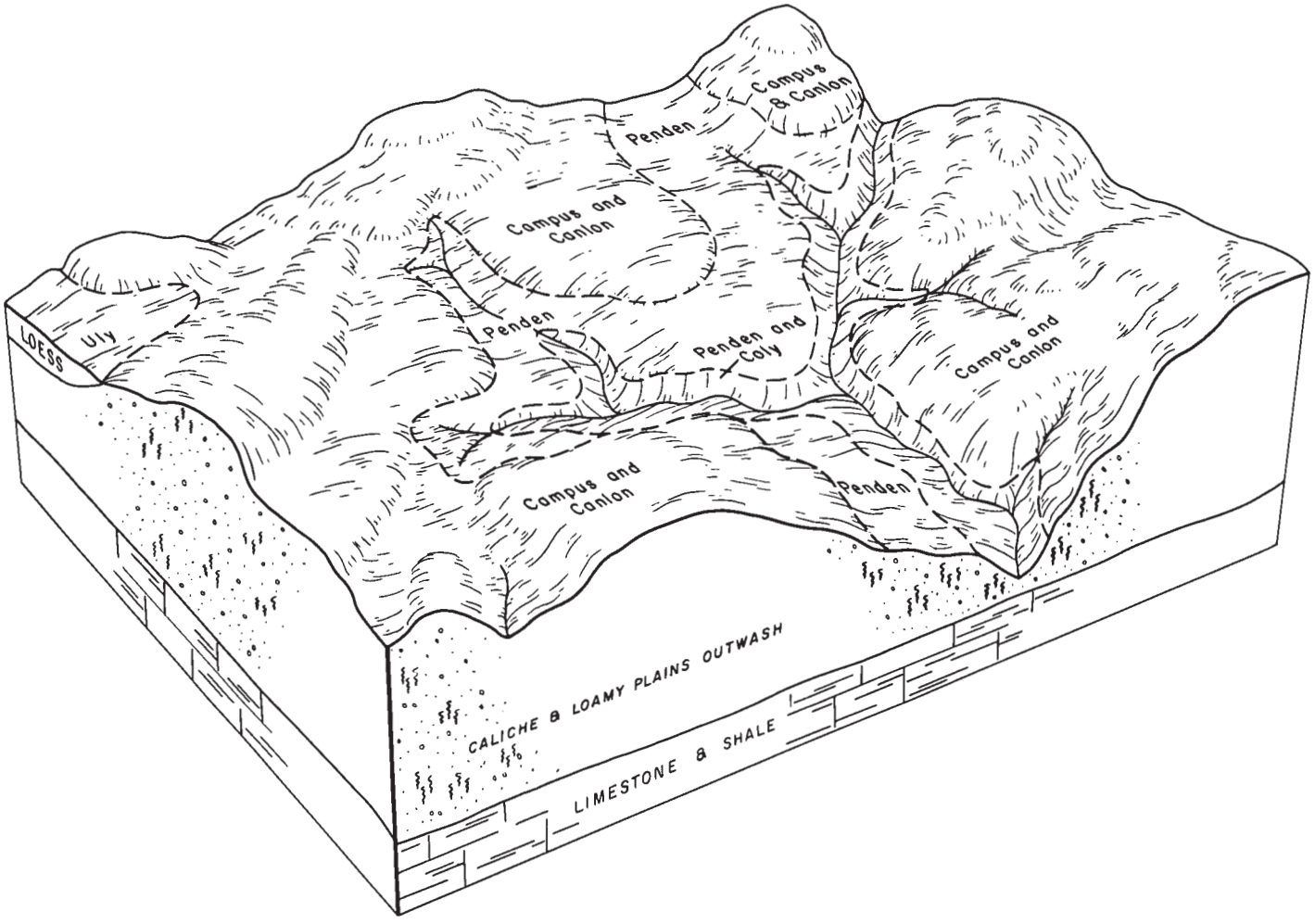

Figure 5.—**Parent material and position of soils in association 5.**

high available water capacity. Campus and Penden soils have moderate fertility. Canlon soils have low fertility. The main concerns in managing cultivated fields are conserving moisture and controlling surface runoff and soil blowing. The main concern in managing grassland is maintaining a vigorous stand of desirable grass.

Descriptions of the Soils

This section describes the soil series and mapping units in Ness County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that 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 soil 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 detailed and in technical terms; it is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a dry soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are of a soil series. Alluvial land, broken, for example, does not belong to a soil series but nevertheless is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page for the description of each range site can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The approximate 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 at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*9*).

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

Soil	Area	Extent
	Acres	*Percent*
Alluvial land, broken	8,730	1.3
Bridgeport silt loam	13,250	1.9
Campus-Canlon complex	10,340	1.5
Coly-Uly silt loams, 3 to 6 percent slopes, eroded	21,360	3.1
Detroit silty clay loam	840	.1
Harney silt loam, 0 to 1 percent slopes	171,440	24.8
Harney silt loam, 1 to 3 percent slopes	170,660	24.7
Harney silty clay loam, 1 to 3 percent slopes, eroded	6,930	1.0
Harney-Uly silt loams, 0 to 1 percent slopes	5,300	.8
Harney-Uly silt loams, 1 to 3 percent slopes	3,990	.6
Heizer-Wakeen complex	29,050	4.2
Hord silty clay loam	14,200	2.0
Ness clay	600	.1
Nibson-Wakeen complex	2,150	.3
Penden clay loam, 3 to 6 percent slopes	11,270	1.6
Penden clay loam, 3 to 6 percent slopes, eroded	2,920	.4
Penden-Bridgeport complex	15,770	2.3
Penden-Coly complex	27,360	4.0
Rock land-Heizer complex	1,660	.2
Roxbury silt loam	23,930	3.5
Roxbury silt loam, frequently flooded	15,220	2.2
Timken complex	3,610	.5
Uly silt loam, 1 to 3 percent slopes	68,540	9.9
Uly silt loam, 3 to 6 percent slopes	35,820	5.2
Uly-Coly silt loams, 1 to 3 percent slopes, eroded	9,810	1.4
Uly-Corinth complex, 1 to 3 percent slopes	4,250	.6
Uly-Corinth complex, 3 to 6 percent slopes	1,380	.2
Wakeen silt loam, 1 to 3 percent slopes	6,780	1.0
Wakeen silt loam, 3 to 6 percent slopes	4,480	.6
Gravel pits and limestone quarries	200	(1)
Total	691,840	100.0

[1] Less than 0.05 percent.

Alluvial Land, Broken

Alluvial land, broken (Ab), consists of the steep, broken banks of streams and narrow, irregularly shaped, disconnected areas of low bottom lands that are subject to frequent flooding. The streambanks have slopes that range from about 10 percent to nearly vertical. The bottom lands have slopes that range from 0 to 3 percent. Areas of this mapping unit are 150 feet or more in width (fig. 6). Steep, broken banks of streams and channels form most of the unit. When the water is high, the entire acreage is subject to scouring and deposition. This unit separates areas of Bridgeport, Roxbury, and Hord soils and is along the major creeks and their tributaries.

The streambanks are loamy and excessively drained.

Figure 6.—**An area of Alluvial land, broken. Trees are growing on the narrow bottom lands that adjoin the stream channel.**

The low bottom lands are loamy, subject to frequent overflow, and generally well drained.

This mapping unit is better suited to range than to most other uses because of the steep slopes and the frequent flooding of the bottom lands. The vegetation is mainly annual weeds and grasses, but there is some western wheatgrass. Elm, ash, willow, and cottonwood trees grow on some of the narrow bottom lands near the base of the steep banks. In some places, waterholes dry up only in times of prolonged drought. Dryland capability unit VIIw–1; range site and windbreak suitability group not assigned.

Bridgeport Series

The Bridgeport series consists of deep, loamy soils on bottom lands and low stream terraces. These soils formed in silty alluvium. The dominant slopes are 0 to 1 percent, but in a few areas slopes range up to 2 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 12 inches thick. The next layer is grayish-brown, friable silt loam about 10 inches thick. The underlying material is light brownish-gray light silt loam.

Bridgeport soils are well drained and have moderate permeability. They have a high available water capacity and moderate fertility.

Representative profile of Bridgeport silt loam, 200 feet east and 320 feet south of the northwest corner of the northeast quarter of sec. 8, T. 19 S., R. 23 W., in range:

A1—0 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; many fine roots; few worm casts; slightly effervescent below a depth of 4 inches; moderately alkaline; gradual, smooth boundary.

AC—12 to 22 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky and weak, fine, granular structure; slightly hard, friable; common fine roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—22 to 60 inches, light brownish-gray (10YR 6/2) light silt loam, grayish brown (10YR 5/2) moist; stratified with thin lenses of sandy loam and, in the lower part of the horizon, with broader bands of darker colored silt loam; massive; hard, friable; few fine roots; few fine pores; few threads and films of free carbonates; strongly effervescent; moderately alkaline.

The A1 horizon ranges from very dark grayish brown to grayish brown and is 10 to 20 inches thick. This horizon is silt loam in most places but is loam or fine sandy loam in some places. The AC horizon ranges from brown or grayish brown to light brownish gray or pale brown. It is silt loam or loam and is 6 to 15 inches thick. In some places the AC horizon is stratified with thin layers of coarser textured sediment. The C horizon ranges from grayish brown or brown to light gray or very pale brown. In some places faint mottles are below a depth of 40 inches.

Bridgeport soils are on bottom lands similar to those occupied by Roxbury soils. In most places they are in lower positions than Hord soils. Bridgeport soils are not dark colored to so great a depth as Roxbury soils. They lack the B2 horizon of Hord soils and are calcareous nearer the surface than those soils.

Bridgeport silt loam (0 to 2 percent slopes) (Br).—This soil is nearly level and is on bottom lands, mostly near stream channels. Included with it in mapping are a few small areas of Roxbury and Hord soils and a few small areas of a soil that is similar to Bridgeport soils but is more sandy.

Wheat and sorghum are the main dryland crops grown on this soil. Corn and alfalfa are commonly grown under irrigation. Some places in the lower areas are subject to occasional flooding, which harms crops and delays tillage and planting. This soil blows when dry if it lacks a protective cover of crop residue or vegetation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. Dryland capability unit IIc–2, irrigated capability unit I–1; Loamy Terrace range site; windbreak suitability group 1.

Campus Series

The Campus series consists of moderately deep, loamy soils on uplands. These soils formed in material weathered from the underlying caliche. Slopes range from 2 to 10 percent. Caliche bedrock is at a depth of 20 to 40 inches. In this county these soils are mapped only in a complex with Canlon soils.

In a representative profile the surface layer is grayish-brown heavy loam about 7 inches thick. The next layer is light brownish-gray, friable clay loam about 8 inches thick. The underlying material is very pale brown clay loam about 13 inches thick. Caliche bedrock is at a depth of 28 inches.

Campus soils are well drained and have moderate permeability. They have a low available water capacity and moderate fertility.

Representative profile of Campus loam, in an area of Campus-Canlon complex, 600 feet west and 1,320 feet north of the southeast corner of sec. 24, T. 17 S., R. 24 W., in range:

A1—0 to 7 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; many fine roots; few soft masses of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

AC—7 to 15 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, granular structure; slightly hard, friable; common fine roots; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1ca—15 to 28 inches, very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) moist; massive; hard, firm; few fine roots; many fragments of caliche and soft masses of lime; lime content more than 25 percent; violently effervescent; mildly alkaline; clear, smooth boundary.

C2—28 inches, semiconsolidated caliche.

The A horizon ranges from grayish brown to dark grayish brown and is 6 to 10 inches thick. This horizon is loam or clay loam. The AC horizon ranges from light brownish gray to grayish brown. It is about 18 to 35 percent clay and more than 15 percent fine or coarser sand. It is 4 to 12 inches thick. The content of lime in the Cca horizon ranges from about 25 to 50 percent.

Campus soils are near Canlon and Penden soils. They are deeper than Canlon soils, which formed in similar material, and are dark colored to a greater depth. They are not so deep as Penden soils, which formed in calcareous outwash sediment.

Campus-Canlon complex (Cc).—This mapping unit is on uplands (fig. 7). It consists of gently rolling to steep soils that are underlain by caliche. It is about 55 percent Campus soil, about 30 percent Canlon soil,

Figure 7.—Area of Campus-Canlon complex.

about 10 percent Penden soils, and 5 percent Wakeen soils and caliche outcrops.

The Campus soil has slopes of about 2 to 10 percent; the Canlon soil has slopes of about 3 to 40 percent. The Campus and Canlon soils have the profiles described as representative of their series.

The soils of this mapping unit are better suited to range than to most other uses because of variable slopes, limited depth of the root zone, low available water capacity, and occasional outcrops. A few small areas are cultivated with larger areas of arable soils. The vegetation is mainly mid and short grasses. Deferred grazing, rotation grazing, and proper stocking rates help to maintain a desirable stand of native grasses. Dryland capability unit VIe–2; Campus soil is in Limy Upland range site, Canlon soil is in Shallow Limy range site; windbreak suitability group not assigned for either soil.

Canlon Series

The Canlon series consists of shallow, loamy soils on uplands. These soils formed in material weathered from caliche (fig. 8). Slopes are about 3 to 40 percent. Underlying caliche is at a depth of 10 to 20 inches. In this county these soils are mapped only in a complex with Campus soils.

In a representative profile the surface layer is grayish-brown loam about 4 inches thick. The next layer is grayish-brown, friable loam about 5 inches thick. The underlying material is light brownish-gray loam about 5 inches thick. Hard caliche is at a depth of 14 inches.

Canlon soils are well drained to somewhat excessively drained and have moderate permeability. They have a very low available water capacity and low fertility.

Representative profile of Canlon loam, in an area of Campus-Canlon complex, 530 feet west and 790 feet south of the northeast corner of the northwest quarter of sec. 26, T. 17 S., R. 24 W., in range:

A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; common fine roots; few sand grains and fragments of caliche; strongly effervescent; moderately alkaline; gradual, smooth boundary.

AC—4 to 9 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; slightly hard, friable; common fine roots; common small fragments of limestone and caliche; strongly effervescent; moderately alkaline; clear, smooth boundary.

C—9 to 14 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak, medium, granular structure; slightly hard, friable; common fine roots; many fragments of limestone and caliche; violently effervescent; moderately alkaline; clear, wavy boundary.

R—14 inches, hard caliche.

The A1 horizon ranges from dark grayish brown or brown to light gray or very pale brown and is 3 to 6 inches thick. This horizon is loam in most places but is silt loam or fine sandy loam in some places. The AC horizon ranges from grayish brown or brown to light gray or very pale brown. It is silt loam, loam, or fine sandy loam and is 4 to 8 inches thick. The C horizon ranges from light brownish gray, pale brown, or light yellowish brown to white or very pale brown and is silt loam, loam, or fine sandy loam.

Canlon soils are near Campus and Penden soils. Canlon soils are not so deep as Campus or Penden soils, and their dark-colored surface layer is not so thick. Canlon soils have topography similar to Heizer soils, but they are underlain by caliche rather than chalky limestone. They occur on similar landscapes as Nibson soils, which are underlain by chalky shale.

Coly Series

The Coly series consists of deep, loamy soils on up-

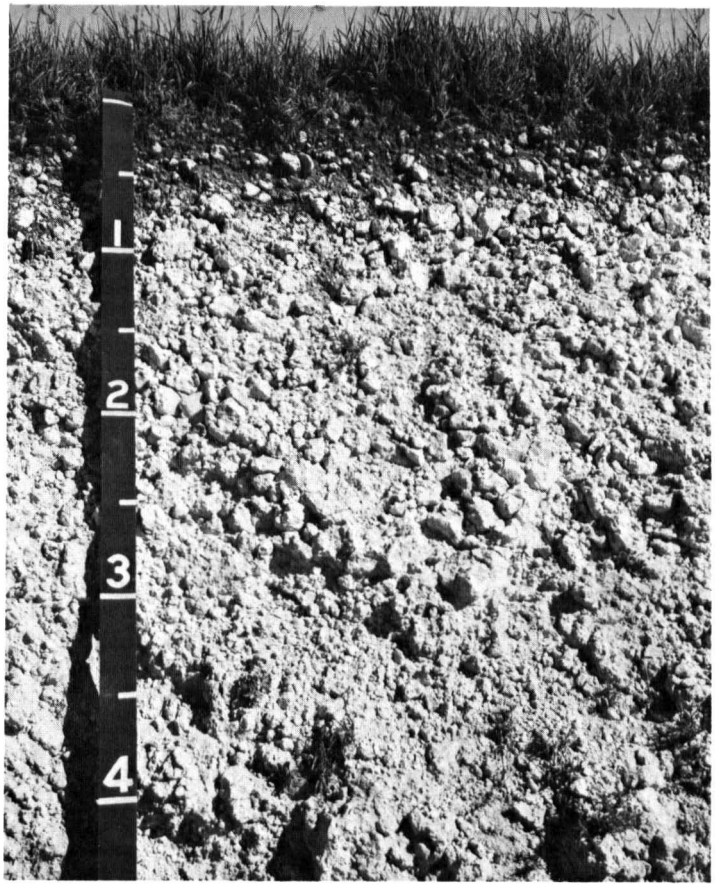

Figure 8.—Profile of Canlon loam.

lands. These soils formed in loess. Slopes are about 1 to 30 percent. In this county these soils are mapped only in complexes with Uly and Penden soils.

In a representative profile the surface layer is grayish-brown silt loam about 3 inches thick. The next layer is pale-brown, friable silt loam about 11 inches thick. The underlying material is very pale brown silt loam.

Coly soils are well drained to somewhat excessively drained and have moderate permeability. They have a high available water capacity and moderate fertility.

Representative profile of Coly silt loam, in an area of Coly-Uly silt loams, 3 to 6 percent slopes, eroded, 1,450 feet south and 100 feet east of the northwest corner of sec. 36, T. 16 S., R. 24 W., in grass (formerly cropland):

A1—0 to 3 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; few fine roots; slightly effervescent; mildly alkaline; abrupt, smooth boundary.

AC—3 to 14 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate, medium, granular structure; slightly hard, friable; few fine roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—14 to 60 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable; strongly effervescent.

The A1 horizon ranges from grayish brown or light gray to brown or very pale brown and is 3 to 6 inches thick. This horizon is very fine sandy loam or silt loam. The AC horizon ranges from light brownish gray or pale brown to pinkish gray, light gray, or very pale brown. It is silt loam in most places but in some places it is loam. This horizon ranges from 5 to 15 inches in thickness. Between depths of 10 and 40 inches, the soil material is silt loam or loam averaging more than 18 percent clay and less than 15 percent sand coarser than very fine.

Coly soils are near Penden, Uly, and Corinth soils. Coly soils have a thinner A horizon than Penden and Uly soils. They have less clay in all horizons than Corinth soils and are deeper.

Coly-Uly silt loams, 3 to 6 percent slopes, eroded (Cu).—This is a complex of sloping soils on uplands. It is about 50 percent Coly soil, 35 percent Uly soil, and 15 percent Penden, Harney, and Corinth soils.

The 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 series, but in some places the surface layer is thinner because it has been eroded.

Much of this complex is cultivated, but the soils are not well suited to crops because of the effects of erosion and slope. Wheat and sorghum are the main crops grown on these soils. In most cultivated areas, water erosion has thinned the surface layer and tillage has mixed the lighter colored subsoil material with the remaining surface layer. Rills and shallow gullies have formed near the bottom of the slopes. These soils blow when dry if they lack a protective cover. Careful management of crop residue and the use of terraces, contour farming, and stubble-mulch tillage help to control soil blowing and runoff. Dryland capability unit IVe–1; Coly soil is in Limy Upland range site, Uly soil is in Loamy Upland range site; both soils are in windbreak suitability group 2.

Corinth Series

The Corinth consists of moderately deep, loamy soils on uplands. These soils formed in material weathered from calcareous clayey shale. Slopes are 1 to 6 percent. Calcareous clayey shale is at a depth of 20 to 40 inches. In this county these soils are mapped only in complexes with Uly soils.

In a representative profile the surface layer is grayish-brown silty clay loam about 6 inches thick. The subsoil is about 16 inches thick. In the upper 3 inches it is light brownish-gray, firm heavy silty clay loam; in the lower 13 inches it is light yellowish-brown, firm light silty clay. The underlying material is light yellowish-brown light silty clay about 11 inches thick. Platy shale is at a depth of 33 inches.

Corinth soils are well drained and have moderately slow permeability. They have a moderate to high available water capacity and moderate fertility.

Representative profile of Corinth silty clay loam, in an area of Uly-Corinth complex, 1 to 3 percent slopes, 750 feet east and 1,000 feet south of the northwest corner of the northeast quarter of sec. 30, T. 20 S., R. 24 W., in range:

A1—0 to 6 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 4/2) moist; moderate, medium, granular structure; hard, friable; few fine roots; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B1—6 to 9 inches, light brownish-gray (2.5Y 6/3) heavy silty clay loam, olive brown (2.5Y 4/4) moist; weak, medium, granular structure; hard, firm; few fine roots; few tiny concretions of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B2—9 to 22 inches, light yellowish-brown (2.5Y 6/4) light silty clay, light olive brown (2.5Y 5/4) moist; weak, coarse, blocky structure; hard, firm; few fine roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C1—22 to 33 inches, light yellowish-brown (2.5Y 6/4) light silty clay, light olive brown (2.5Y 5/4) moist; weak, fine, platy structure; hard, firm; few small concretions of lime; few, thin, light brownish-gray fragments of shale; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C2—33 inches, light yellowish-brown (2.5Y 6/4) and light brownish-gray (2.5Y 6/2), calcareous, fine, platy shale.

