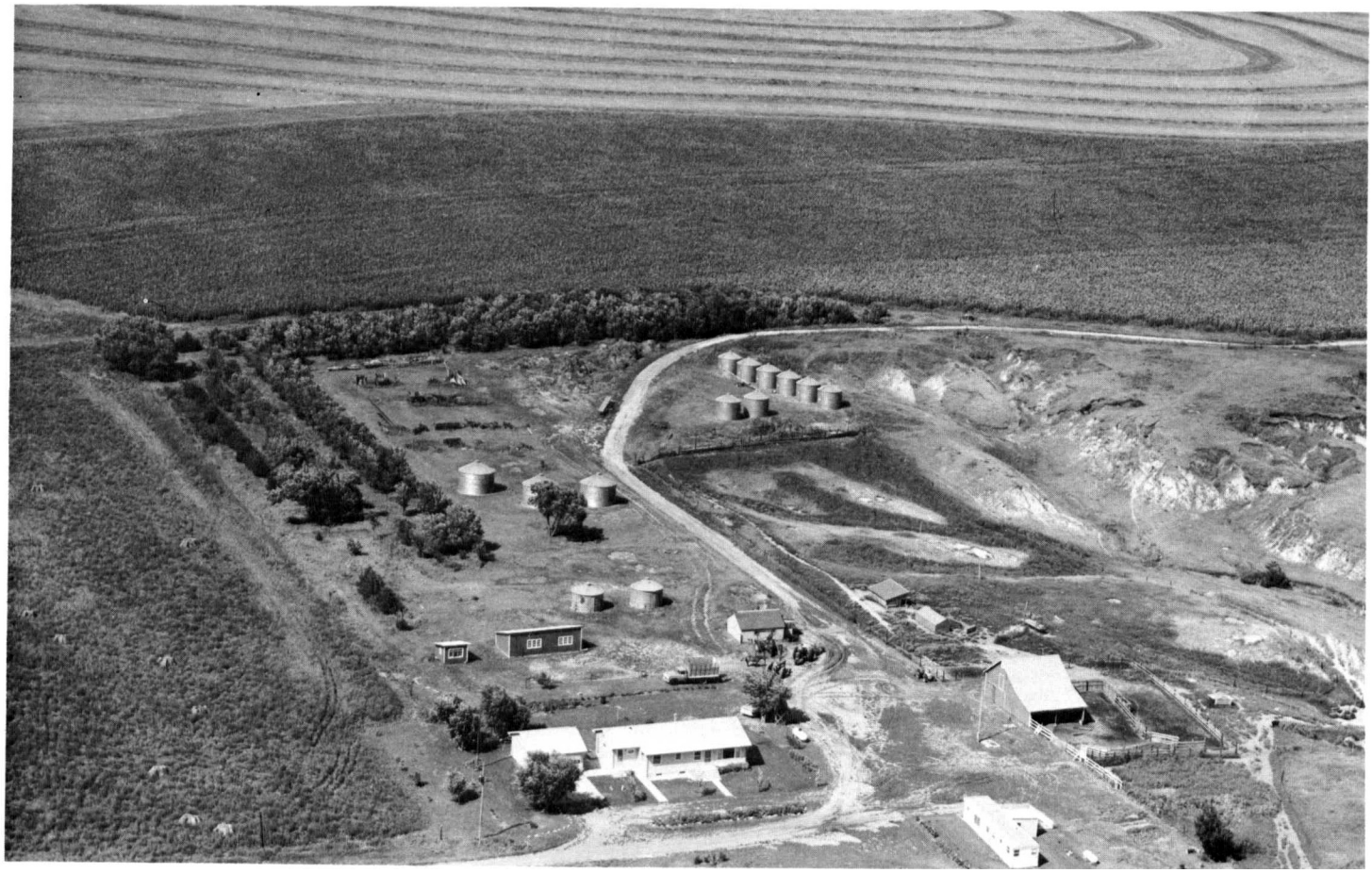
SOIL SURVEY OF

Frontier County, Nebraska



United States Department of Agriculture
Soil Conservation Service

in cooperation with
University of Nebraska
Conservation and Survey Division

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

Major fieldwork for this soil survey was completed in the period 1964–73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1974. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska Conservation and Survey Division. It is part of the technical assistance furnished to the Middle Republican and Central Platte Natural Resources Districts.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification 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 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 the use and management of the soils from the soil descriptions and from the discussions of the capability units, the range sites, and the windbreak suitability groups.

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

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

Ranchers and others can find 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 in the section "Range."

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

Scientists and others can read about soil formation and classification in the section "Formation and Classification of Soils."

Newcomers in Frontier 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 "Environmental Factors Affecting Soil Use."

Cover: Terraces and a good farmstead windbreak are conservation practices on this Frontier County farm, south of Moorefield. The cultivated land is Hall soils, and the rangeland is Coly and Uly soils.

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