The A1 horizon ranges from grayish brown or brown to light brownish gray to pale brown and is 4 to 7 inches thick. This horizon typically is silty clay loam but is silt loam or clay loam in some places. The B1 and B2 horizons range from brown, grayish brown, yellowish brown, or light olive brown to very pale brown, pale yellow, or yellow. The B1 horizon is about 2 to 6 inches thick, and the B2 horizon is about 8 to 20 inches thick. The B1 and B2 horizons range from silty clay loam to light silty clay and are 35 to 45 percent clay. The C horizon ranges from light yellowish brown, brownish yellow, or olive yellow to very pale brown, pale yellow, or yellow. It is silty clay loam or silty clay.

Corinth soils are near Coly and Uly soils. They have more clay in all horizons and are not so deep as Coly and Uly soils.

Detroit Series

The Detroit series consists of deep, loamy soils on bottom lands and low terraces. These soils formed in silty alluvium. Slopes are 0 to 1 percent.

In a representative profile the surface layer is dark

grayish-brown silty clay loam about 9 inches thick. The subsoil is about 27 inches thick. In the upper 16 inches it is dark grayish-brown, firm light silty clay; in the lower 11 inches it is grayish-brown and brown, firm silty clay loam. The underlying material is pale-brown silty clay loam.

Detroit soils are well drained to moderately well drained and have slow permeability. They have a high available water capacity and high fertility.

Representative profile of Detroit silty clay loam, 1,320 feet south and 1,450 feet east of the northwest corner of sec. 24, T. 19 S., R. 24 W., in a cultivated field:

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and medium, granular structure; slightly hard, friable; few fine roots; slightly acid; gradual, smooth boundary.

B21t—9 to 16 inches, dark grayish-brown (10YR 4/2) light silty clay, very dark brown (10YR 2/2) moist; moderate, medium, subangular blocky and weak, fine, blocky structure; hard, firm; few fine roots; neutral; gradual, smooth boundary.

B22t—16 to 25 inches, dark grayish-brown (10YR 4/2) light silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, blocky structure; hard, firm; neutral; gradual, smooth boundary.

B3—25 to 36 inches, grayish-brown (10YR 5/2) and brown (10YR 5/3) silty clay loam, very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) moist; thin strata of darker silty clay loam; moderate, fine and medium, blocky structure; hard, firm; slightly effervescent; mildly alkaline; gradual, smooth boundary.

Cca—36 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; thin strata of darker silty clay loam; massive; hard, firm; thin films and soft masses of lime; strongly effervescent; moderately alkaline.

The A1 horizon ranges from very dark gray to very dark grayish brown to gray or grayish brown and is 9 to 14 inches thick. This horizon is silty clay loam or silt loam. The B2t horizon ranges from very dark grayish brown or dark brown to grayish brown or brown and is about 12 to 30 inches thick. It is heavy silty clay loam or silty clay and is 35 to 45 percent clay. The C horizon ranges from dark grayish brown or brown to light brownish gray, pale brown, or light brown.

Detroit soils have topography similar to that of Hord and Roxbury soils, and they are near these soils. Detroit soils have more clay in the B horizon than either of these soils, and they are also leached of lime to a greater depth than Roxbury soils. They differ from Ness soils in having a B2t horizon and less clay in the A horizon.

Detroit silty clay loam (0 to 1 percent slopes) (De).—This soil is nearly level and is on low stream terraces. Included with it in mapping are a few small areas of Roxbury, Hord, and Ness soils and some areas of a soil that is similar to Detroit soils but is calcareous nearer the surface.

Wheat and sorghum are the main dryland crops grown on this soil. Alfalfa and sometimes corn are grown under irrigation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. Dryland capability unit IIc–3, irrigated capability unit I–2; Loamy Terrace range site; windbreak suitability group 1.

Harney Series

The Harney series consists of deep, loamy soils on uplands. These soils formed in loess. Slopes are about 0 to 3 percent.

In a representative profile the surface layer is about 11 inches thick (fig. 9). The upper 5 inches of this layer is grayish-brown silt loam; the lower 6 inches is dark grayish-brown light silty clay loam. The subsoil is about 22 inches thick. The upper 13 inches of the subsoil is grayish-brown, firm to very firm heavy silty clay loam; the lower 9 inches is very pale brown, firm silty clay loam. The underlying material is very pale brown light silty clay loam.

Harney soils are well drained and have moderately slow permeability. They have a high available water capacity and high fertility.

Representative profile of Harney silt loam, 0 to 1 percent slopes, 200 feet east and 80 feet south of the northwest corner of sec. 22, T. 20 S., R. 26 W., in a cultivated field:

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

A3—5 to 11 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, firm; common fine roots; few worm casts; slightly acid; gradual, smooth boundary.

B21t—11 to 17 inches, grayish-brown (10YR 5/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky

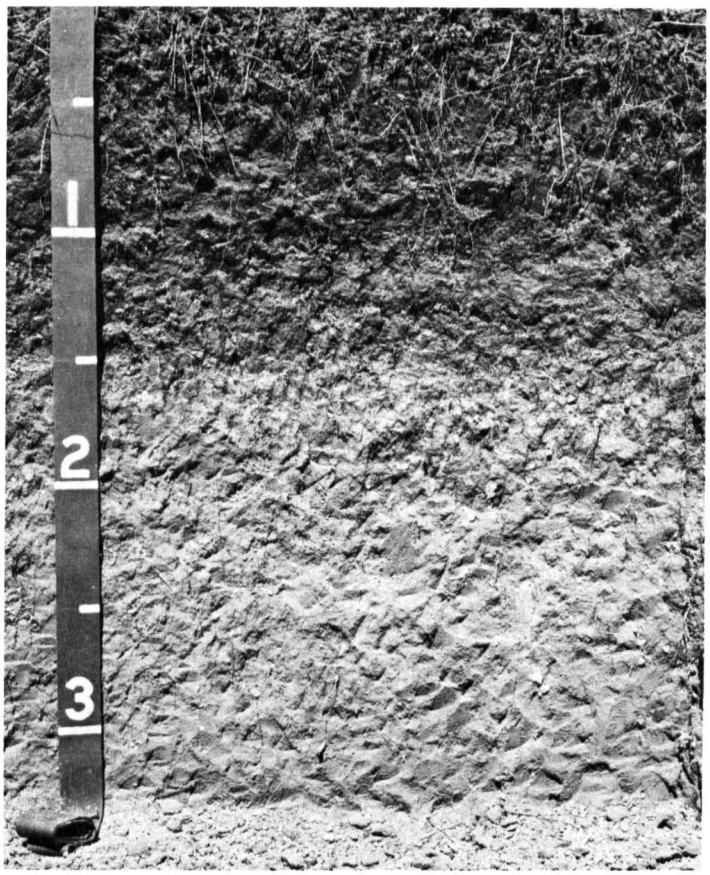

Figure 9.—**Profile of Harney silt loam in an area of range.**

structure; very hard, firm; few fine roots; few worm casts; neutral; gradual, smooth boundary.

B22t—17 to 24 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic and moderate, medium, blocky structure; very hard, very firm; few fine roots; mildly alkaline; gradual, smooth boundary.

B3ca—24 to 33 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; weak, medium and coarse, subangular blocky structure; hard, firm; few fine roots; common coatings and fine threads of free lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1ca—33 to 47 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) moist; structureless, massive; slightly hard, friable; common very fine pores; common fine threads and coatings of free lime; strongly effervescent; moderately alkaline; diffuse, smooth boundary.

C2—47 to 60 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable; many fine pores; strongly effervescent; moderately alkaline.

The A horizon ranges from dark grayish brown or brown to grayish brown and is 8 to 18 inches thick. This horizon is medium acid to neutral silt loam or light silty clay loam. The B2t horizon ranges from grayish brown or brown to light brownish gray or pale brown. It is silty clay loam or silty clay and is 8 to 22 inches thick. It ranges from neutral to moderately alkaline. The B3ca horizon contains some visible free carbonates and is 7 to 12 inches thick. Depth to free carbonates ranges from about 20 to 30 inches but averages about 22 to 24 inches.

Harney soils are near Hord, Penden, and Uly soils. Harney soils have more clay in the B horizon than Hord soils. They differ from Penden and Uly soils in having a Bt horizon and in being leached of lime to greater depths. Harney soils have less clay throughout the profile than Ness soils, which occupy the floors of enclosed depressions.

Harney silt loam, 0 to 1 percent slopes (Ha).—This nearly level soil is in broad areas. It has the profile described as representative of the series. Included with this soil in mapping are a few small areas of Uly soils and a few small areas of a soil that is similar to Harney soils but has a thinner surface horizon and free carbonates nearer the surface.

Wheat and grain sorghum are the main crops grown on this soil. The soil blows when dry if it lacks a protective cover of crop residue or vegetation. Contour farming, stubble-mulch tillage, and terracing help to conserve moisture and control soil blowing. Land leveling and the use of fertilizer are desirable if the soil is irrigated. Dryland capability unit IIc–1, irrigated capability unit I–3; Loamy Upland range site; windbreak suitability group 2.

Harney silt loam, 1 to 3 percent slopes (Hb).—This gently sloping soil is in broad areas. Included with it in mapping are a few small areas of Uly soils and some areas of a soil that is similar to Harney soils but has a thinner surface horizon and free carbonates nearer the surface. Also included are a few small eroded areas which are shown on the detailed soil map by a symbol for severely eroded area.

Wheat and sorghum are the main crops grown on this soil. Erosion is the principal hazard to dryland farming, and the soil blows when dry if it lacks a protective cover of crop residue or vegetation. Terraces, contour farming, and stubble-mulch tillage help to conserve moisture and to control soil blowing and water erosion. Land leveling and the use of fertilizer are desirable if the soil is irrigated. Dryland capability unit IIe–1, irrigated capability unit IIe–1; Loamy Upland range site; windbreak suitability group 2.

Harney silty clay loam, 1 to 3 percent slopes, eroded (Hc).—This soil has short, gentle slopes and is moderately eroded. It has a profile similar to the one described as representative of the series except that the surface layer has been thinned by erosion and is silty clay loam. Cultivation has mixed some of the subsoil material into the plow layer. Included with this soil in mapping are a few small areas of Uly, Coly, and Wakeen soils and some Harney silt loam.

Wheat and sorghum are the main crops grown on this soil. Erosion is the principal hazard to dry farming. It has caused this soil to be slightly more difficult to cultivate than Harney silt loam and has somewhat reduced the permeability of the surface layer. Terracing, contour farming, and stubble-mulch tillage help to conserve moisture and to control soil blowing and water erosion. Dryland capability unit IIIe–3; Loamy Upland range site; windbreak suitability group 2.

Harney-Uly silt loams, 0 to 1 percent slopes (Hu).—This is a complex of nearly level soils in broad areas. It is about 45 percent Harney silt loam, 20 percent Uly silt loam, 20 percent a soil that is similar to Harney soils but has carbonates at a depth of less than 18 inches, and 15 percent included soils.

Included with this complex in mapping are a few small areas of Penden, Wakeen, and Coly soils and a few small areas of a soil that is similar to Harney soils but has a thinner surface horizon and free carbonates nearer the surface.

Wheat and sorghum are the main crops grown on the soils of this unit. The soils blow when dry if they lack an adequate protective cover of crop residue or vegetation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. Dryland capability unit IIc–1, irrigated capability unit I–3; Loamy Upland range site; windbreak suitability group 2.

Harney-Uly silt loams, 1 to 3 percent slopes (Hv).—This is a complex of gently sloping soils in broad areas. It is about 45 percent Harney silt loam, 25 percent Uly silt loam, 15 percent a soil that is similar to Harney soils but has carbonates at a depth of less than 18 inches, and 15 percent included soils.

Included with this complex in mapping are a few small areas of Penden, Wakeen, and other Uly soils and a few small areas of a soil that is similar to Harney soils but has a thinner surface horizon and free carbonates nearer the surface.

The soils of this mapping unit are suited to all locally grown crops; wheat and sorghum are the main crops grown. Erosion is a major hazard to dryland farming, and these soils blow when dry if they lack a protective cover of crop residue or vegetation. Terraces, contour farming, and stubble-mulch tillage help to conserve moisture and to control soil blowing and water erosion. Dryland capability unit IIe–1, irrigated capability unit IIe–1; Loamy Upland range site; windbreak suitability group 2.

Heizer Series

The Heizer series consists of shallow, loamy soils on

uplands. These soils formed in material weathered from chalky limestone (fig. 10). Slopes are about 3 to 30 percent. Chalky limestone is at a depth of 10 to 20 inches. In this county these soils are mapped only in complexes with Wakeen soils and with Rock land.

In a representative profile the surface layer is grayish-brown loam about 6 inches thick. The next layer is gray, friable gravelly loam about 3 inches thick. The underlying material is light brownish-gray channery loam. Consolidated chalky limestone is at a depth of 13 inches.

Heizer soils are well drained and have moderate permeability. They have a very low available water capacity and low fertility.

Representative profile of Heizer loam, in an area of Heizer-Wakeen complex, 1,200 feet east and 1,000 feet south of the northwest corner of the southwest quarter of sec. 7, T. 17 S., R. 22 W., in range:

A1—0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, granular structure; slightly hard, friable; many fine roots; common small fragments of limestone; strongly effervescent; mildly alkaline; gradual, smooth boundary.

AC—6 to 9 inches, gray (10YR 5/1) gravelly loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; many fine roots; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C—9 to 13 inches, light brownish-gray (10YR 6/2) channery loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; slightly hard, friable; few fine roots; common to many fragments of limestone, 1 to 6 inches in length; violently effervescent; moderately alkaline; clear, smooth boundary.

R—13 inches, consolidated chalky limestone.

The A horizon ranges from very gray or very dark grayish brown to gray or grayish brown and is 6 to 10 inches thick. This horizon is loam or gravelly loam. The AC horizon ranges from gray or grayish brown to light brownish gray. It is gravelly loam or channery loam and is 2 to 4 inches thick. The C horizon ranges from grayish brown or brown to light gray or very pale brown. These soils are calcareous to the surface.

Heizer soils are near Wakeen soils, but they are not so deep as Wakeen soils. They are on landscapes similar to those occupied by Nibson, Timken, and Canlon soils, but Heizer soils are underlain by chalky limestone whereas Nibson soils are underlain by chalky shales, Timken soils by acid shales, and Canlon soils by caliche.

Heizer-Wakeen complex (Hw).—This mapping unit consists of gently rolling to steep soils that are on uplands and are underlain by chalky limestone. It is about 40 percent Heizer soil, 20 percent Wakeen soil, 15 percent Penden soils, 10 percent a soil that is similar to Heizer soils but is more than 20 inches deep, and 15 percent small areas of Uly, Nibson, Campus, and Canlon soils and rock outcrops. The Heizer soil has slopes of about 3 to 40 percent. The Wakeen soil has slopes of about 3 to 15 percent.

The Heizer soil has the profile described as representative of the series. The Wakeen soil has a profile similar to the one described as representative of its series.

The soils of this complex are better suited to range than to most other uses because of variable slopes, limited depth of root zone, limited available water capacity, and rock outcrops. A few small areas of this mapping unit are cultivated in conjunction with larger areas of arable soils. The dominant vegetation is mid and short grasses. Deferred grazing, rotation grazing, and proper stocking rates help to maintain a desirable stand of native grasses. Figure 11 shows a farm pond built in an area of this complex. Dryland capability unit VIe–2; Heizer soil is in Shallow Limy

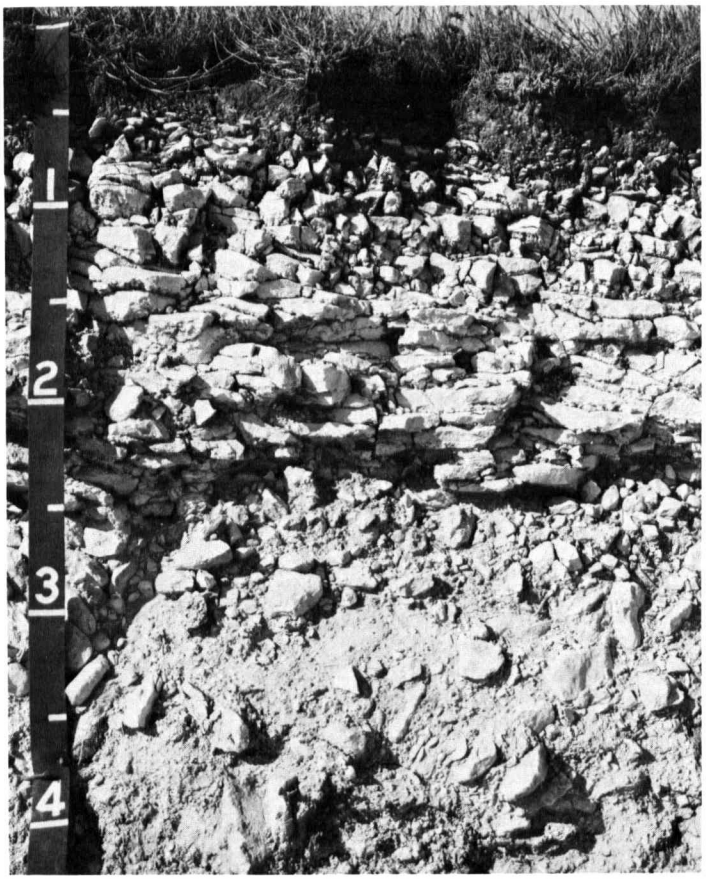

Figure 10.—Profile of Heizer loam. The underlying material is chalky limestone.

Figure 11.—Farm pond that furnishes water for livestock. The soils are in the Heizer-Wakeen complex.

range site, Wakeen soil is in Limy Upland range site; windbreak suitability group not assigned.

Hord Series

The Hord series consists of deep, loamy soils on stream terraces. These soils formed in silty alluvium or loess. The dominant slopes are 0 to 1 percent.

In a representative profile the surface layer is dark grayish-brown silty clay loam about 12 inches thick. The subsoil is firm silty clay loam about 23 inches thick. The upper 12 inches of the subsoil is dark grayish brown; the lower 11 inches is grayish brown. The underlying material is brown silty clay loam.

Hord soils are well drained and have moderate permeability. They have a high available water capacity and high fertility.

Representative profile of Hord silty clay loam, 200 feet east and 1,300 feet north of the southwest corner of sec. 28, T. 20 S., R. 22 W., in a cultivated field:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, granular structure; slightly hard, friable; few fine roots; neutral; clear, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, medium, granular structure; hard, friable; few fine roots; neutral; gradual, smooth boundary.

B2—12 to 24 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; hard, firm; few fine roots; neutral; gradual, smooth boundary.

B3—24 to 35 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; hard, firm; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C—35 to 60 inches, brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; strongly effervescent; moderately alkaline.

The A horizon ranges from dark gray or dark grayish brown to gray or grayish brown and is about 10 to 16 inches thick. This horizon ranges from light silty clay loam to silt loam. The B2 and B3 horizons range from dark grayish brown to grayish brown and from silt loam to silty clay loam. The B2 horizon is about 10 to 14 inches thick; the B3 horizon is about 10 to 20 inches thick. In most places the depth to free lime coincides with the top of the B3 horizon. The C horizon is dominantly grayish brown or brown.

Hord soils are near Bridgeport, Roxbury, and Detroit soils and, in some places, Harney soils. Hord soils have a B2 horizon, which is lacking in Bridgeport soils. They are deeper to free carbonates than Bridgeport and Roxbury soils. Hord soils have less clay in the B horizon than the Detroit and Harney soils.

Hord silty clay loam (0 to 1 percent slopes) (Hz).—This nearly level soil is on broad stream terraces. Included with it in mapping are a few small areas of Roxbury and Detroit soils.

Wheat and sorghum are the main dryland crops grown on this soil, and sorghum, alfalfa, and corn are grown under irrigation. This soil blows when dry if it lacks an adequate protective cover of crop residue or vegetation. Proper crop residue management and the use of fertilizer are desirable irrigation management practices. Leveling is generally necessary for efficient application of water. Dryland capability unit IIc–2, irrigated capability unit I–1; Loamy Terrace range site; windbreak suitability group 1.

Ness Series

The Ness series consists of deep, clayey soils on floors of enclosed depressions that vary from a few inches to several feet below the level of surrounding soils. Dominant slopes are less than 1 percent.

In a representative profile the surface layer is dark-gray clay about 14 inches thick. The next layer is dark-gray, very firm clay about 16 inches thick. The underlying material is pale-brown silty clay loam.

Ness soils are poorly drained and have very slow permeability. They have a high available water capacity and moderate fertility.

Representative profile of Ness clay, 1,600 feet west and 120 feet south of the northeast corner of sec. 2, T. 17 S., R. 24 W., in a cultivated field:

A1—0 to 14 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, very fine, blocky structure; very firm; few fine roots; neutral; gradual, smooth boundary.

AC—14 to 30 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, fine, blocky structure; some irregularly shaped peds have the two long axes not parallel to the surface; few slicken-sides; very hard, very firm; mildly alkaline; gradual, smooth boundary.

C—30 to 60 inches, pale-brown (10YR 6/3) silty clay loam, decreasing in clay content with depth, brown (10YR 4/3) moist; massive; slightly hard, firm; strongly effervescent; moderately alkaline.

The A horizon ranges from very dark gray to gray and is about 10 to 20 inches thick. This horizon is clay or silty clay. The AC horizon ranges from very dark gray to gray. It is clay or silty clay and is about 8 to 25 inches thick. The A and AC horizons range from neutral to mildly alkaline. The C horizon ranges from grayish brown or brown to light gray or very pale brown; in a few places this horizon is faintly mottled with colors more gray or more red than the soil mass. Depth to free carbonates ranges from about 24 to 40 inches.

Ness soils are near Harney soils, but they have more clay in all horizons than those soils. They have more clay in the A horizon and lack the B2t horizon of Detroit soils.

Ness clay (0 to 1 percent slopes) (Nc).—This soil is in enclosed depressions that are a few inches to several feet deep. These depressions range from about 5 to 160 acres in size, but most are about 10 to 20 acres. Included with this soil in mapping are areas of a soil that is similar but has free carbonates at a depth of less than 24 inches.

In many places this soil is cultivated in conjunction with the surrounding soils. Ponding delays planting and harvesting. In seasons of heavy rainfall, crops are frequently drowned and are lost unless the areas dry out in time for replanting. This soil is not well suited to range, because ponding damages the native grasses. Native plants and the amount of forage are variable. Most uncultivated areas are ponded, bare, or sparsely covered with weeds and western wheatgrass. Soil blowing is likely in dry periods if the soil lacks a sufficient protective cover of crop residue. Dryland capability unit VIw–1; range site and windbreak suitability group not assigned.

Nibson Series

The Nibson series consists of shallow, loamy soils on uplands. These soils formed in material weathered from chalky shale. Slopes are about 3 to 40 percent. Chalky shale is at a depth of 10 to 20 inches. In this

county these soils are mapped only in a complex with Wakeen soils.

In a representative profile the surface layer is grayish-brown silt loam about 8 inches thick. The subsoil is light brownish-gray, friable light silty clay loam about 5 inches thick. Hard chalky shale is at a depth of 17 inches.

Nibson soils are somewhat excessively drained and have moderate permeability. They have a very low available water capacity and low fertility.

Representative profile of Nibson silt loam, in an area of Nibson-Wakeen complex, 1,010 feet east and 655 feet south of the northwest corner of sec. 7, T. 19 S., R. 21 W., in range:

A1—0 to 8 inches, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; moderate, fine and medium, granular structure; slightly hard, friable; many fine roots; small limestone and chalky fragments make up less than 15 percent of the soil mass; strongly effervescent; moderately alkaline; clear, smooth boundary.

B2—8 to 13 inches, light brownish-gray (2.5Y 6/2) light silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium, granular structure; slightly hard, friable; many fine roots; few fragments of limestone and shale that make up less than 15 percent of the soil mass; strongly effervescent; moderately alkaline; clear, smooth boundary.

C1—13 to 17 inches, very pale brown (10YR 7/3) light silty clay loam, brown (10YR 5/3) moist; weak, thin, platy and weak, medium, granular structure; slightly hard, friable; few fine roots; many small fragments of limestone and shale; strongly effervescent; strongly alkaline; clear, smooth boundary.

C2—17 inches, very pale brown hard chalky shale.

The A horizon ranges generally from grayish brown to dark grayish brown, but in some places it is very dark gray to gray. It is 7 to 10 inches thick. This horizon is generally silt loam, but it is heavy silt loam or loam in some places. The B2 horizon ranges from grayish brown or brown to light gray or very pale brown. It is silt loam or silty clay loam 3 to 6 inches thick. The C horizon ranges from light brownish gray to very pale brown and is silt loam or silty clay loam.

Nibson soils adjoin Wakeen soils and have topography similar to Heizer and Canlon soils. Nibson soils are not so deep as Wakeen soils. They are underlain by chalky shale; Heizer soils are underlain by chalky limestone, and Canlon soils are underlain by caliche.

Nibson-Wakeen complex (Nw).—This mapping unit consists of gently rolling to steep soils on uplands. The soils are underlain by chalky shale and limestone. This mapping unit is about 45 percent Nibson soil, 35 percent Wakeen soil, and 5 percent each of Heizer soils, Penden soils, rock outcrops, and soils that are similar to Nibson soil but are more than 20 inches deep to shale. The Nibson soil has slopes of about 3 to 40 percent. The Wakeen soil has slopes of about 2 to 15 percent.

The Nibson soil has the profile described as representative of its series. The Wakeen soil has a profile similar to the one described as representative of its series.

The soils of this mapping unit are better suited to range than to most other uses because of variable slopes, variable depth of the root zone, limited available water capacity, and rock outcrops. The dominant vegetation is mid and short grasses. Deferred grazing, rotation grazing, and proper stocking rates help to maintain a desirable stand of native grasses. Dryland capability unit VIe–2; Limy Upland range site; windbreak suitability group not assigned.

Penden Series

The Penden series consists of deep, loamy soils on uplands. These soils formed in calcareous loamy sediment that is modified in some places by more silty loess material. Slopes are 3 to 20 percent.

In a representative profile the surface layer is about 14 inches thick. The upper 8 inches of this layer is dark grayish-brown light clay loam; the lower 6 inches is grayish-brown clay loam. The underlying material is pale-brown clay loam that extends to a depth of 60 inches. The upper part is firm, and the lower part is friable.

Penden soils are well drained and have moderately slow permeability. They have a high available water capacity and moderate fertility.

Representative profile of Penden clay loam, 3 to 6 percent slopes, 300 feet west and 1,400 feet north of the southeast corner of sec. 11, T. 17 S., R. 26 W., in range:

A11—0 to 8 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark brown (10YR 2/2) moist; moderate, medium, granular structure; hard, friable; many fine roots; few worm casts; few coarse sand grains; strongly effervescent; mildly alkaline; gradual, smooth boundary.

A12—8 to 14 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; hard, friable; common fine roots; few small concretions of lime; few worm casts; few coarse sand grains; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1ca—14 to 32 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; very hard, firm; few fine roots; few fine pores; common soft masses of lime; few small concretions of lime; common coarse sand grains; strongly effervescent; moderately alkaline; diffuse, smooth boundary.

C2—32 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable; common fine pores; common soft masses and threads of free carbonates; common coarse sand grains; strongly effervescent; moderately alkaline.

The A11 and A12 horizons range from dark grayish brown or brown to grayish brown and are about 10 to 20 inches thick. These horizons are generally clay loam but are silty clay loam in some places. Typically the A horizon has free carbonates throughout, but free carbonates are lacking in the upper 6 inches in some places. The C1ca and C2 horizons range from brown to light gray. The carbonate content of the C1ca horizon ranges from 15 to 25 percent.

In some areas of Penden clay loam, 3 to 6 percent slopes, eroded, the surface layer is not so thick as defined in the range for the series, but this soil is included with the Penden series.

Penden soils are in areas similar to those occupied by Campus, Coly, and Uly soils. Penden soils are deeper than Campus soils, which are underlain at a depth of 20 to 40 inches by caliche. Penden soils have a darker surface layer than Coly soils. They have more sand in the profile than Uly soils, which formed in loess, and are typically calcareous nearer the surface. Penden soils have more sand in the profile than Harney soils and lack the B2t horizon of those soils. They are deeper than Canlon soils, which are underlain by caliche at a depth of less than 20 inches.

Penden clay loam, 3 to 6 percent slopes (Pc).—This soil has short slopes and is on uplands. It has the

profile described as representative of the series. Included with this soil in mapping are a few small areas of Uly, Coly, Wakeen, and Campus soils.

Wheat and sorghum are the main crops grown on this soil. Water erosion is a hazard to farming, and the soil blows when dry if it lacks a protective cover of crop residue or vegetation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. Dryland capability unit IIIe–2; Limy Upland range site; windbreak suitability group 2.

Penden clay loam, 3 to 6 percent slopes, eroded (Pd).—This soil has short slopes and is on uplands. It has a profile similar to the one described as representative for the series, but its surface layer is 7 to 10 inches thick. The A horizon has been thinned by erosion. Included with this soil in mapping are small areas of Campus, Coly, Uly, and Wakeen soils.

Many areas of this soil are used for growing wheat and sorghum. In most years lack of adequate rainfall is a hazard to dryland farming. This soil blows when dry if it lacks a protective cover of crop residue or vegetation. Terraces, contour farming, stubble-mulch tillage, and summer fallow help to conserve moisture and to control soil blowing and water erosion. Dryland capability unit IVe–1; Limy Upland range site; windbreak suitability group 2.

Penden-Bridgeport complex (Pr).—This mapping unit consists of areas of Penden clay loam on the sides of narrow valleys and areas of Bridgeport silt loam on the valley floors. It is about 50 percent Penden soils with slopes of 3 to 20 percent, 15 percent Bridgeport soils with slopes of 0 to 2 percent, and 10 percent Roxbury and Hord soils, which are also on the valley floors. Included with these soils in mapping are areas of Canlon, Nibson, and Uly soils on the valley sides that make up about 25 percent of the acreage.

This complex is better suited to range than to most other uses because of the steep valley sides and variability of the mapping unit. Some small areas are cultivated where the slopes are less steep and the bottom lands comprise a significant portion of the unit. The dominant vegetation is mid and short grasses. Deferred grazing and proper stocking rates help to maintain a desirable stand of native grasses. Dryland capability unit VIe–1; Penden soil is in Limy Upland range site, Bridgeport soil is in Loamy Lowland range site; windbreak suitability group 2.

Penden-Coly complex (Px).—This mapping unit consists of gently rolling to steep soils on uplands. It is about 50 percent Penden clay loam, 20 percent Coly silt loam, and 20 percent Heizer, Uly, and Wakeen soils and some small rock outcrops. The Penden soil has slopes of about 3 to 20 percent, and the Coly soil has slopes of about 3 to 30 percent. Included with this soil in mapping are Bridgeport and Roxbury soils on the flood plains of small drainageways that make up about 10 percent of the acreage.

This complex is better suited to range than to most other uses because of the variable slopes. In some places small areas are cultivated as parts of large fields. The dominant native vegetation is mid and short grasses. Deferred grazing and proper stocking rates help to maintain a desirable stand of native grasses. Dryland capability unit VIe–1; Limy Upland range site; windbreak suitability group not assigned.

Rock Land

Rock land consists of areas of limestone and chalky shale outcrops on steep, broken hillsides along drainageways and on the sides of isolated hills. In most places the outcrops form almost vertical escarpments. The soil material is very shallow over limestone. In this county Rock land is mapped only in a complex with Heizer soils.

Rock land-Heizer complex (Rh).—This mapping unit consists of barren outcrops of chalky shale and limestone intermixed with Heizer and other soils. It is on uplands. It is about 40 percent Rock land, 35 percent Heizer soils, and 25 percent other similar soils. Rock land has slopes of about 6 to 40 percent. Heizer soils have slopes of about 3 to 20 percent.

This complex is better suited to range than to most other uses. Slopes are highly variable and the root zone is very shallow or shallow. Vegetation is sparse; it consists of some buffalograss, sideoats grama, and broom snakeweed. Dryland capability unit VIIs–1; Heizer soil is in Shallow Limy range site, range site not assigned for Rock land; windbreak suitability group not assigned.

Roxbury Series

The Roxbury series consists of deep, loamy soils on bottom lands. These soils formed in alluvium (fig. 12). The dominant slopes are 0 to 1 percent.

In a representative profile the surface layer is grayish-brown heavy silt loam about 21 inches thick. The subsoil is dark grayish-brown, friable silty clay loam 13 inches thick. The underlying material is silty clay loam. The upper part of this material is grayish brown, and the lower part is light brownish gray.

Roxbury soils are well drained to moderately well drained and have moderate permeability. They have a high available water capacity and high fertility.

Representative profile of Roxbury silt loam, 1,900 feet east and 1,400 feet north of the southwest corner of sec. 21, T. 18 S., R. 24 W., in a cultivated field:

A1—0 to 21 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; few fine roots; common threads of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B2—21 to 34 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; few fine roots; common threads of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1—34 to 48 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, granular structure; slightly hard, friable; common threads of lime; few worm casts; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C2—48 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; stratified with darker material in layers from ¼ to 1 inch thick; weak, fine and medium, granular structure; slightly hard, friable; common films of lime; strongly effervescent; mildly alkaline.

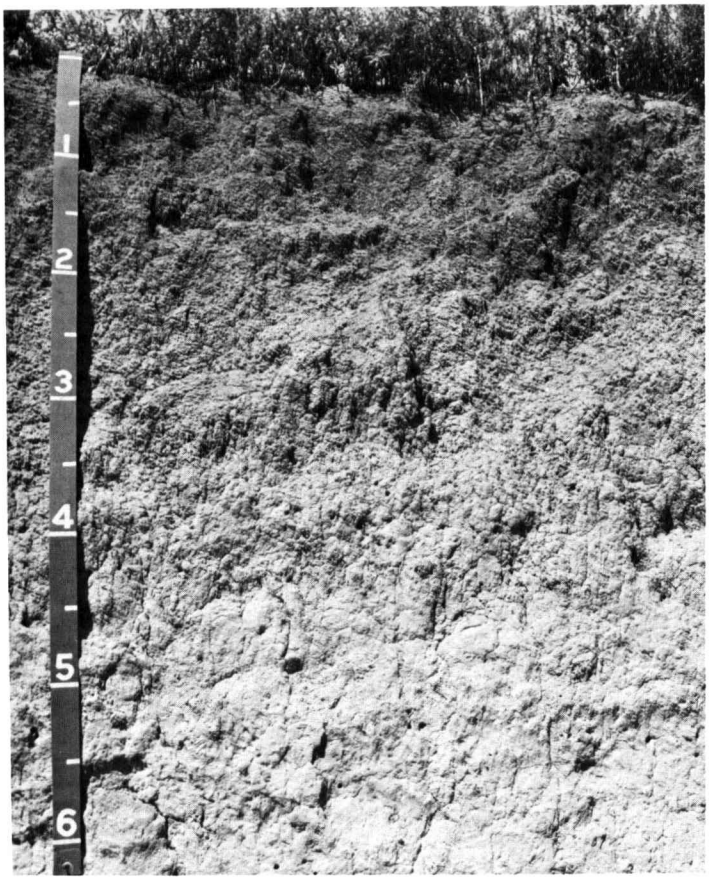

Figure 12.—**Profile of Roxbury silt loam.**

The A horizon ranges from dark grayish brown to grayish brown and is 10 to 24 inches thick. This horizon is silt loam or light silty clay loam. The B horizon ranges from very dark grayish brown to grayish brown. It is 10 to 25 inches thick. The C horizon ranges from grayish brown or brown to light gray or very pale brown. Free carbonates are at a depth of less than 15 inches. In many places stratification is evident at a depth of 20 inches or more from small variations in color value and clay content.

Roxbury soils are near Bridgeport, Hord, and Detroit soils. Roxbury soils are dark colored to a greater depth than Bridgeport soils. They have free carbonates at a depth of 15 inches or less, but Hord and Detroit soils are leached of free carbonates to a depth of 15 inches or more. Roxbury soils lack the clayey Bt horizon of Detroit soils.

Roxbury silt loam (0 to 1 percent slopes) (Ro).—This nearly level soil is on broad, low stream terraces. It has the profile described as representative for the series. Included with this soil in mapping are a few small areas of Bridgeport and Hord soils.

Wheat and sorghum are the main crops grown on this soil. Other crops, such as corn and alfalfa, are grown under irrigation. In some places, the soil blows when dry if it lacks a protective cover of crop residue or vegetation or if fertilizer is not used. In most places leveling is necessary for efficient utilization of irrigation water. Dryland capability unit IIc–2, irrigated capability unit I–1; Loamy Terrace range site; windbreak suitability group 1.

Roxbury silt loam, frequently flooded (0 to 2 percent slopes) (Rs).—This soil is on narrow, low flood plains that are cut in some places by meandering stream channels. Included with it in mapping are small areas of Bridgeport and other similar soils.

Wheat, sorghum, and alfalfa are the main crops grown on this soil. In some years flooding delays planting or harvesting or destroys the crop. In a few places the water table is high enough to be helpful to deep-rooted crops during dry periods. Proper crop residue management helps to control soil blowing. Dryland capability unit IIIw–1; Loamy Lowland range site; windbreak suitability group 1.

Timken Series

The Timken series consists of shallow, clayey soils on uplands. These soils formed in material weathered from acid shale. The dominant slopes are about 3 to 45 percent.

In a representative profile the surface layer is grayish-brown silty clay about 4 inches thick (fig. 13). The next layer is grayish-brown, very firm clay about 5 inches thick. The underlying material is grayish-brown clay about 5 inches thick. Clay shale is at a depth of 14 inches.

Timken soils are moderately well drained and have very slow permeability. They have a low available water capacity and low fertility.

Representative profile of Timken silty clay, in an area of Timken complex, 200 feet west and 600 feet

Figure 13.—**Profile of Timken silty clay. Clay shale is at a depth of about 14 inches.**

south of the northeast corner of sec. 17, T. 17 S., R. 21 W., in range:

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, fine, subangular blocky structure; very hard, very firm; few fine roots; few small concretions of lime; neutral; gradual, smooth boundary.

AC—4 to 9 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate, fine, blocky and weak, medium, subangular blocky structure; very hard, very firm; few fine roots; neutral except for a few calcareous concretions; gradual, smooth boundary.

C1—9 to 14 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky and thin, platy structure; very hard, very firm; common weathered fragments of shale; few yellowish-brown stains; medium acid except for a few calcareous concretions; clear, smooth boundary.

C2—14 inches, gray (N 5/0) clay shale, dark gray (N 4/0) moist; weak and moderate, medium, platy structure; very hard, very firm; few seams of gypsum crystals; strongly acid.

The A and AC horizons range from very dark gray or very dark grayish brown to gray or grayish brown. The A1 horizon is 2 to 6 inches thick and the AC horizon about 4 to 8 inches thick. Both horizons are silty clay or clay. The C1 horizon is dominantly grayish brown or light brownish gray. It is clay and is 3 to 8 inches thick. Depth to unweathered shale ranges from about 9 to 20 inches. Septarian concretions and selenite crystals are common.

In some places Timken soils are in areas similar to those in which Heizer soils occur, but they are underlain by acid shale instead of chalky limestone.

Timken complex (Tx).—This mapping unit consists of gently rolling to steep soils on uplands. It is about 40 percent Timken soils, 20 percent soil that is similar to Timken soils but is 20 to 40 inches deep to shale, 10 percent clayey shale outcrops, 10 percent clayey soils formed in alluvium, and 20 percent Wakeen, Penden, Heizer, and Corinth soils and concretionary knobs. The Timken soils have slopes of about 3 to 45 percent. Scattered selenite crystals are common on the surface in some places.

The soils of this mapping unit are better suited to range than to most other uses. Vegetation is not uniform and is sparse in many places. Native vegetation consists of variable stands of mid and tall grasses. Carefully controlled grazing and stocking rates help to maintain adequate stands of grass. Dryland capability unit VIIs–2; Blue Shale range site; windbreak suitability group not assigned.

Uly Series

The Uly series consists of deep, loamy soils on uplands. These soils formed in thick deposits of calcareous loess. The dominant slopes are 1 to 6 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil is grayish-brown, friable heavy silt loam about 8 inches thick. The underlying material, reaching to a depth of 60 inches, is light silty clay loam. The upper part of this material is pale brown; the lower part is light brown.

Uly soils are well drained and have moderate permeability. They have a high available water capacity and moderate fertility.

Representative profile of Uly silt loam, 1 to 3 percent slopes, 800 feet east and 1,320 feet south of the northwest corner of the southwest quarter of sec. 5, T. 16 S., R. 25 W., in range:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; common fine roots; slightly acid; gradual, smooth boundary.

B2—8 to 16 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; common fine roots; slightly effervescent; neutral; gradual, smooth boundary.

C1—16 to 55 inches, pale-brown (10YR 6/3) light silty clay loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable; common films and threads of lime; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C2—55 to 60 inches, light-brown (7.5YR 6/3) light silty clay loam, brown (7.5YR 5/3) moist; massive; hard, friable; strongly effervescent; mildly alkaline.

The A horizon ranges from very dark grayish brown to grayish brown and is 6 to 12 inches thick. This horizon is silt loam in most places but is light silty clay loam in some places. The B horizon ranges from dark grayish brown or brown to light brownish gray or pale brown. It is silt loam or light silty clay loam and is 4 to 10 inches thick. The C horizon ranges from light brown to light gray or very pale brown and from silt loam to silty clay loam.

Uly soils are near Coly, Harney, Penden, and Corinth soils. Uly soils have a thicker A horizon than Coly soils. They have carbonates nearer the surface than Harney soils and lack the developed Bt horizon of those soils. Uly soils have less sand in the profile than Penden soils and typically are leached of lime to a greater depth. They are deeper and have less clay than Corinth soils.

Uly silt loam, 1 to 3 percent slopes (Ub).—This soil has short slopes and is on uplands. It has the profile described as representative of the series. Included with this soil in mapping are a few small areas of Penden and Harney soils.

Wheat and sorghum are the main crops grown on this soil. Water erosion is a hazard to farming, and the soil blows when dry if it lacks a protective cover of crop residue or vegetation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. Dryland capability unit IIe–2, irrigated capability unit IIe–1; Loamy Upland range site; windbreak suitability group 2.

Uly silt loam, 3 to 6 percent slopes (Uc).—This soil has short slopes and is near or adjacent to small upland drainageways. Included with it in mapping are some small areas of Penden and Harney soils.

Wheat and sorghum are the main crops grown on this soil. Water erosion is a hazard to farming because the soil is subject to runoff during periods of heavy rainfall. This soil blows when dry if it lacks a protective cover of crop residue or vegetation. Stubble-mulch tillage helps to conserve moisture and to control soil blowing and runoff. Dryland capability unit IIIe–2; Loamy Upland range site; windbreak suitability group 2.

Uly-Coly silt loams, 1 to 3 percent slopes, eroded (Ue).—This is a complex of soils that have short slopes and are on uplands. It is about 45 percent Uly soil, 35 percent Coly soil, and 20 percent Harney, Penden, and Wakeen soils.

The Uly soil has a profile similar to the one described as representative for the series, but the surface layer

has been thinned by erosion. In most places, material from the subsoil has been mixed into the plow layer and the soil is calcareous to the surface. The Coly soil has a profile similar to the one described as representative of its series.

The soils of this mapping unit are suited to crops; wheat and sorghum are the main crops grown. In most years water erosion is a hazard to farming. These soils blow when dry if they are left bare. Stubble-mulch tillage helps to conserve moisture and to control soil blowing and runoff. Dryland capability unit IIIe–1; Uly soil is in Loamy Upland range site, Coly soil is in Limy Upland range site; both soils are in windbreak suitability group 2.

Uly-Corinth complex, 1 to 3 percent slopes (Ux).—This mapping unit is on uplands. It is about 65 percent Uly soil, 15 percent Corinth soil, and 20 percent Harney and Penden soils.

The Uly soil has a profile similar to the one described as representative of its series. The Corinth soil has the profile described as representative of its series.

Wheat and sorghum are the main crops grown on the soils of this unit. In most years, water erosion is a hazard. These soils blow when dry if they are left unprotected. Stubble-mulch tillage helps to conserve moisture and to control soil blowing and runoff. Dryland capability unit IIIe–1; Uly soil is in Loamy Upland range site, Corinth soil is in Limy Upland range site; both soils are in windbreak suitability group 3.

Uly-Corinth complex, 3 to 6 percent slopes (Uy).—This mapping unit consists of gently rolling soils on uplands. It is about 60 percent Uly soils, 20 percent Corinth soils, and 20 percent Harney and Penden soils.

In a few areas the surface layer of the Uly and Corinth soils has been thinned by erosion. These areas are shown on the detailed soil map by a spot symbol for severely eroded area. In some places a few small areas of Timken soils are included.

Much of this complex is cultivated, but the soils are not well suited to crops, because of slope and runoff. The main crops grown are wheat and sorghum. In dry periods these soils blow if they are left unprotected. Water erosion is a major hazard. Stubble-mulch tillage helps to conserve moisture and to control runoff and soil blowing. Dryland capability unit IVe–1; Uly soil is in Loamy Upland range site, Corinth soil is in Limy Upland range site; both soils are in windbreak suitability group 3.

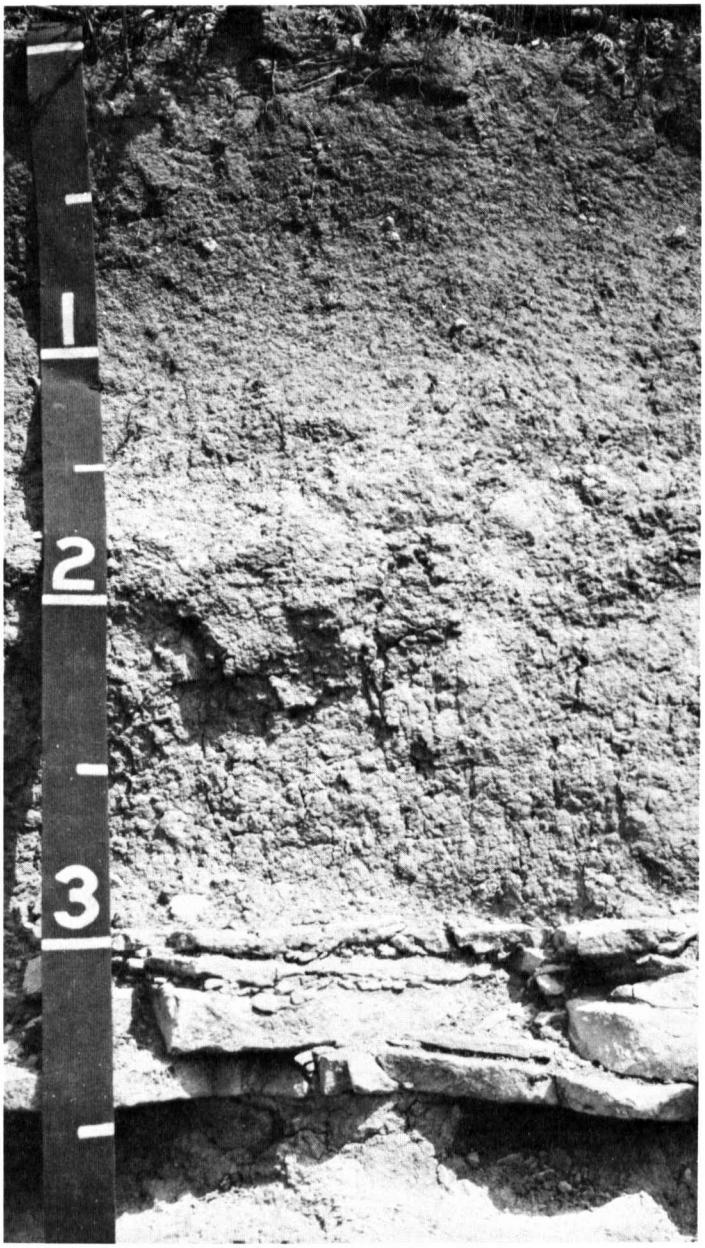

Figure 14.—**Profile of Wakeen silt loam. The underlying material is chalky limestone.**

Wakeen Series

The Wakeen series consists of moderately deep, loamy soils on uplands. These soils formed in material weathered from chalky limestone (fig. 14). The dominant slopes are about 1 to 6 percent but in some places range to about 15 percent.

In a representative profile the surface layer is grayish-brown heavy silt loam about 13 inches thick. The subsoil is pale-brown, friable silty clay loam about 10 inches thick. The underlying material is very pale brown silty clay loam about 9 inches thick. Chalky limestone is at a depth of 32 inches.

Wakeen soils are well drained and have moderate permeability. They have a high available water capacity and moderate fertility.

Representative profile of Wakeen silt loam, 1 to 3 percent slopes, 1,000 feet east and 1,400 feet north of the southwest corner of sec. 18, T. 20 S., R. 21 W., in range:

A1—0 to 13 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; many fine roots; strongly effervescent; mildly alkaline; gradual, smooth boundary.

B2—13 to 23 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; weak, medium, granular structure; slightly hard, friable; few fine roots; few threads of free lime; strongly

effervescent; moderately alkaline; gradual, smooth boundary.

C1—23 to 32 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; weak, coarse, blocky structure parting to weak, fine, granular; some weak platy structure just above bedrock; hard, friable; few fine roots; common masses or pockets of chalky material; violently effervescent; strongly alkaline; clear, smooth boundary.

C2—32 inches, white (10YR 8/2) chalky limestone.

The A horizon ranges from very dark grayish brown or dark brown to grayish brown or brown and is 7 to 18 inches thick. This horizon is silt loam or silty clay loam. The B horizon ranges from grayish brown or brown to light gray or very pale brown. It is dominantly silty clay loam and is about 6 to 15 inches thick. The C horizon ranges from light brownish gray or pale brown to nearly white or very pale brown and is dominantly silty clay loam. The C horizon is about 7 to 15 inches thick. Chalky limestone is at a depth of 20 to 40 inches. Depth to carbonates is less than 12 inches.

Wakeen soils are near Heizer and Nibson soils. Wakeen soils are 20 to 40 inches deep over chalky limestone; Heizer soils are 10 to 20 inches deep to chalky limestone, and Nibson soils are 10 to 20 inches deep to chalky shale.

Wakeen silt loam, 1 to 3 percent slopes (Wb).—This soil has relatively short slopes and is on uplands. It has the profile described as representative of the series. Included with this soil in mapping are a few small areas of Pendon, Uly, Nibson, and Heizer soils. Also included are a few small rock outcrops which are shown on the detailed soil map by a spot symbol.

Wheat and sorghum are the principal crops grown on this soil. Water erosion is a hazard to farming, and the soil blows when dry if it is left bare. Stubble-mulch tillage helps to conserve moisture and to control soil blowing. In some places this soil is used for range. The dominant native vegetation is mid and short grasses. Sideoats grama is common where the soil is shallower. Deferred grazing and proper stocking rates help to maintain desirable plant growth. Dryland capability unit IIIe–1; Limy Upland range site; windbreak suitability group 3.

Wakeen silt loam, 3 to 6 percent slopes (Wc).—This soil occupies short side slopes on uplands. Included with it in mapping are a few small areas of Penden, Uly, Nibson, and Heizer soils. Also included are a few small eroded areas and rock outcrops, which are shown on the detailed soil map by spot symbols.

This soil is suited to crops if extensive conservation measures are used, and about half the acreage is cultivated. The soil is subject to runoff and water erosion during seasons of heavy rainfall, and it blows when dry if it is left bare. In some places the available water capacity is restricted because of the limited depth to limestone. In some places rocks on or near the surface make tillage difficult. Stubble-mulch tillage helps to conserve moisture and to control soil blowing and erosion. In range areas mid and short grasses are the dominant native species with sideoats grama where the soil is shallow. Deferred grazing and controlled stocking rates help to maintain desirable vegetation. Dryland capability unit IVe–1; Limy Upland range site; windbreak suitability group 3.

Use and Management of the Soils

The soils of Ness County are used mainly for growing crops and, to a lesser extent, for grazing. According to the Conservation Needs Inventory of 1967, about 60 percent of the county is dry farmed and about 1 percent is irrigated.

In this section, management of soils for both dryland and irrigated crops is discussed, the system of capability grouping is explained, and the capability groups in Ness County are described. A table shows predicted yields for both dryland and irrigated crops. Use of the soils for windbreaks, range, wildlife, recreation, and engineering are also discussed.

Management of the Soils for Dryland Crops

In Ness County the management of soils for dryland crops consists of a combination of practices that reduce water erosion and soil blowing, help to 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.

In most years the lack of adequate rainfall limits crop production. Summer fallow and stubble-mulch tillage can be used to help store sufficient moisture for the next crop.

Terracing (fig. 15) and contour farming help to reduce water erosion and to 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, holding water back and letting 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 Ness County. This practice helps to maintain good soil structure, aids the infiltration of water, and helps to control both water erosion and soil blowing. A cover of residue on the surface helps to hold the soil in place and to reduce 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

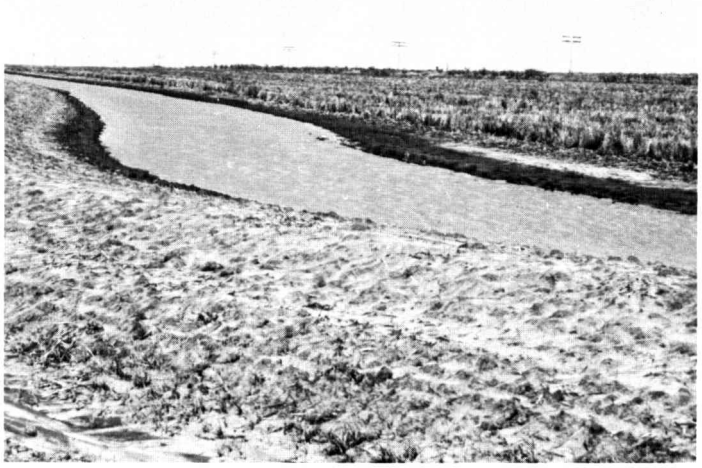

Figure 15.—Level terracing where water from recent rainfall is held and allowed to soak into the soil. The soil is Harney silt loam.

a tillage pan to form, particularly in the loam and silt loam soils. Emergency tillage is sometimes used to help control soil blowing in fields when the soil is bare, for instance, when a recently prepared seedbed has started to blow.

Wheat and sorghum are the major dryland crops grown in Ness County. In a few places some alfalfa is grown on bottom land. The sequence of crops grown affects the combination of management practices needed on a particular soil. Close-growing crops, such as wheat, 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 the Soils for Irrigated Crops

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 with 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.

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. 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 both the rate at which water will enter the soil and the internal drainage. The rate of water intake is also affected by the condition of the surface layer.

The characteristics of each soil in the county are discussed in this survey. Permeability and available water capacity are listed for each soil in table 6 in the section "Engineering Uses of Soils." Soil features affecting the use of soils for irrigation are given in table 8 in the engineering section.

Wheat, sorghum, corn, and alfalfa are the main crops grown under irrigation in Ness County (fig. 16). Most irrigation systems in the county use the border method or the furrow method to distribute water. There are very few sprinkler systems in the county. Wells are the most common source of water. The water is transported to the fields by pipes or ditches.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they 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.

Figure 16.—**Irrigated sorghum. In foreground are siphon tubes that draw and distribute water from an irrigation ditch. The soil is Hord silty clay loam.**

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 of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they 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 the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, 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 limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit 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. Thus,

the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–2 or IIIe–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

The eight classes in the capability system and the subclasses and units in Ness County are described in the list that follows. The capability unit for each soil in the county can be found in the "Guide to Mapping Units."

Class I. Soils that have few limitations that restrict their use.
- (No subclasses.)
  - Unit I–1. Deep, nearly level, well-drained soils that are loamy throughout; on bottom lands and low stream terraces.
  - Unit I–2. Deep, nearly level, well-drained to moderately well drained, loamy soils that have a clayey subsoil; on low stream terraces.
  - Unit I–3. Deep, nearly level, well-drained, loamy soils that have clayey and loamy subsoils; on uplands.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe. Soils subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, gently sloping, well-drained, loamy soils that have a clayey and loamy subsoil; on uplands.
  - Unit IIe–2. Deep, gently sloping, well-drained soils that are loamy throughout; on uplands.
- Subclass IIc. Soils subject to climatic limitations of temperature and lack of moisture.
  - Unit IIc–1. Deep, nearly level, well-drained, loamy soils that have clayey and loamy subsoils; on uplands.
  - Unit IIc–2. Deep, nearly level, well-drained soils that are loamy throughout; on bottom lands and low stream terraces.
  - Unit IIc–3. Deep, nearly level, well drained to moderately well drained, loamy soils that have a clayey subsoil; on low stream terraces.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Subclass IIIe. Soils subject to severe erosion if they are not protected.
  - Unit IIIe–1. Deep and moderately deep, gently sloping, well-drained to somewhat excessively drained soils that have loamy and clayey subsoils; on uplands.
  - Unit IIIe–2. Deep, sloping, well-drained soils that are loamy throughout; on uplands.
  - Unit IIIe–3. Deep, gently sloping, well-drained, loamy soils that have a clayey subsoil; on uplands.
- Subclass IIIw. Soils that have severe limitations because of excess water.
  - Unit IIIw–1. Deep, nearly level, well-drained to moderately well-drained, loamy soils that are frequently flooded; on bottom lands.

Class IV. Soils that have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Subclass IVe. Soils subject to very severe erosion if they are not protected.
  - Unit IVe–1. Deep and moderately deep, sloping, well-drained to somewhat excessively drained soils that have loamy and clayey subsoils; on uplands.

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

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife food and cover.
- Subclass VIe. Soils severely limited, chiefly by steepness and configuration of slopes and severe hazard of erosion if protective cover is not maintained.
  - Unit VIe–1. Deep, nearly level to steep, well-drained to somewhat excessively drained soils that are loamy throughout; on uplands and narrow bottom lands.
  - Unit VIe–2. Moderately deep and shallow, gently sloping to steep, well-drained to somewhat excessively drained soils that are loamy throughout; on uplands.
- Subclass VIw. Soils severely limited by excess water.
  - Unit VIw–1. Deep, nearly level, poorly drained soils that are clayey throughout; dominantly in enclosed depressions on uplands.

Class VII. Soils that have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife food and cover.
- Subclass VIIw. Soils very severely limited by excess water.
  - Unit VIIw–1. Deep, moderately steep and steep, excessively drained stream banks and stream channels and low, dissected flood plains; on bottom lands.
- Subclass VIIs. Soils very severely limited in the root zone by shallow depth, stoniness, and rockiness.
  - Unit VIIs–1. Shallow, gently sloping to steep, well-drained to excessively drained, loamy soils; on uplands.
  - Unit VIIs–2. Shallow, gently sloping to steep, moderately well drained, clayey soils; on uplands.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife food and

cover, water supply, or esthetic purposes. (None in Ness 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, which includes the following:

1. Crop varieties are suited to the area.
2. Proper seeding rates are used. Suitable methods of planting and harvesting are used at the proper time.
3. Adequate practices for controlling weeds, diseases, and insects are used at the proper time.
4. Tillage is timely.
5. Fertility program is based on 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 keep the soil in good physical condition.

Use of the Soils for Windbreaks

A well-placed windbreak, properly spaced and cared for, is a practical and esthetic improvement to the farmstead. It protects farmsteads and livestock feedlots (fig. 17) and provides shelter for some species of wildlife. It helps control snowdrifts by reducing the velocity of the wind.

There are no native forests or woodlands in Ness County. Sparse, mixed stands of cottonwood, elm, and other trees grow on the flood plains of Pawnee River, Walnut Creek, and some of the other tributaries in places that receive extra moisture. The only tree plantings in the county are for windbreaks, for shade or ornamental purposes on the farmstead, or in yards in urban areas.

Proper care of windbreaks includes controlling grass and weeds so as 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 years. This can be provided by diverting runoff from other areas, by hauling from irrigation wells, or by diversion terraces. Areas between tree rows of newly planted windbreaks should be seeded to a cover crop to protect the soil and seedlings from winter wind and to hold snow.

In Ness County the soils that are suitable for windbreak plantings are placed into three windbreak suitability groups. Group 1 consists of deep, loamy soils on lowlands, group 2 of deep, loamy soils on uplands, and group 3 of moderately deep, loamy soils on uplands. Trees and shrubs grow slightly faster on the soils of group 1 than on those of group 2, partly because these soils receive extra moisture as runoff from other areas.

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

[Only soils suited to cultivation are listed. Absence of a yield indicates that the soil is not suited to the crop or is not irrigated]

Soil	Dryland		Irrigated		
	Wheat	Sorghum	Sorghum	Sorghum (forage)	Alfalfa (hay)
	Bu	*Bu*	*Bu*	*Tons*	*Tons*
Bridgeport silt loam	26	42	90	9.0	4.2
Coly-Uly silt loams, 3 to 6 percent slopes, eroded	18	30			
Detroit silty clay loam	27	40	85	8.5	3.2
Harney silt loam, 0 to 1 percent slopes	27	44			
Harney silt loam, 1 to 3 percent slopes	25	40			
Harney silty clay loam, 1 to 3 percent slopes, eroded	22	36			
Harney-Uly silt loams, 0 to 1 percent slopes	27	42			
Harney-Uly silt loams, 1 to 3 percent slopes	25	40			
Hord silty clay loam	28	46	86	8.6	3.8
Penden clay loam, 3 to 6 percent slopes	20	28			
Penden clay loam, 3 to 6 percent slopes, eroded	17	24			
Roxbury silt loam	28	42	89	8.9	4.0
Roxbury silt loam, frequently flooded	23	34			
Uly silt loam, 1 to 3 percent slopes	23	36			
Uly silt loam, 3 to 6 percent slopes	21	34			
Uly-Coly silt loams, 1 to 3 percent slopes, eroded	20	34			
Uly-Corinth complex, 1 to 3 percent slopes	20	30			
Uly-Corinth complex, 3 to 6 percent slopes	16	26			
Wakeen silt loam, 1 to 3 percent slopes	20	34			
Wakeen silt loam, 3 to 6 percent slopes	18	30			

Figure 17.—**A windbreak, about 10 years old, that protects an adjacent feedlot. The soil is Harney silt loam.**

The soils in group 3 are not so deep as those in the other two groups and therefore lack the available water capacity and root zone area of the other soils.

Table 3 lists the average height, in feet, that the specified trees and shrubs attain in 10 years in dryland and irrigated windbreaks. The windbreak suitability group of each soil in the county is listed in the "Guide to Mapping Units" at the back of this survey. Soils not suitable for windbreak plantings are not placed in any windbreak suitability groups.

Use of the Soils for Range[2]

Range is land on which the climax or natural potential plant community is composed principally of native grasses, sedges, forbs, and shrubs valuable for grazing. Some range is used by wildlife and for recreation.

In Ness County about 40 percent of the farm income is from the sale of livestock, milk, and other livestock products. The number of cattle, including calves, in the county usually ranges from 55,000 to 71,000.

The major source of livestock forage is range, but large amounts of crops and their by-products are used for supplemental feed. Approximately 36 percent of the land area in the county, or 242,000 acres, is range.

The potential plant cover on range in the county varies considerably in the kind and amount of native plants. For proper management, range operators need to be familiar with the capabilities of different kinds of range and to appraise the present condition of the range in relation to its potential.

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential for producing native plants. The major differences in potential are the result of differences in soil depth, texture, permeability, and topography.

In its natural state a range site supports a mixture of native plants best suited to the soil and the environment of the site. This plant cover is called the natural potential or climax plant community. Climax vegetation is generally the most productive combination of range plants that a site is capable of growing under natural conditions.

With proper grazing management a mixture of plants representative of the climax community can be maintained indefinitely. When a site is subjected to continuous excessive grazing, however, the climax cover is altered. Plants within the climax vegetation are not equally palatable to grazing animals. Livestock graze selectively, continually seeking the more palatable plants. All range plants are placed into three cate-

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

TABLE 3.—*Trees and shrubs suitable for windbreaks and estimated height attained in 10 years*

Suitable trees and shrubs	Windbreak suitability group 1		Windbreak suitability group 2		Windbreak suitability group 3	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Redcedar	13	18	10	18	9	14
Siberian (Chinese) elm	27	32	22	32	14	18
Russian-olive	14	22	12	22	10	15
Mulberry	17	24	15	20	9	15
Osage-orange	16	22	13	22	11	20
Honeylocust	16	23	14	23	12	17
Ponderosa pine	11	12	9	11	8	10
Skunkbush sumac	10	11	8	11	7	10
Tamarisk	13	20	11	20	9	18
Cotoneaster	8	10	6	10	5	8

gories: decreasers, increasers, and invaders, depending on their response to continuous overgrazing.

Decreasers are plants in the climax community that tend to decrease in number under continued excessive grazing. They generally are the most palatable to livestock.

Increasers are plants in the climax community that increase in number under continuous overgrazing. Under prolonged excessive grazing, decreaser plants are largely removed and increaser plants dominate the site. Increasers are less palatable to livestock than decreasers.

Invaders are not part of the climax community for the site. They grow as a result of various kinds of disturbances, such as prolonged excessive grazing, drought, fire, or rodent and insect infestations.

Changes in the vegetation within each range site can be determined by comparing the present vegetation with the climax vegetation for that site. This is expressed as *range condition.* It provides a measure of the changes that have taken place in the plant cover and provides a basis for predicting the amount of improvement that can be expected in the plant community with proper management.

Four range condition classes are recognized. Range is in excellent condition if 76 to 100 percent of the vegetation is characteristic of the climax vegetation on the same site; it is in good condition if the percentage is between 51 to 75; in fair condition if the percentage is between 26 to 50; and in poor condition if the percentage is less than 26.

Major changes or trends in range vegetation take place so gradually that they are often overlooked, unless the operator is familiar with the characteristics of the range sites and the response of different kinds of plants to grazing. Sometimes during periods of favorable rainfall, plant growth is stimulated, giving the appearance of range improvement when actually the long term trend is toward less palatable grasses and lower production. On the other hand, a dry period may result in the overgrazing of a healthy range and cause it to appear degraded when actually the setback is only seasonal or temporary.

Descriptions of the range sites

The soils of Ness County have been grouped into range sites according to the climax vegetation produced. In the following paragraphs, the soils in each site are described, and the more important decreaser, increaser, and invader plants common to the site are briefly discussed.

Even though research has been limited and estimates are based on a limited amount of clippings, yields of air-dry herbage are given for each site. Since rainfall varies widely from year to year, the estimates are given for years when moisture is both favorable and unfavorable.

The range site for each soil in the county is listed in the "Guide to Mapping Units" at the back of this soil survey.

BLUE SHALE RANGE SITE

Timken complex is the only mapping unit in this range site. These soils are shallow to moderately deep, gently sloping to moderately steep and are on uplands. They have relatively smooth and convex slopes. The soils are clayey throughout. Abundant fractures are common in the subsoil, and this allows deep penetration of water and plant roots. In most places permeability is slow to very slow, and the soils have limited available water capacity because of their limited depth. This site is subject to severe water erosion and soil blowing, unless grazing is carefully regulated.

About 70 percent of the climax plant community consists of decreasers, mainly big bluestem, western wheatgrass, and side-oats grama. Other common decreasers on this site are little bluestem, switchgrass, indiangrass, leadplant, blacksampson, Illinois bundleflower, and purple prairie-clover. Increasers make up 30 percent of the climax plant community, and the dominant increasers are blue grama and buffalograss. Other common increasers on this site are tall dropseed, slimflower scurf-pea, heath aster, western ragweed, and small soapweed. Common invaders are silver bluestem, windmillgrass, tumblegrass, annual bromes, and annual sunflower.

If this site is in excellent condition, the average annual production of air-dry herbage is 3,000 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

LIMY UPLAND RANGE SITE

This range site consists of soils of the Campus, Coly, Corinth, Nibson, Penden, and Wakeen series. These soils are deep and moderately deep, gently sloping to sloping soils on uplands. They have a surface layer that is typically calcareous and well granulated. These soils take water well, and the plant-moisture relationship is good.

The climax plant community on this site is a mixture of grasses, shrubs, and forbs. At least 70 percent of the climax vegetation is big bluestem, little bluestem, indiangrass, switchgrass, leadplant, catclaw sensitivebrier, blacksamson, purple prairie-clover, white prairie-clover, and other decreasers. As much as 30 percent is blue grama, buffalograss, sideoats grama, western wheatgrass, tall dropseed, broom snakeweed, Missouri goldenrod, western ragweed, and other increasers. Common invaders on this site are silver bluestem, windmillgrass, annual bromes, and annual sunflower.

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 range site consists of Bridgeport and Roxbury soils. These soils are deep and nearly level to sloping and are on bottom lands along rivers and major streams. The Roxbury soil is frequently flooded. The soils have a loamy or silty surface layer. They have a high capacity for root growth and moisture storage.

About 80 percent of the climax plant community is a mixture of big bluestem, indiangrass, switchgrass, little bluestem, and other warm-season decreaser grasses. Other decreasers on this site are prairie cordgrass, Canada wildrye, Virginia wildrye, maximilian sunflower, Illinois bundleflower, and wholeleaf rosin-

weed. Increasers, mainly western wheatgrass and tall dropseed, make up about 20 percent of the climax vegetation. Other common increasers are meadow dropseed, sideoats grama, blue grama, buffalograss, and Baldwin ironweed. Common invaders on this site are silver bluestem, Kentucky bluegrass, cocklebur, annual bromes, annual sunflower, and snow-on-the-mountain.

Trees, mainly elm, cottonwood, willow, and hackberry, grow naturally along streambanks. Under the canopy of these trees are Canada wildrye, Virginia wildrye, green muhly and other shade-tolerant grasses.

If the 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 range site consists of soils of the Bridgeport, Detroit, Hord, and Roxbury series. These soils are deep, nearly level to gently sloping and are on alluvial benches or terraces. Flooding is infrequent, but additional moisture is received as water that runs in from nearby uplands. The soils have a silt loam to silty clay loam surface layer and subsoil. They are permeable to water and plant roots and have a high available water capacity.

The climax plant community on this site is mainly mid and tall grasses. About 70 percent of the vegetation is decreasers, mainly big bluestem, switchgrass, and little bluestem. Other common decreasers are indiangrass, Canada wildrye, maximilian sunflower, leadplant, and Illinois bundleflower. Increasers make up about 30 percent of the climax vegetation. Common increasers on this site are western wheatgrass, tall dropseed, blue grama, buffalograss, sideoats grama, tall goldenrod, Baldwin ironweed, heath aster, and western ragweed. As the site deteriorates as a result of continuous excessive grazing, annual grasses and weeds invade. Common invaders are silver bluestem, annual bromes, windmillgrass, tumblegrass, annual sunflower, snow-on-the-mountain, and little barley.

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 range site consists of soils of the Harney and Uly series. These soils are deep, nearly level to moderately sloping, and on uplands. They have a loamy surface layer and a loamy to clayey subsoil. They have moderate to moderately slow permeability and a high available water capacity.

The climax plant community on this site is about 50 percent big bluestem, little bluestem, switchgrass, and side-oats grama and other decreaser grasses. Other common decreasers are breadroot scurf-pea, Illinois bundleflower, dotted gayfeather, stiffleaf vetch, and serrateleaf eveningprimrose. Increasers make up about 50 percent of the climax vegetation. The major increasers are blue grama, buffalograss, and western wheatgrass. Other common increasers are tall dropseed, prairie coneflower, prairie sagewort, slimflower scurf-pea, and western ragweed. Common invaders on this site are annual bromes, little barley, annual sunflower, gumweed, windmillgrass, and tumblegrass.

If this site is in excellent condition, the average annual production of air-dry herbage is 3,500 pounds per acre in years of favorable moisture and 1,000 pounds per acre in years of unfavorable moisture.

SHALLOW LIMY RANGE SITE

This range site consists of soils of the Canlon and Heizer series. These soils are sloping to steep and are on uplands. They have a loamy surface layer that is calcareous and ranges from 4 to 20 inches in depth to limestone. The soils are moderately permeable to water and plant roots, but they are limited in available water capacity because they are shallow. The terrain is generally rough and broken, and there are many vertical ledges that make travel difficult for livestock (fig. 18).

The climax plant community is mainly tall and mid grasses, but numerous legumes and forbs commonly grow on the site. Decreasers make up nearly 80 percent of the climax vegetation. The common decreasers are big bluestem, little bluestem, switchgrass, indiangrass, plains muhly, blacksamson, Jersey-tea, resinous skullcap, catclaw sensitivebrier, leadplant, purple prairie-clover, and white prairie-clover. Increasers make up about 20 percent of the climax vegetation, and the common ones are blue grama, hairy grama, side-oats grama, buffalograss, smooth sumac, stiff goldenrod, broom snakeweed, and purple three-awn. Common invaders are annual bromes, silver bluestem, little barley, six-weeks fescue, tumblegrass, and annual sunflower.

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.

Use of the Soils for Wildlife[3]

All soils have potential for wildlife management, regardless of their capability classes or use. The vegetation that results when the soils are managed for various uses is a part of the wildlife habitat. Many kinds of wildlife require a variety of plants in order to provide the habitat elements needed for survival. Bobwhite quail, for example, require woody cover in the form of shrubby thickets or brushpiles. Because a variety of plants is needed, the management of wildlife is dependent on land use.

In the following paragraphs wildlife in the county is discussed by soil associations, which are shown on the general soil map at the back of this survey. Table 4 gives the potential of each of the soil associations for producing food and cover for the three broad groupings of wildlife in the county.

The three main groups of wildlife are openland, woodland, and wetland. *Openland wildlife* are pheasant, quail, cottontail rabbit, coyote, and other animals that normally inhabit cultivated fields, pasture, meadow, and odd areas where herbaceous plants grow. *Woodland wildlife* normally inhabit wooded or partly

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

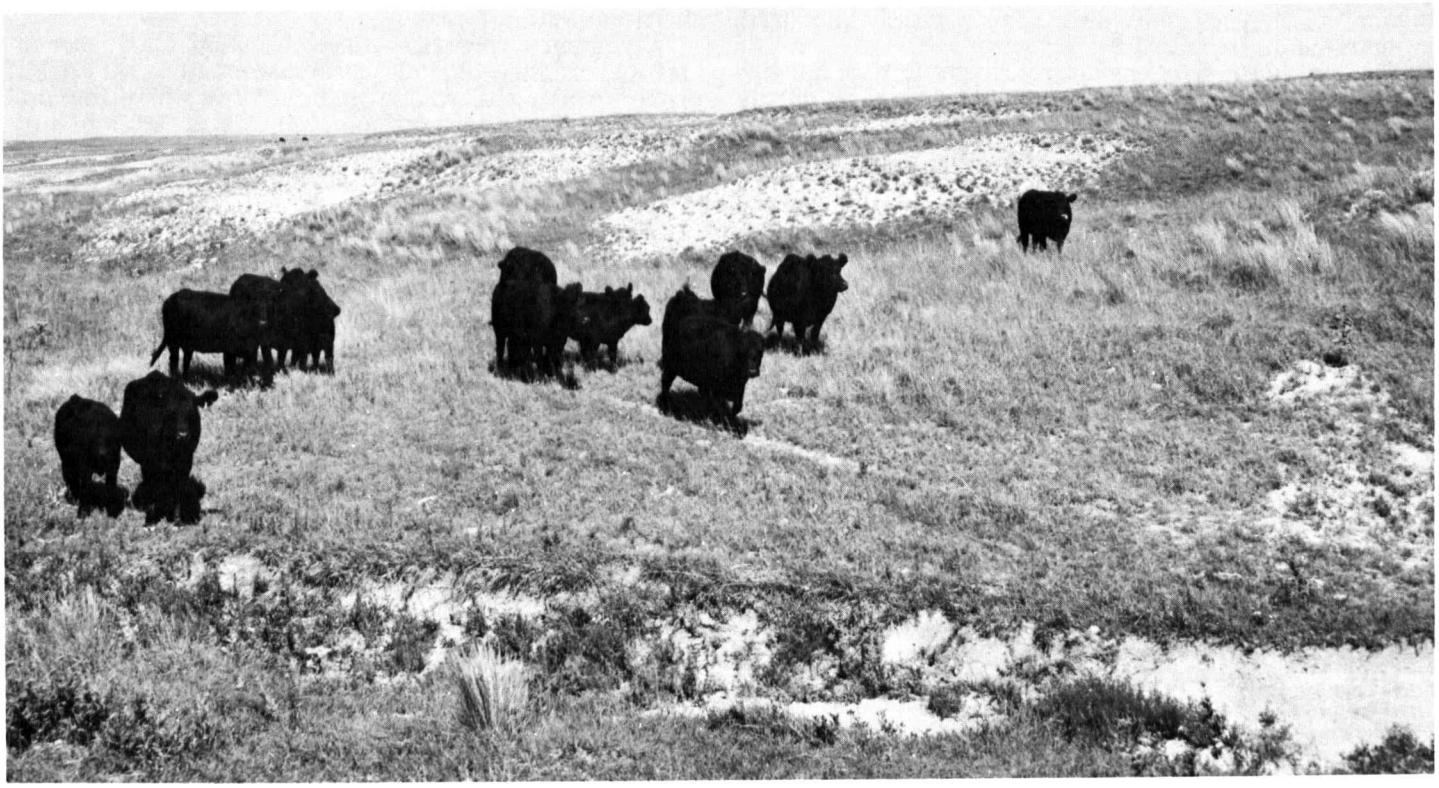

Figure 18.—**Cattle in a native grass pasture on Shallow Limy range site.**

wooded areas. Examples of woodland wildlife are thrushes, deer, raccoon, and squirrel. *Wetland wildlife* normally inhabit ponds, marshes, streams, and swamps. Examples are ducks, shorebirds, beaver, mink, and muskrat.

Two kinds of deer inhabit Ness County. In the western half of the county, the mule deer is dominant, but in the eastern half, the white-tailed deer is most numerous. Deer generally inhabit the Roxbury-Bridgeport-Hord association, but the population varies in density, depending on the location of woody habitat. The population is limited by a lack of suitable cover,

TABLE 4.—*Potential of soil associations for providing wildlife habitat*

Soil association	Kinds of wildlife	Potential for producing—			
		Woody cover	Herbaceous cover	Food	Aquatic habitat
Roxbury-Bridgeport-Hord.	Openland	Good	Good	Good	Good.
	Woodland	Good	Good	Good	Fair.
	Wetland		Good	Good	Good.[1]
Harney-Uly.	Openland	Good	Good	Good	Good.
	Woodland	Fair	Good	Good	Fair.
	Wetland		Good	Good	Good.[1]
Harney-Uly-Coly.	Openland	Good	Good	Good	Good.
	Woodland	Fair	Good	Good	Fair.
	Wetland		Good	Good	Good.
Heizer-Wakeen-Uly.	Openland	Fair	Good	Good	Good.
	Woodland	Poor	Good	Good	Fair.
	Wetland		Good	Fair	Poor.
Campus-Canlon-Penden.	Openland	Fair	Good	Good	Good.
	Woodland	Poor	Good	Good	Fair.
	Wetland		Good	Fair	Poor.

[1] Potential for Ness soils as noted in text.

which consists of woody plants. Studies of their feeding habits indicate that deer have a yearly diet that is nearly half farm crops.

The ring-necked pheasant is the most popular upland game bird in Ness County. The density of the pheasant population approaches 100 birds a square mile in years when nesting is successful. The Roxbury-Bridgeport-Hord, Harney-Uly, and Harney-Uly-Coly associations support the largest pheasant population. Fields of wheat, grain and forage sorghum, and corn provide suitable nesting and food-producing areas, but the amount of available winter cover limits the growth of the population.

The mourning dove is a popular game bird that nests in Ness County. The dove is a migratory species and occupies a habitat similar to that of the pheasant. An adequate supply of water, such as that provided for livestock or found in potholes on the Ness soils during years of favorable moisture, is necessary.

The bobwhite quail is a favorite, but scarce, game bird in Ness County. The optimum habitat is along the Walnut and Pawnee Rivers on the Roxbury-Bridgeport-Hord association. To improve habitat for quail, additional brushy areas should be created or fenced from grazing cattle. Plum thickets or sumac make excellent quail cover, and if they are located near undisturbed nesting cover and fields, an increase in quail and other wildlife can be assured.

Although Ness County is within the historic range of both the greater and lesser prairie chicken, the extensive plowing of grasslands for cultivation has destroyed the habitat of these prairie species and they are no longer found in the area.

The coyote lives on all soil associations in Ness County, but prefers the grassland areas of the Heizer-Wakeen-Uly and Campus-Canlon-Penden associations.

The black-tailed prairie dog also lives in these areas. This species was once common on the prairies but now is few in numbers as a result of rodent-control programs.

Mink, muskrat, and beaver are limited to a few areas within the Roxbury-Bridgeport-Hord association along the Walnut and Pawnee Rivers where water is available the entire year. Raccoons and fox squirrels are also found in these areas where trees provide the required woody habitat.

Waterfowl and shorebirds use the habitat provided by the scattered livestock ponds throughout all soil associations in the county. In years of above average precipitation, the pothole depressions of the Ness soils in the Harney-Uly-Coly, Harney-Uly, and Roxbury-Bridgeport-Hord associations provide an aquatic habitat attractive to waterfowl. When these areas are farmed and planted to a grain crop and are then flooded by late fall rains, the habitat is excellent for waterfowl. Management of these areas for this purpose is an alternate use for these soils.

Fishing is limited to farm ponds and ponded areas on the Pawnee River. The Cedar Bluff Reservoir, 30 miles northeast of Ness City, has a conservation pool area of 6,869 surface acres and provides good fishing and other water-based recreation opportunities.

Ness County is within the boundaries of the Wet Walnut Watershed. With the completion of flood control and multipurpose dams, additional fish, wildlife, and recreation opportunities will be developed to serve the needs of the area.

Management practices that are particularly beneficial to wildlife include stubble-mulching of fields, proper grazing of range and pastures, planting and maintaining shelterbelts and wildlife areas, and protecting the soil from erosion by the use of terraces, waterways, and other conservation practices.

Practices that are harmful to wildlife include mowing and spraying of roadside vegetation, burning of fencerows, clearing of brush and trees, overgrazing of ranges and pastures, draining of wetland areas, and indiscriminate use of pesticides.

Technical assistance in planning developments for wildlife or fish production may be obtained from the Soil Conservation Service in Ness City. Assistance is also available from the Kansas Forestry, Fish and Game Commission, from the Fish and Wildlife Service, and from the Extension Service.

Use of the Soils for Recreation [4]

Because it has only 20 to 22 inches of annual rainfall and because it lacks the large watersheds needed to maintain suitable water areas for recreation, Ness County has had little potential for water-based activities. This potential has been greatly increased as a result of a watershed program. A few of the floodwater detention dams are to be developed for multiple uses but others are to be developed for incidental recreation uses.

Cedar Bluff Reservoir, 30 miles northeast of Ness City, has an area of 6,869 surface acres. The level of the water in this reservoir fluctuates as rainfall and irrigation cause inflow and drawdown. The reservoir provides fishing, boating, swimming, picnicking, and camping for a large area in western Kansas.

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

In table 5 the degree of limitation is expressed as slight, moderate, or severe for the specified uses. *None to slight* means that soil properties are generally favorable and that there are either no limitations or limitations so minor that they easily can be overcome. *Moderate* means that the limitations can be overcome or modified by planning, by design, or by special maintenance. *Severe* means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used for tents and small camp trailers and the 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 best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. Suitability of the soil for establishing and

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

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

[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 may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Alluvial land, broken: Ab	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding; slope.
Bridgeport: Br	Severe: subject to flooding.	Moderate: subject to flooding.	Moderate: subject to flooding.	None to slight.
*Campus: Cc For the Canlon part, see the Canlon series.	None to slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent.	Moderate where slopes are less than 6 percent. Severe where slopes are more than 6 percent.	None to slight.
Canlon Mapped only in a complex with Campus soils.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent: rockiness.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.	Severe: slope; rockiness.	Moderate: rockiness.
*Coly: Cu For the Uly part, see the Uly series.	None to slight	None to slight	Moderate: slope	None to slight.
Corinth Mapped only in complexes with Uly soils.	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: moderately slow permeability; slope; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Detroit: De	Moderate: subject to flooding; silty clay loam surface layer.	Moderate: subject to flooding; silty clay loam surface layer.	Moderate: subject to flooding; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
*Harney:				
Ha, Hu For the Uly part of Hu, see the Uly series.	None to slight	None to slight	None to slight	None to slight.
Hb, Hv For the Uly part of Hv, see the Uly series.	None to slight	None to slight	Moderate: slope	None to slight.
Hc	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slope; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
*Heizer: Hw For the Wakeen part, see the Wakeen series.	Moderate where slopes are less than 15 percent: rockiness. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent: rockiness. Severe where slopes are more than 15 percent.	Severe: slope; rockiness; bedrock at a depth of 10 to 20 inches.	Moderate: rockiness.
Hord: Hz	Moderate: subject to flooding; silty clay loam surface layer.	Moderate: silty clay surface layer; subject to flooding.	Moderate: subject to flooding; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Ness: Nc	Severe: wetness; very slow permeability; silty clay surface layer; subject to flooding.	Severe: wetness; silty clay surface layer; subject to flooding.	Severe: wetness; very slow permeability; silty clay surface layer; subject to flooding.	Severe: wetness; silty clay surface layer; subject to flooding.

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

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
*Nibson: Nw For the Wakeen part, see the Wakeen series.	Moderate where slopes are less than 15 percent: rockiness. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent: rockiness. Severe where slopes are more than 15 percent.	Severe: slope; underlying chalky shale at a depth of 10 to 20 inches.	Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent: rockiness.
*Penden: Pc, Pd, Pr, Px For the Bridgeport part of Pr and the Coly part of Px, see the Bridgeport and Coly series.	Moderate: moderately slow permeability; clay loam surface layer. Severe where slopes are more than 15 percent.	Moderate: clay loam surface layer. Severe where slopes are more than 15 percent.	Moderate: slope; clay loam surface layer. Severe where slopes are more than 6 percent.	Moderate: clay loam surface layer.
*Rock land: Rh For the Heizer part, see the Heizer series.	Severe: slope; rockiness.	Severe: slope; rockiness.	Severe: slope; bedrock at a shallow depth; rockiness.	Severe: slope; rockiness.
Roxbury:				
Ro	Severe: subject to flooding.	Moderate: subject to flooding.	Moderate: subject to flooding.	None to slight.
Rs	Severe: subject to flooding.	Moderate to severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Timken: Tx	Severe: clay surface layer; slope.	Severe: clay surface layer; slope.	Severe: clay surface layer; slope.	Severe: clay surface layer.
*Uly: Ub, Uc, Ue, Ux, Uy For the Coly part of Ue and the Corinth part of Ux and Uy, see the Coly and Corinth series.	None to slight	None to slight	Moderate: slope	None to slight.
Wakeen: Wb, Wc	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent.	None to slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent.	Moderate where slopes are 2 to 6 percent. Severe where slopes are more than 6 percent.	None to slight.

maintaining a good cover of vegetation should be considered separately in selecting sites for this use.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stones that greatly increase cost of leveling sites or of building access roads. These ratings are based on the features of the soil only; other considerations, such as lakes, trees, or beauty, may affect the desirability of the site.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. They are subject to intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important. It is assumed that good cover of vegetation can be established and maintained on areas where it is needed.

Paths and trails are used for local and cross-country travel on foot or horseback. Design and layout should require little or no cutting and filling. The best soils 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.

For technical assistance in developing a rural recreation enterprise, see your local Soil Conservation Service representative in Ness County.

Engineering Uses of the Soils [5]

This section is useful to those who need information about soils used as structural material or as foundation upon 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

[5] By LAWRENCE E. ROBINS, civil engineer, and DONALD E. ROTT, soil scientist, Soil Conservation Service.

in engineering are permeability, strength, compaction characteristics, drainage condition, 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.

Most of the information in this section is presented in tables. Table 6 shows estimated soil properties significant in engineering; table 7 gives the suitability of the soils for use as construction material; table 8 gives interpretations of the soils for various engineering uses; and table 9 shows 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 7 and 8 and also can be used to make other useful maps.

This information, however, does not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Inspection of sites, especially small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used by soil scientists may have different meanings in soil science than they have in engineering. Many of these terms are defined in the Glossary at the back of the survey.

Engineering classification systems

The two systems most commonly used in classifying soil horizons for engineering are the Unified system used by the SCS engineers, Department of Defense, and others (*12*), and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (*1*). Both systems are explained in the PCA Soil Primer (*6*).

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and 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. 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, or the best soils for subgrade (foundation) and, at the other extreme, clay soils that have low strength when wet. The best soils for subgrade are therefore classified as A–1, the next best A–2, and so on to class A–7. 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. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest. The AASHTO classification for tested soils with group index numbers in parentheses, is shown in table 8; 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 typical soil profiles, by layers sufficiently different to have different significance for soil engineering. 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 distance from the surface of the soil to the upper surface of the rock layer.

Soil texture is described in table 6 in the standard terms used by the Department of Agriculture. These terms take into account relative 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 soil survey.

Permeability is the quality that enables a soil to

TABLE 6.—*Estimated soil properties*

[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 instructions for referring to other series that appear in the first column of

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification	
				Unified [1]	AASHTO
	Inches	*Inches*			
Alluvial land, broken: Ab. Properties are too variable to be estimated.					
Bridgeport: Br [2]	>60	0–22	Silt loam	ML or CL	A–4 or A–6
		22–60	Light silt loam	ML or CL	A–4 or A–6
*Campus: Cc	20–40	0–7	Heavy loam	ML or CL	A–4 or A–6
		7–15	Clay loam	ML or CL	A–6
For the Canlon part, see the Canlon series.		15–28	Clay loam	CL–ML or SC–SM	A–6
		28	Semihard caliche.		
Canlon	10–20	0–4	Loam	ML or CL–ML	A–4 or A–6
		4–9	Loam	ML or CL–ML	A–4 or A–6
Mapped only in a complex with Campus soils.		9–14	Loam	ML or SM	A–4 or A–6
		14	Hard caliche.		
*Coly: Cu	>60	0–3	Silt loam	ML or CL	A–4 or A–6
		3–14	Silt loam	ML or CL	A–4 or A–6
For the Uly part, see the Uly series.		14–60	Silt loam	ML or CL	A–4 or A–6
Corinth	20–40	0–6	Silty clay loam	CH	A–7
		6–9	Heavy silty clay loam	CH	A–7
Mapped only in complexes with Uly soils.		9–33	Light silty clay loam	CL or CH	A–7
		33	Calcareous shale.		
Detroit: De [2]	>60	0–9	Silty clay loam	CL–ML or CL	A–7
		9–25	Light silty clay	CH or CL	A–7
		25–36	Silty clay loam	CL–ML or CL	A–7
		36–60	Silty clay loam	CL–ML or CL	A–7
*Harney: Ha, Hb, Hc, Hu, Hv	>60	0–5	Silt loam	CL–ML or CL	A–6
		5–11	Light silty clay loam	CL	A–6
For the Uly part of Hu and Hv, see the Uly series.		11–17	Heavy silty clay loam	CL or CH	A–7
		17–24	Heavy silty clay loam	CL or CH	A–7
		24–33	Silty clay loam	CL	A–7
		33–60	Light silty clay loam	CL or CL–ML	A–6 or A–7
*Heizer: Hw	10–20	0–5	Loam	SM or ML	A–4 or A–6
		5–8	Gravelly loam	GM or SM	A–2, A–4, or A–6
For the Wakeen part, see the Wakeen series.		8–12	Channery loam	GM or SM	A–2, A–4, or A–6
		12	Hard chalky limestone.		
Hord: Hz [2]	>60	0–6	Light silty clay loam	CL–ML or CL	A–6
		6–24	Silty clay loam	CL	A–6 or A–7
		24–35	Silty clay loam	CL–ML or CL	A–6 or A–7
		35–60	Silty clay loam	CL–ML or CL	A–6 or A–7
Ness: Nc [2]	>60	0–14	Clay	CH	A–7
		14–30	Clay	CH	A–7
		30–60	Silty clay loam	CH or CL	A–7 or A–6
*Nibson: Nw	10–20	0–8	Silt loam	ML	A–4 or A–6
		8–13	Light silty clay loam	CL–ML or CL	A–6 or A–7
For the Wakeen part, see the Wakeen series.		13–17	Light silty clay loam	SM–SC or CL–ML	A–6 or A–7
		17	Hard shales.		
*Penden: Pc, Pd, Pr, Px	>60	0–8	Light clay loam	CL–ML or CL	A–6 or A–7
		8–14	Clay loam	CL	A–6 or A–7
For the Bridgeport part of Pr and the Coly part of Px, see the Bridgeport and Coly series.		14–60	Clay loam	CL	A–6 or A–7

significant in engineering

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the this table. The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–100	75–100	0.63–2.0	0.16–0.18	7.9–8.4	Low.
100	100	90–100	85–100	0.63–2.0	0.16–0.18	7.9–8.4	Low.
100	95–100	80–90	51–80	0.63–2.0	0.16–0.18	7.4–7.8	Low.
95–100	90–100	75–90	51–80	0.63–2.0	0.17–0.19	7.4–7.8	Low.
95–100	85–95	70–80	45–75	0.63–2.0	0.17–0.19	7.4–7.8	Low.
95–100	85–95	80–95	55–75	0.63–2.0	0.16–0.18	7.9–8.4	Low.
85–100	80–95	80–90	50–70	0.63–2.0	0.16–0.18	7.9–8.4	Low.
85–95	80–90	75–85	45–65	0.63–2.0	0.16–0.18	7.9–8.4	Low.
100	95–100	90–100	70–90	0.63–2.0	0.16–0.18	7.4–7.8	Low.
100	95–100	90–100	70–90	0.63–2.0	0.16–0.18	7.9–8.4	Low.
95–100	90–100	90–100	70–90	0.63–2.0	0.16–0.18	7.9–8.4	Low.
100	95–100	85–95	70–90	0.20–0.63	0.17–0.19	7.4–7.8	Moderate.
95–100	95–100	90–100	75–95	0.20–0.63	0.17–0.19	7.4–7.8	Moderate.
95–100	90–100	85–95	75–95	0.20–0.63	0.17–0.19	7.9–8.4	Moderate.
100	95–100	90–100	75–95	0.20–0.63	0.17–0.19	6.1–6.5	Moderate.
100	95–100	90–100	75–100	0.06–0.20	0.16–0.18	6.6–7.3	High.
100	95–100	90–100	75–95	0.20–0.63	0.17–0.19	7.4–7.8	Moderate.
100	95–100	90–100	75–95	0.20–0.63	0.17–0.19	7.9–8.4	Moderate.
100	100	90–100	80–100	0.63–2.0	0.16–0.18	6.1–6.5	Moderate.
100	100	90–100	80–100	0.20–0.63	0.17–0.19	6.1–6.5	Moderate.
100	100	95–100	85–100	0.20–0.63	0.17–0.19	6.6–7.3	Moderate to high
100	100	95–100	85–100	0.20–0.63	0.17–0.19	7.4–7.8	Moderate to high
100	100	95–100	85–100	0.20–0.63	0.17–0.19	7.9–8.4	Moderate.
95–100	95–100	90–100	80–100	0.20–0.63	0.17–0.19	7.9–8.4	Moderate.
85–95	70–80	60–75	40–60	0.63–2.0	0.10–0.14	7.4–7.8	Low.
65–80	55–70	50–60	30–50	0.63–2.0	0.08–0.11	7.9–8.4	Low.
55–70	35–50	35–45	20–40	0.63–2.0	0.05–0.08	7.9–8.4	Low.
100	95–100	90–100	75–100	0.63–2.0	0.17–0.19	6.6–7.3	Moderate.
100	95–100	90–100	85–100	0.63–2.0	0.17–0.19	6.6–7.3	Moderate.
100	95–100	90–100	80–100	0.63–2.0	0.17–0.19	7.4–7.8	Moderate.
95–100	90–100	85–100	80–100	0.63–2.0	0.17–0.19	7.9–8.4	Moderate.
100	100	95–100	90–100	<0.06	0.14–0.16	6.6–7.3	High.
100	100	95–100	90–100	<0.06	0.12–0.14	7.4–7.8	High.
100	90–100	90–100	80–95	0.20–0.63	0.16–0.18	7.9–8.4	High.
95–100	90–100	90–100	65–90	0.63–2.0	0.16–0.18	7.9–8.4	Low.
95–100	90–100	65–85	50–80	0.63–2.0	0.17–0.19	7.9–8.4	Low.
75–95	70–95	55–75	40–70	0.63–2.0	0.17–0.19	8.5–9.0	Low.
95–100	90–100	80–95	70–90	0.63–2.0	0.17–0.19	7.4–7.8	Low.
90–100	90–100	80–95	65–85	0.20–0.63	0.17–0.19	7.4–7.8	Low.
85–95	90–100	85–95	65–85	0.20–0.63	0.17–0.19	7.9–8.4	Low.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to bedrock	Depth from surface	USDA texture	Classification	
				Unified [1]	AASHTO
	Inches	*Inches*			
*Rock land: Rh. Properties are too variable to be estimated. For the Heizer part, see the Heizer series.					
Roxbury: Ro, Rs [2]	>60	0–21	Heavy silt loam	CL–ML or CL	A–6 or A–7
		21–60	Silty clay loam	CL	A–6 or A–7
Timken: Tx	9–20	0–4	Silty clay	CH	A–7
		4–9	Clay	CH	A–7
		9–14	Clay	CH	A–7
		14	Clay shales.		
*Uly: Ub, Uc, Ue, Ux, Uy. For the Coly part of Ue and the Corinth part of Ux and Uy, see the Coly and Corinth series.	>60	0–8	Silt loam	ML	A–4 or A–6
		8–16	Heavy silt loam	ML or CL	A–4 or A–6
		16–60	Light silty clay loam	ML or CL	A–6 or A–7
Wakeen: Wb, Wc	20–40	0–13	Heavy silt loam	ML or CL	A–4 or A–6
		13–23	Silty clay loam	CL–ML or CL	A–6 or A–7
		23–32	Silty clay loam	CL–ML or CL	A–6 or A–7
		32	Limestone.		

[1] The Soil Conservation Service and the Bureau of Public Roads have agreed that all soils that have plasticity indexes within two points of the A-line are to be given a borderline classification such as MH–CH. When the quantity of fines is between 5 percent

transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 6 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

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

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material when the moisture content changes, that is, the extent to which the soil shrinks as it dries or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to 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.

Ground water is many feet below the surface in most soils in Ness County. However, in Roxbury silt loam, frequently flooded, the water table may be at a depth of 3 or 4 feet during wet periods.

Engineering interpretations of the soils

Table 7 gives suitability ratings of the soils as sources of sanitary landfill cover material, topsoil, sand and gravel, road subgrade, and road fill. Table 8 gives interpretations of properties of the soils for specific structures. The estimated interpretations in tables 7 and 8 are based on the engineering properties of the soils shown in table 6, on test data for soils in this survey area and others nearby, and on the experience of engineers and soil scientists with the soils of Ness County.

In table 7, the ratings for suitability as a source of sanitary landfill cover material are based on the soil properties that reflect workability, that is, the ease of digging, moving, and spreading the soil material over the refuse daily.

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

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. 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

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)				
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	90–100	85–100	0.63–2.0	0.16–0.18	7.4–7.8	Low.
100	100	90–100	85–100	0.63–2.0	0.17–0.19	7.4–7.8	Moderate.
100	100	95–100	80–100	0.06–0.20	0.16–0.18	6.6–7.3	High.
100	100	90–100	85–100	<0.06	0.16–0.18	6.6–7.3	High.
100	100	90–100	85–100	<0.06	0.16–0.18	5.6–6.0	High.
100	100	90–100	75–95	0.63–2.0	0.16–0.18	6.1–6.5	Low.
100	100	90–100	85–95	0.63–2.0	0.16–0.18	6.6–7.3	Low.
100	95–100	95–100	85–95	0.63–2.0	0.17–0.19	7.4–7.8	Moderate.
100	100	95–100	75–95	0.63–2.0	0.16–0.18	7.4–7.8	Moderate.
100	95–100	90–100	80–95	0.63–2.0	0.17–0.19	7.9–8.4	Moderate.
95–100	90–100	85–100	80–100	0.63–2.0	0.17–0.19	8.5–9.0	Moderate.

and 12 percent, the borderline classifications of GP–GM, GP–GC, and SP–SM are used.

[3] Subject to flooding.

the water table, or other factors that affect mining of the materials, and neither do they indicate quality or size of the deposit.

Road subgrade is the uppermost material used in a roadway. It supports the subbase, base course, and surface course. Ratings are based on the performance of the soil material when excavated and used for this purpose.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material from borrow areas.

In table 8 the suitability of the soils is summarized for highway location; ponds and reservoirs; embankments; terraces, diversions, and waterways; and irrigation. For other uses, limitations are shown that should not be overlooked in planning, installation, and maintenance of the specified structures.

Soil limitations are indicated by the terms slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the specified use, or that the limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but that they can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfaovrable and so difficult to correct or overcome that major soil reclamation and special designs are required.

In the following paragraphs are explanations of some of the columns in table 8.

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 soil 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 is a soil property that affects difficulty of layout and construction and also the risk of soil 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 sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope; if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amount of stones, if any, that influence 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, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil 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.

Trench type sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. Every site should be investigated before it is selected.

Area type sanitary landfill is another method of disposing of waste. The refuse is placed in successive layers on the surface of the soil and covered with a final layer of soil material. Ratings are based on soil qualities and characteristics affecting this type of use.

Highway location considers those features of the undisturbed soil that affect location, construction, and maintenance of highways. The soil features listed, favorable as well as unfavorable, are the principal ones that affect the geographic location of highways. It should be assumed that the surface soil, because of its higher amount of organic matter, will be removed in construction.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their 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. Presence of stones or organic material in a soil 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 soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

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

Soil test data

Table 9 contains engineering test data for some of the major soil series in Ness 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 limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at a successively higher 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 with an increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

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 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 the semisolid to 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 moisture content within which a soil material is plastic.

Formation and Classification of the Soils

This section tells how the factors of soil formation have affected the development of soils in Ness County and explains the system of soil classification currently used. In table 10 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 plant and animal life on and in the soil, the relief, or lay of the land, and the length of

TABLE 7.—*Suitability of the soils as construction material*

[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 may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbols	Suitability as source of—				
	Sanitary landfill cover material [1]	Topsoil [1]	Sand and gravel	Road subgrade [2]	Road fill [2]
Alluvial land, broken: Ab. Interpretations not made; properties too variable.					
Bridgeport: Br	Good	Good	Poor: some small pockets.	Fair: medium soil support.	Fair: fair shear strength.
*Campus: Cc For the Canlon part, see the Canlon series.	Fair: caliche at a depth of 20 to 40 inches; slopes of 2 to 10 percent; clay loam below surface layer.	Fair: firm clay loam below surface layer; highly calcareous.	Unsuited	Poor: low soil support.	Fair: fair shear strength.
Canlon Mapped only in a complex with Campus soils.	Poor: slopes of 3 to 40 percent; 25 to 50 percent coarse fragments; caliche at a depth of 10 to 20 inches.	Poor: slopes of 3 to 40 percent; 25 to 50 percent coarse fragments; caliche at a depth of 10 to 20 inches.	Unsuited	Poor: low soil support.	Fair: fair shear strength.
*Coly: Cu For the Uly part, see the Uly series.	Good	Good	Unsuited	Good	Good.
Corinth Mapped only in complexes with Uly soils.	Poor: firm silty clay subsoil; shale at a depth of 20 to 40 inches.	Fair: 9 inches of firm silty clay loam over silty clay.	Unsuited	Fair: fair shear strength.	Fair: fair shear strength.
Detroit: De	Fair: firm silty clay loam.	Fair: 9 inches of silty clay loam over silty clay.	Unsuited	Poor: high plasticity.	Fair: fair shear strength.
*Harney: Ha, Hb, Hc, Hu, Hv. For the Uly part of Hu and Hv, see the Uly series.	Fair: firm silty clay loam subsoil.	Fair: 5 inches of silt loam over silty clay loam.	Unsuited	Fair: medium plasticity.	Fair: fair shear strength.
*Heizer: Hw For the Wakeen part, see the Wakeen series.	Poor: gravelly loam; limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Fair: slopes of 3 to 40 percent; 0 to 10 percent coarse fragments; limestone at a depth of 10 to 20 inches.	Poor: high silt content.	Poor: platy fragments at a depth of 3 to 12 inches.	Fair: poor workability.
Hord: Hz	Fair: firm silty clay loam.	Fair: firm silty clay loam.	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
Ness: Nc	Poor: very firm, poorly drained clay.	Poor: very firm, poorly drained clay.	Unsuited	Poor: high plasticity.	Poor: poor shear strength.

TABLE 7.—*Suitability of the soils as construction material*—Continued

Soil series and map symbols	Suitability as source of—				
	Sanitary landfill cover material [1]	Topsoil [1]	Sand and gravel	Road subgrade [2]	Road fill [2]
*Nibson: Nw For the Wakeen part, see the Wakeen series.	Poor: slopes of 3 to 40 percent; shale at a depth of 10 to 20 inches.	Fair to poor: shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent; silty clay loam subsoil; 0 to 10 percent coarse fragments.	Unsuited	Poor: low soil support.	Fair: fair shear strength.
*Penden: Pc, Pd, Pr, Px For the Bridgeport part of Pr and the Coly part of Px, see the Bridgeport and Coly series.	Fair: clay loam	Fair: clay loam	Poor: local pockets below a depth of 5 feet.	Poor: low soil support.	Fair: fair shear strength.
*Rock land: Rh. Interpretations not made; properties too variable. For the Heizer part, see the Heizer series.					
Roxbury: Ro, Rs	Fair: silty clay loam subsoil.	Good	Unsuited	Fair: medium soil support.	Fair: fair shear strength.
Timken: Tx	Poor: clay; slopes of 3 to 45 percent; shale at a depth of 9 to 20 inches.	Poor: clay; shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent.	Unsuited	Poor: high plasticity.	Poor: poor shear strength.
*Uly: Ub, Uc, Ue, Ux, Uy For the Coly part of Ue and the Corinth part of Ux and Uy, see the Coly and Corinth series.	Fair: silty clay loam subsoil.	Good	Unsuited	Good	Good.
Wakeen: Wb, Wc	Fair: limestone at a depth of 20 to 40 inches; silty clay loam subsoil.	Fair: silty clay loam subsoil.	Unsuited	Poor: low soil support.	Fair: fair shear strength.

[1] All consistence is considered as moist consistence.

[2] Data for Road subgrade and Road fill columns prepared with the assistance of Norman Clark, engineer of soils, and Herbert E. Worley, soils research engineer, Kansas State Highway Commission. This assistance was given under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors in 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 has genetically related horizons. The effects of climate and plant and animal life 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 and for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

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

Parent material

Parent material refers to the unconsolidated mass in which the soil profile develops (*8*). It determines to a large extent the mineral and chemical composition of the soil and 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 of water, crystal growth, plant and animal action, wetting and drying, abrasion, and corrosion (4). Chemical weathering is more complex. In most places it results in the reduction of particle size, the addition of water, oxygen, and carbon dioxide, and the loss of soluble salts of some metals such as sodium and potassium (4).

Most of the soils of Ness County formed in deposits of loess, some in alluvial sediments, some in loamy outwash sediments, and some in material weathered from limestone, caliche, and shale.

A loess mantle, probably Peorian Loess of the Wisconsinan Stage, covers most of the uplands of Ness County. In most places it is pale-brown, calcareous, friable, and porous silt. Coly, Harney, and Uly silt loams are the major soils in Ness County that formed in loess. It is probable that, in some places, a thin mantle of loess has modified the surface characteristics of some other soils in the county.

Alluvium of a relatively recent age occurs on bottom lands along the Pawnee River and Walnut Creek and, to a lesser extent, along some of the other streams in the county. It consists mainly of sand, silt, and clay and has small pockets of gravel in some places. Bridgeport, Detroit, Hord, and Roxbury soils formed in alluvium. Detroit soils have a loamy surface layer and a clayey subsoil, but the other soils are loamy throughout.

Outwash, probably from Rocky Mountain deposits during the late Pleistocene Epoch, occurs in some places, mainly in the western and northern parts of the county. This outwash is limy, contains coarse sand grains, and is the material in which Penden soils formed.

The Ogallala Formation, consisting of caliche and chalky limestone, occurs in some places in the northern part of the county (fig. 19). This formation gives rise to irregularly sloping areas that have an elevation that varies greatly over short distances. Campus and Canlon soils formed in material weathered from the beds of caliche. Heizer and Wakeen soils formed in material weathered from the chalky limestone.

Greenhorn Limestone and Granerous Shale of the Cretaceous System crop out dominantly along the ridges and slope breaks south of Walnut Creek and along the Pawnee River in the southeastern part of the county. Nibson soils formed in material weathered from shale and Wakeen soils in material weathered from limestone.

Climate

The climate of Ness County is continental and semiarid and is characterized by extremes in temperatures in both summer and winter. There is a deficiency of moisture in most seasons. The soils formed somewhat more slowly than those in areas of higher rainfall.

Climate affects the physical, chemical, and biological relationships in soil. The amount of water that percolates through the soil depends mainly on rainfall, humidity, and length of frost-free periods. Because of the limited amount of rainfall in Ness County, the soils have not been weathered and leached greatly. Calcium carbonate has been leached to depths of about 18 to 30 inches in soils such as Harney, but calcium carbonate is at or near the surface in soils such as Bridgeport and Roxbury.

Plant and animal life

Plant and animal life, both on and in the soil, are active in the soil-forming processes. Small burrowing animals, worms, and insects help to mix the soil. Bacteria, fungi, and other micro-organisms help to weather rock and to decompose organic matter. Plants and animals also influence the chemical and biological processes. Plant root channels and worm holes and casts improve aeration, mix the soil horizons, and aid in decomposing plant material residue.

The kinds and amount of vegetation affect soil formation and are determined in part by the climate and in part by the kind of soil material. Plants need moisture to grow, but they also affect the temperature of the soil by providing shade, which in turn helps the soil to retain moisture. Because vegetation also adds organic matter, it affects the physical and chemical characteristics of the soil.

The soils of Ness County formed under grass. As a result, they typically have a dark-colored surface horizon.

Relief

Relief refers to the gradient, length, shape, and pattern of slopes. It influences soil formation mainly through its effect on drainage, runoff, erosion, and movement of water on and in the soil. Other factors being equal, soil formation is less rapid in the more sloping areas because runoff and erosion are greater.

Many of the uplands in Ness County are broad, smooth, and nearly level to gently sloping. Harney soils, the main soils on these uplands, have well-expressed horizons and are some of the more strongly developed soils in the county. Soils that have parent

Figure 19.—**An outcrop of the Ogallala Formation, which, in this place, is capped with a thick layer of limestone.**

TABLE 8.—*Interpretations of*

[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 instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings [1]
Alluvial land, broken: Ab. Interpretations not made; properties too variable.				
Bridgeport: Br	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Severe: subject to occasional flooding.
*Campus: Cc For the Canlon part, see the Canlon series.	Severe: caliche at a depth of 20 to 40 inches; slopes of 2 to 10 percent; moderate permeability.	Severe: slopes of 2 to 10 percent; caliche at a depth of 20 to 40 inches.	Severe: caliche at a depth of 20 to 40 inches.	Moderate: caliche at a depth of 20 to 40 inches. Severe for basements.
Canlon Mapped only in a complex with Campus soils.	Severe: caliche at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Severe: caliche at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Severe: slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.	Severe: slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.
*Coly: Cu For the Uly part, see the Uly series.	Slight: moderate permeability; slopes of 1 to 6 percent.	Moderate: slopes of 1 to 6 percent; moderate permeability.	Slight	Moderate: ML–CL soil group.
Corinth Mapped only in a complex with Uly soils.	Severe: shale at a depth of 20 to 40 inches; moderately slow permeability.	Severe: shale at a depth of 20 to 40 inches.	Severe: shale at a depth of 20 to 40 inches; silty clay subsoil.	Moderate: moderate shrink-swell potential; shale at a depth of 20 to 40 inches. Severe for basements.
Detroit: De	Severe: subject to flooding; slow permeability.	Severe: subject to flooding.	Severe: subject to flooding; silty clay subsoil.	Severe: subject to flooding; high shrink-swell potential; CL or CH soil group.

engineering properties of the soils

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the that appear in the first column of this table]

Degree and kind of limitation for—continued		Soil features affecting—				
Sanitary landfill		Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Trench type	Area type					
Severe: subject to occasional flooding.	Severe: subject to occasional flooding.	Subject to flooding.	Moderate permeability; slopes of 0 to 2 percent.	Poor stability; good compaction with close control; high piping hazard.	Slopes of 0 to 2 percent; silt loam texture; moderate permeability.	Slopes of 0 to 2 percent; deep; well drained; moderate hazard of flooding; high available water capacity.
Severe: caliche at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent.	High erodibility; slopes of 2 to 10 percent; caliche at a depth of 20 to 40 inches.	Moderate permeability; slopes of 2 to 10 percent; caliche at a depth of 20 to 40 inches.	Fair stability; fair compaction characteristics; moderate piping hazard.	Caliche at a depth of 20 to 40 inches; slopes of 2 to 10 percent; high erodibility; moderate permeability.	Caliche at a depth of 20 to 40 inches; slopes of 2 to 10 percent; well drained; low available water capacity.
Severe: slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.	Severe: slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.	High erodibility; slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.	Moderate permeability; slopes of 3 to 40 percent; caliche at a depth of 10 to 20 inches.	Poor stability; fair compaction characteristics; high piping hazard.	Caliche at a depth of 10 to 20 inches; slopes of 3 to 40 percent; loam texture; high erodibility.	Caliche at a depth of 10 to 20 inches; slopes of 3 to 40 percent; very low available water capacity; high erodibility.
Slight	Slight	Moderate erodibility; slopes of 1 to 6 percent.	Moderate permeability; slopes of 1 to 6 percent.	Poor stability; good compaction with close control; high piping hazard.	Slopes of 1 to 6 percent; silt loam texture; moderate permeability.	Slopes of 1 to 6 percent; somewhat excessively drained; high available water capacity.
Severe: silty clay subsoil; shale at a depth of 20 to 40 inches.	Slight	Shale at a depth of 20 to 40 inches; slopes of 1 to 6 percent; high erodibility.	Moderately slow permeability; shale at a depth of 20 to 40 inches; slopes of 1 to 6 percent.	Fair stability; fair compaction characteristics; poor workability.	Shale at a depth of 20 to 40 inches; slopes of 1 to 6 percent; silty clay subsoil; calcareous.	Shale at a depth of 20 to 40 inches; slopes of 1 to 6 percent; moderately slow permeability; calcareous; moderate to high available water capacity.
Severe: subject to flooding; silty clay subsoil.	Moderate: subject to flooding.	No adverse features.	Slopes of 0 to 1 percent; slow permeability.	Fair stability; fair compaction characteristics; moderate erodibility.	Slopes of 0 to 1 percent; silty clay subsoil; slow permeability; moderate erodibility.	Slopes of 0 to 1 percent; deep; high available water capacity; well drained to moderately well drained; hazard of flooding; slow permeability.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings [1]
*Harney: Ha, Hb, Hc, Hu, Hv For the Uly part of Hu and Hv, see the Uly series.	Severe: moderately slow permeability.	Moderate: slopes of 0 to 3 percent.	Slight	Moderate to severe: moderate to high shrink-swell potential.
*Heizer: Hw For the Wakeen part, see the Wakeen series.	Severe: limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Severe: slopes of 3 to 40 percent; limestone at a depth of 10 to 20 inches.	Severe: limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent; gravelly loam texture.	Severe: limestone at a depth of 10 to 20 inches; platy fragments at a depth of 3 to 12 inches; slopes of 3 to 40 percent.
Hord: Hz	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Ness: Nc	Severe: subject to flooding; very slow permeability.	Moderate: hazard of local flooding.	Severe: clay texture; poorly drained; seasonal ponding.	Severe: CH soil group; poorly drained; high shrink-swell potential; seasonal ponding.
*Nibson: Nw For the Wakeen part, see the Wakeen series.	Severe: shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Severe: slopes of 3 to 40 percent; shale at a depth of 10 to 20 inches.	Severe: shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Severe: slopes of 3 to 40 percent; shale at a depth of 10 to 20 inches.
*Penden: Pc, Pd, Pr, Px For the Bridgeport part of Pr and the Coly part of Px, see the Bridgeport and Coly series.	Moderate to severe: moderately slow permeability.	Moderate where slopes are 3 to 7 percent. Severe where slopes are more than 7 percent.	Moderate: clay loam texture. Severe where slopes are more than 15 percent.	Moderate: CL soil group. Severe where slopes are more than 15 percent.
*Rock land: Rh. Interpretations not made; properties too variable. For the Heizer part, see the Heizer series.				

properties of the soils—Continued

Degree and kind of limitation for—continued		Soil features affecting—				
Sanitary landfill		Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Trench type	Area type					
Moderate to severe: silty clay loam to silty clay subsoil.	Slight	Slopes of 0 to 3 percent.	Moderately slow permeability; slopes of 0 to 3 percent.	Fair stability; fair compaction characteristics; moderate to high shrink-swell potential; medium compressibility.	Silty clay loam subsoil; slopes of 0 to 3 percent; moderate erodibility; moderately slow permeability.	Slopes of 0 to 3 percent; well drained; moderate erodibility; high available water capacity.
Severe: slopes of 3 to 40 percent; limestone at a depth of 10 to 20 inches; gravelly loam texture.	Severe: slopes of 3 to 40 percent; limestone at a depth of 10 to 20 inches; gravelly loam texture.	Limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Moderate permeability; limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Poor stability; fair shear strength; high piping hazard; poor workability; good compaction with close control.	Limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent; gravelly loam texture; high erodibility.	Limestone at a depth of 10 to 20 inches; slopes of 3 to 40 percent; very low available water capacity; gravelly loam texture.
Severe: subject to flooding.	Moderate: subject to flooding.	No adverse features.	Moderate permeability; slopes of 0 to 1 percent.	Fair stability; good compaction characteristics; fair shear strength.	Slopes of 0 to 1 percent; silty clay loam texture; high fertility; well drained.	Slopes of 0 to 1 percent; deep; well drained; moderate permeability; hazard of flooding; high available water capacity.
Severe: seasonal ponding; clay texture; poorly drained.	Severe: seasonal ponding; clay texture; poorly drained.	Poor foundation; subject to ponding.	Very slow permeability; slopes of 0 to 1 percent.	Fair stability in level areas; poor shear strength; poor compaction characteristics; high plasticity; high shrink-swell potential.	Poorly drained; slopes of 0 to 1 percent; clay texture; very slow permeability; seasonal ponding.	Slopes of 0 to 1 percent; poorly drained; clay texture; very slow permeability.
Severe: slopes of 3 to 40 percent; shale 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.	Moderate permeability; shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Moderate permeability; shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent.	Fair stability; good compaction with close control; high erodibility; moderate piping hazard; fair shear strength.	Shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent; silty clay loam subsoil; high erodibility; low fertility.	Shale at a depth of 10 to 20 inches; slopes of 3 to 40 percent; somewhat excessively drained; very low available water capacity.
Moderate: clay loam texture.	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 3 to 20 percent.	Moderately slow permeability; slopes of 3 to 20 percent.	Fair stability; good compaction characteristics; fair shear strength; moderate piping hazard; high erodibility.	Slopes of 3 to 20 percent; clay loam texture; high erodibility; high available water capacity.	Slopes of 3 to 20 percent; well drained; high erodibility; moderately slow permeability; high available water capacity.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—			
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Foundations for low buildings [1]
Roxbury: Ro, Rs	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Timken: Tx	Severe: very slow permeability; slopes of 3 to 45 percent; shale at a depth of 9 to 20 inches.	Severe: shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent.	Severe: slopes of 3 to 45 percent; shale at a depth of 9 to 20 inches; clay texture.	Severe: shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent; CH soil group; high shrink-swell potential.
*Uly: Ub, Uc, Ue, Ux, Uy. For the Coly part of Ue and the Corinth part of Ux and Uy, see the Coly and Corinth series.	Slight: moderate permeability.	Moderate: moderate permeability; slope.	Slight	Moderate: moderate shrink-swell potential; ML or ML–CL soil group.
Wakeen: Wb, Wc	Severe: limestone at a depth of 20 to 40 inches.	Severe: limestone at a depth of 20 to 40 inches.	Severe: limestone at a depth of 20 to 40 inches.	Moderate: moderate shrink-swell potential; limestone at a depth of 20 to 40 inches. Severe for basements.

[1] Soil group refers to the Unified Classification of Soils.

[2] Data for highway location prepared with the assistance of Norman Clark, engineer of soils, and Herbert E. Worley, soils

material similar to that in which Harney soils formed, but which occur in more sloping areas, have less horizon development and a thinner surface layer. Uly and Coly soils are examples of these soils. Ness soils also have similar parent material, but they occur in ponded depressions that receive runoff from adjacent areas. They have a clayey texture and gray color, which indicate the effect of additional moisture and poor drainage.

Time

Time is required for soil formation. The length of time needed depends largely on the kind of parent material and 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. The amount of the materials leached and deposited into the subsoil depends on the amount of time that has elapsed and the amount of water penetrating through the soil. Bridgeport soils, for example, formed in recent alluvium and show little horizon development other than a darkening of the surface layer. Harney soils, on the other hand, have been exposed to soil-forming processes for a much longer time and have well-defined soil horizons.

Classification of the 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. 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.

In classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland, in developing

properties of the soils—Continued

Degree and kind of limitation for—continued		Soil features affecting—				
Sanitary landfill		Highway location [2]	Pond reservoir areas	Embankments, dikes, and levees	Terraces, diversions, and waterways	Irrigation
Trench type	Area type					
Severe: subject to flooding.	Severe: subject to flooding.	Subject to flooding.	Moderate permeability; slopes of 0 to 1 percent.	Fair stability; good compaction characteristics; moderate shrink-swell potential; fair shear strength.	Slopes of 0 to 1 percent; moderate permeability; high fertility; moderate hazard of flooding.	Moderately well drained; deep; moderate hazard of flooding; high available water capacity.
Severe: slopes of 3 to 45 percent; clay texture; shale at a depth of 9 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.	Poor foundation; shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent.	Shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent; very slow permeability.	Fair stability in level areas; poor compaction characteristics; high shrink-swell potential.	Shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent; very slow permeability; low fertility.	Shale at a depth of 9 to 20 inches; slopes of 3 to 45 percent; moderately well drained; very slow permeability.
Moderate: silty clay loam subsoil.	Slight ----------	Moderate erodibility; slopes of 1 to 6 percent.	Moderate permeability; slopes of 1 to 6 percent.	Fair stability; fair compaction characteristics; moderate piping hazard; moderate erodibility; moderate shrink-swell potential.	Slopes of 1 to 6 percent; silty clay loam subsoil; high available water capacity; moderate erodibility.	Slopes of 1 to 6 percent; well drained; deep; high available water capacity; moderate permeability; moderate erodibility.
Severe: limestone at a depth of 20 to 40 inches.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent.	Moderate erodibility; limestone at a depth of 20 to 40 inches; slopes of 1 to 15 percent.	Moderate permeability; limestone at a depth of 20 to 40 inches; slopes of 1 to 15 percent.	Poor stability; high piping hazard; good compaction with close control.	Slopes of 1 to 15 percent; limestone at a depth of 20 to 40 inches; moderate erodibility.	Limestone at a depth of 20 to 40 inches; slopes of 1 to 15 percent; moderate permeability; well drained.

research engineer, Kansas State Highway Commission. This assistance was given under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

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 currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Readers interested in developments of the current system should read the latest literature available (*7, 10*). In table 10, the soil series of Ness County are placed in some categories of the current system.

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 together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 10 shows that the four soil orders in Ness County are Entisols, Inceptisols, Mollisols, and Vertisols.

Entisols are mineral soils which are recently formed. They have little or no evidence of genetic horizons and do not have features which reflect soil mixing caused by shrinking and swelling.

Inceptisols are mineral soils that have weakly expressed genetic horizons. The surface layer is generally lighter colored than the Mollisols, and the soils do

TABLE 9.—*Engineering*

[Tests performed by the State Highway Commission of Kansas in accordance with standard procedures of

Soil name and location	Parent material	Report number	Depth	Moisture density [1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb/cu ft*	*Pct*
Bridgeport silt loam: 240 feet south and 130 feet east of northwest corner of NE¼ section 8, T. 19 S., R. 23 W. (Modal)	Recently deposited alluvium.	S69 Kans 68–1–1	0–14	99	20
		68–1–2	14–23	100	19
		68–1–3	23–58	108	15
Harney silt loam: 100 feet east and 70 feet south of northwest corner of section 22, T. 20 S., R. 23 W. (Modal)	Calcareous loess.	S68 Kans 68–2–1	0–5	103	18
		68–2–2	11–17	97	23
		68–2–3	24–33	96	23
		68–2–4	33–47	96	24
Penden silty clay loam: 1,440 feet north and 300 feet west of southeast corner of section 11, T. 17 S., R. 26 W. (Modal)	Calcareous loamy sediments modified by silty loess material.	S69 Kans 68–3–1	0–8	104	17
		68–3–2	14–32	108	18
		68–3–3	32–65	110	13
Roxbury silty clay loam: 2,080 feet east and 1,320 feet north of southwest corner of section 21, T. 18 S., R. 24 W. (Modal)	Alluvium.	S68 Kans 68–1–1	5–18	100	21
		68–1–2	18–32	96	23
		68–1–3	32–52	95	22

[1] Based on AASHTO Designation T 99–61, Method A (*1*), with the following variations: (1) All material is ovendried at 230°F.; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analyses according to the AASHTO Designation T 88–57 (*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 silicate 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

not have features which reflect soil mixing caused by shrinking and swelling.

Mollisols are mineral soils that have thick, dark-colored surface horizons containing colloids dominated by bivalent cations. They do not have features which reflect soil mixing caused by shrinking and swelling.

Vertisols are mineral soils that are high in clay throughout and have evidence of soil mixing caused by shrinking and swelling.

SUBORDER.—Each order has been divided into suborders, primarily on the basis of the characteristics that seemed 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 waterlogging or soil differences resulting from the climate or vegetation. The suborder is not shown separately in table 10, because it is identified by the last part of the last word in the name of the subgroup.

GREAT GROUPS.—Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 10, because it is the last word in the name of the subgroup.

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.

FAMILY.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Additional Facts About the County

Ness County was laid out in 1867 by the Kansas State

test data

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

Mechanical analysis [2]							Liquid limit	Plasticity index	Classification	
Percentage less than 3 inches passing sieve—			Percentage smaller than—							
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			AASHTO	Unified [3]
100	99	96	78	52	29	22	39	15	A–6(10)	CL–ML
100	99	93	83	56	29	21	35	13	A–6(9)	CL–ML
100	99	95	82	43	20	15	30	8	A–4(8)	CL–ML
100	100	96	85	50	28	19	33	12	A–6(9)	CL
100	100	97	90	70	51	44	57	34	A–7–6(19)	CH
100	100	98	95	68	43	37	43	19	A–7–6(12)	CL
100	100	99	97	69	40	30	44	18	A–7–6(12)	CL–ML
98	86	66	58	38	22	17	38	16	A–6(9)	CL
100	92	78	71	52	34	28	37	17	A–6(11)	CL
100	90	78	73	55	36	27	33	15	A–6(10)	CL
100	100	96	84	60	36	27	41	19	A–7–6(12)	CL
100	100	98	91	65	41	31	43	21	A–7–6(13)	CL
100	100	98	95	77	51	42	47	24	A–7–6(15)	CL

would have been obtained by soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, 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 soil survey 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] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is CL–ML.

Legislature, was designated the 52nd county in 1868, and officially proclaimed as organized in 1873 (*5*). The earliest settlers came in the summer of 1873, but settlers did not begin to claim land in significant numbers until about 1875 or 1876. Since that time, according to figures taken from reports of the Kansas State Board of Agriculture, the population of the county has decreased from about 8,400 in 1932 to about 5,300 in 1969. Ness City, the county seat and largest town in the county, had a population of 1,881 in 1969. According to the 1964 Census of Agriculture, the density of population is 5 people per square mile.

When the early settlers arrived, native grass covered the soil. There were few trees in the county, and these were only along the major streams. As the county was settled, the lack of timber for use as fenceposts and building material forced the settlers to seek other material. Consequently, Greenhorn Limestone, the upper layer of which is now named Fencepost Limestone, was widely quarried for fenceposts and building stone in the early days, and many of the posts and some buildings still stand (*5*). Greenhorn Limestone either crops out or is near the surface in the eastern part of the county, along the drainageways of Walnut Creek and the Pawnee River.

Farming is the main enterprise in Ness County. According to the 1964 Census of Agriculture, there are 747 farms in the county averaging 938 acres in size. Nearly all of the land area of the county is in farms. Livestock and livestock products accounted for 63 percent of the value of farm products sold in 1964, and crops accounted for 37 percent. According to the Conservation Needs Inventory of 1967, about 60 percent of the county is used for dryfarming and about 1 percent is irrigated. The rest, excluding towns, roads, and other built-up areas, is used for pasture and range.

Corn was the main grain crop grown in Ness County until about 1890, when it gave way to wheat. Wheat is still the main crop, but much sorghum is grown, especially in the irrigated areas in the valleys of Walnut Creek and the Pawnee River. Farming in Ness County today is on a large scale and is highly mechanized.

The following trends in the acreages of the main crops in Ness County are based on biennial reports of the Kansas State Board of Agriculture and on the Kansas State Board of Agriculture publication "Farm Facts." The acreage in corn decreased from 18,054 in 1929 to 3,000 in 1969; that in wheat increased from 251,000 in 1929 to 310,000 in 1949, but decreased to 185,000 in 1969. The total acres of sorghum harvested for grain, silage, and forage, was 34,950 in 1949 and 32,300 in 1969.

TABLE 10.—*Classification of soil series*

[Classification as of March 13, 1970, or as classified in more recently revised series descriptions]

Soil series	Family	Subgroup	Order
Bridgeport	Fine-silty, mixed, mesic	Fluventic Haplustolls	Mollisols.
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.
Corinth	Fine, mixed, mesic	Typic Ustochrepts	Inceptisols.
Detroit	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Harney	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Heizer	Loamy-skeletal, carbonatic, mesic	Lithic Haplustolls	Mollisols.
Hord	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Ness	Fine, montmorillonitic, mesic	Udic Pellusterts	Vertisols.
Nibson	Loamy, carbonatic, mesic, shallow	Typic Haplustolls	Mollisols.
Penden	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Roxbury	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Timken	Clayey, montmorillonitic, nonacid, mesic, shallow	Typic Ustorthents	Entisols.
Uly	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Wakeen	Fine-silty, carbonatic, mesic	Typic Haplustolls	Mollisols.

Kansas State Board of Agriculture reports indicate the following changes in the number of livestock in the county. The number of beef cattle increased from 22,549 in 1929 to 41,700 in 1949 and 51,800 in 1969. Dairy cattle decreased in number from 3,797 in 1929 to 3,500 in 1949 and 1,200 in 1969. The number of hogs increased from 3,880 in 1929 to 4,400 in 1949 and 5,500 in 1969. The number of sheep and lambs increased from 1,350 in 1929 to 1,700 in 1949 but decreased to 800 in 1969. Chickens decreased in number from 95,000 in 1949 to 83,000 in 1969.

Ness County is served by three highways and two railroads. Both State Highway 96 and the Atchison, Topeka, and Santa Fe Railroad run east and west across the county, slightly south of the center, serving Bazine, Ness City, Laird, and Beeler. State Highway 4 and the Missouri Pacific Railroad both run east and west across the northern part of the county, serving Brownell, Ransom, Arnold, and Utica. United States Highway 183 runs north and south across the center of the county and through Ness City.

All of the towns except Osgood have grain elevators to buy and store grain. Farm machinery is sold in Ness City and Ransom. Cedar Bluff Reservoir, about 30 miles northeast of Ness City on the Smoky Hill River, has camping, boating, fishing, swimming, and picnic facilities.

Climate[6]

Except for a severe moisture deficiency in some years, the dry continental climate of Ness County is generally favorable for the successful production of many farm crops. The percentage of possible sunshine, the length of the growing season, the monthly distribution of precipitation, and the growing season temperatures all contribute to a high potential for farm production in the county.

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

Although the Gulf of Mexico is the principal source of moisture for precipitation in Kansas (*3*), the western part of the state, including Ness County, is infrequently in the flow of moist air from the Gulf. This fact together with the fact that Ness County is in the rain shadow of the Rocky Mountains results in 21 inches of annual rainfall in Ness County. This lack of rainfall is partly offset by the seasonal distribution of precipitation, more than three-fourths of which is received in the period April through September—a fact of great significance to farming. More than 2½ inches is received in each month in the period May through August, and an average of nearly 3½ inches is received in June, the wettest month. Winters are dry. On the average, less than 0.75 inch of precipitation is received in 1 month during the period December through February.

As in most dry climates, precipitation varies widely from month to month and from year to year. In 1927 at Ness City, 0.51 inch of rainfall fell in May, and in the following month 9.31 inches fell. During the period of record, annual precipitation has ranged from 10.06 inches in 1966 to 32.41 inches in 1944. It is not unusual for several consecutive months of dry weather to occur, and droughts extending over a period of years have been recorded at irregular intervals. One of the worst droughts on record lasted from 1952 to 1956; the annual precipitation averaged nearly 6½ inches below the long-term mean.

Because of the dry continental climate, daily and annual temperatures vary greatly. The daily range, which averages more than 27 degrees, is most pronounced in October; daily ranges of more than 40 degrees occur occasionally in that month. Mean monthly temperature varies from 30.0° F in January, the coldest month, to 79.9° F in July. The change from the warm to the cold season is quite rapid; the monthly mean is 58.3° for October and drops to 43.5° in November. Cold winters and hot summers, both typical of mid-latitude continental climates, prevail in Ness County. In most years, annual extremes of temperature range

[6] By MERLE J. BROWN, climatologist for Kansas, NOAA-National Weather Service, Manhattan, Kans.

TABLE 11.—*Temperature and precipitation*

[Data from records kept at Ness City]

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have about 4 days with—		Average monthly total [2]	One year in 10 will have—	
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Totals less than—	Totals greater than—
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*
January	42.8	17.1	63	−3	0.40	0.02	0.99
February	47.4	20.9	68	3	.72	.07	1.82
March	56.5	27.8	78	7	1.03	.11	2.39
April	68.5	39.9	85	24	1.99	.46	3.83
May	78.6	51.2	92	35	3.18	1.00	5.65
June	88.4	61.2	102	48	3.40	.98	6.18
July	93.4	66.4	105	57	2.89	.67	6.55
August	92.6	65.1	105	54	2.66	.83	4.86
September	83.9	55.8	99	40	2.05	.34	4.28
October	72.9	43.6	89	29	1.26	.11	3.08
November	57.2	29.7	73	12	.77	.01	2.01
December	44.8	19.9	65	6	.56	.01	1.32
Year	68.9	41.6	[3] 106	[4] −10	20.91	13.51	28.06

[1] 37-year period, including 1970.

[2] Period 1898–1970.

[3] Average annual highest temperature.

[4] Average annual lowest temperature.

from below zero to above 100°. Temperature extremes for the period of record are –24° and 112°. Occasionally, during all but the summer months, temperatures are moderated by warm chinook winds blowing downslope from higher elevations to the west.

The freeze-free period is more than 5½ months long, and extends from April 28 to October 16 (*2*). The probabilities for specified low temperatures in spring and in fall for the central part of Ness County are given in table 12.

Surface winds are moderate to strong in all seasons and average more than 14 miles an hour for the year. During periods of dry weather, strong winds may be accompanied by soil blowing, particularly during March and April. The prevailing wind direction is southerly.

Snowfall is relatively light in Ness County, averaging about 20 inches per year. It has ranged from less than 10 inches in some winters to more than 45 inches in others. In March, the month when snowfall is heaviest, the largest amount of snow recorded was 34 inches in 1924. Blizzards can occur, but this type of storm is relatively infrequent in the area.

Relative humidity, which averages near 60 percent for the year, is lowest during hot, dry afternoons in midsummer. Humidity of less than 20 percent occurs occasionally, but humidity of less than 10 percent has been reported in the area. The mean percentage of

TABLE 12.—*Probability of specified low temperatures in spring and fall*

[For central part of Ness County]

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 5	April 12	April 19	May 2	May 13
2 years in 10 later than	March 30	April 6	April 14	April 27	May 8
5 years in 10 later than	March 18	March 27	April 5	April 17	April 28
Fall:					
1 year in 10 earlier than	November 3	October 28	October 20	October 12	October 2
2 years in 10 earlier than	November 9	November 2	October 24	October 17	October 6
5 years in 10 earlier than	November 21	November 13	November 3	October 26	October 16

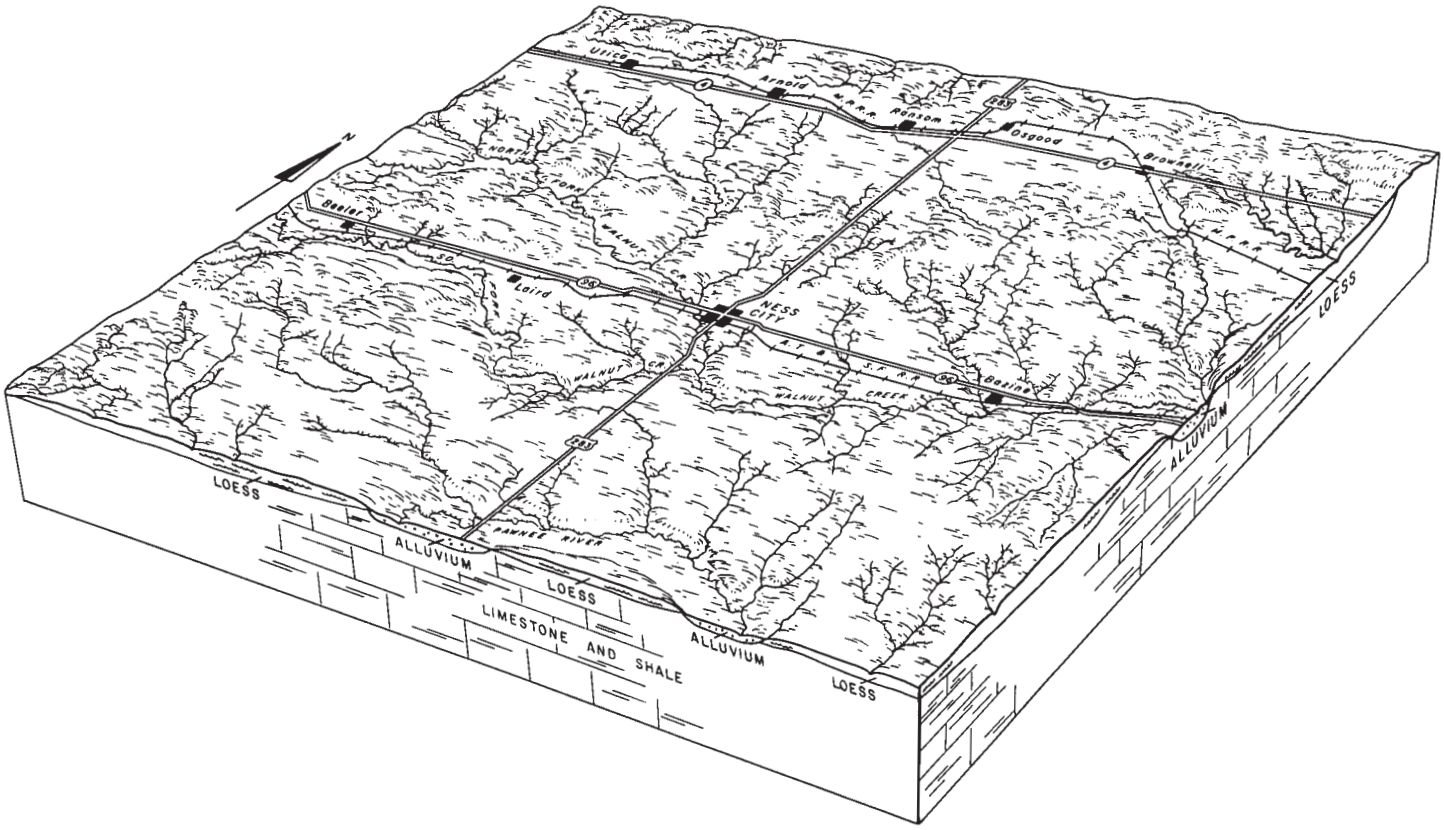

Figure 20.—**Parent material, relief, and drainage in Ness County.**

possible sunshine is over 70 percent, ranging from 65 percent in winter to about 80 percent in July. More than one-third of the days in Ness County are clear, and only one-third are cloudy.

Relief and Drainage

Most of Ness County consists of nearly level, gently sloping, and sloping ridgetops that are mantled with loess and separated by steeper slopes along the drainageways. The remaining parts of the county, which are mainly the west-central part and some areas in the northern part, consist of sloping to steep side slopes and narrow ridgetops, and steep, narrow slopes along drainageways (fig. 20). Caliche, chalky limestone, or shale crops out on the rims of the steep slopes along the drainageways.

Most of the county drains into Walnut Creek, which flows eastward slightly south of the center of the county. It, in turn, enters the Arkansas River near Great Bend in Barton County.

Approximately the southern fourth of the county drains south and southeastward into the Pawnee River, which enters and leaves the county across the southern border, and, in turn, flows into the Arkansas River near Larned in Pawnee County. Most of the extreme northern part of Ness County is drained northward by tributaries which, in turn, empty into the Smoky Hill River in Gove and Trego Counties.

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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.

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

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. An excavation produced by wind action in loose soil, usually sand.

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.

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 betwen thumb and forefinger.

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

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

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. As a soil textural class, a 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.*

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

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

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 groundwater 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.

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.

Silt loam. See Texture.

Silty clay loam. See Texture.

Silty clay. See Texture.

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.

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 grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble-mulch tillage. Tilling operations performed in such a way as to keep protective amounts of vegetative material on the surface of the soil.

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

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

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting of winter grains.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

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

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.

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Underlying material. See Substratum.

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.

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GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. An explanation of the capability classification begins on page 21, and a list of the capability classes and the subclasses and units in Ness County is on page 22. Windbreak groups are discussed in the section that begins on page 23. Other information is given in tables as follows:

Acreage and extent, table 1, page 7.
Predicted yields, table 2, page 23.
Trees and shrubs suitable for windbreaks, table 3, page 24.
Wildlife, table 4, page 27.
Recreation, table 5, page 29.
Use of the soils in engineering, table 6, page 32; table 7, page 37; and table 8, page 40.

Map symbol	Mapping unit	Page	Capability unit Dryland	Capability unit Irrigated	Range site		Windbreak suitability group
			Symbol	Symbol	Name	Page	Number
Ab	Alluvial land, broken	7	VIIw-1	------	----------	--	---
Br	Bridgeport silt loam	8	IIc-2	I-1	Loamy Terrace	26	1
Cc	Campus-Canlon complex	8	VIe-2	------	----------	--	---
	Campus portion	--	------	------	Limy Upland	25	---
	Canlon portion	--	------	------	Shallow Limy	26	---
Cu	Coly-Uly silt loams, 3 to 6 percent slopes, eroded	10	IVe-1	------	----------	--	2
	Coly portion	--	------	------	Limy Upland	25	---
	Uly portion	--	------	------	Loamy Upland	26	---
De	Detroit silty clay loam	11	IIc-3	I-2	Loamy Terrace	26	1
Ha	Harney silt loam, 0 to 1 percent slopes	12	IIc-1	I-3	Loamy Upland	26	2
Hb	Harney silt loam, 1 to 3 percent slopes	12	IIe-1	IIe-1	Loamy Upland	26	2
Hc	Harney silty clay loam, 1 to 3 percent slopes, eroded	12	IIIe-3	------	Loamy Upland	26	2
Hu	Harney-Uly silt loams, 0 to 1 percent slopes	12	IIc-1	I-3	Loamy Upland	26	2
Hv	Harney-Uly silt loams, 1 to 3 percent slopes	12	IIe-1	IIe-1	Loamy Upland	26	2
Hw	Heizer-Wakeen complex	13	VIe-2	------	----------	--	---
	Heizer portion	--	------	------	Shallow Limy	26	---
	Wakeen portion	--	------	------	Limy Upland	25	---
Hz	Hord silty clay loam	14	IIc-2	I-1	Loamy Terrace	26	1
Nc	Ness clay	14	VIw-1	------	----------	--	---
Nw	Nibson-Wakeen complex	15	VIe-2	------	Limy Upland	25	---
Pc	Penden clay loam, 3 to 6 percent slopes	15	IIIe-2	------	Limy Upland	25	2
Pd	Penden clay loam, 3 to 6 percent slopes, eroded	16	IVe-1	------	Limy Upland	25	2
Pr	Penden-Bridgeport complex	16	VIe-1	------	----------	--	2
	Penden portion	--	------	------	Limy Upland	25	---
	Bridgeport portion	--	------	------	Loamy Lowland	25	---
Px	Penden-Coly complex	16	VIe-1	------	Limy Upland	25	---
Rh	Rock land-Heizer complex	16	VIIs-1	------	----------	--	---
	Rock land portion	--	------	------	----------	--	---
	Heizer portion	--	------	------	Shallow Limy	26	---
Ro	Roxbury silt loam	17	IIc-2	I-1	Loamy Terrace	26	1
Rs	Roxbury silt loam, frequently flooded	17	IIIw-1	------	Loamy Lowland	25	1
Tx	Timken complex	18	VIIs-2	------	Blue Shale	25	---
Ub	Uly silt loam, 1 to 3 percent slopes	18	IIe-2	IIe-1	Loamy Upland	26	2
Uc	Uly silt loam, 3 to 6 percent slopes	18	IIIe-2	------	Loamy Upland	26	2
Ue	Uly-Coly silt loams, 1 to 3 percent slopes, eroded	18	IIIe-1	------	----------	--	2
	Uly portion	--	------	------	Loamy Upland	26	---
	Coly portion	--	------	------	Limy Upland	25	---
Ux	Uly-Corinth complex, 1 to 3 percent slopes	19	IIIe-1	------	----------	--	3
	Uly portion	--	------	------	Loamy Upland	26	---
	Corinth portion	--	------	------	Limy Upland	25	---
Uy	Uly-Corinth complex, 3 to 6 percent slopes	19	IVe-1	------	----------	--	3
	Uly portion	--	------	------	Loamy Upland	26	---
	Corinth portion	--	------	------	Limy Upland	25	---
Wb	Wakeen silt loam, 1 to 3 percent slopes	20	IIIe-1	------	Limy Upland	25	3
Wc	Wakeen silt loam, 3 to 6 percent slopes	20	IVe-1	------	Limy Upland	25	3

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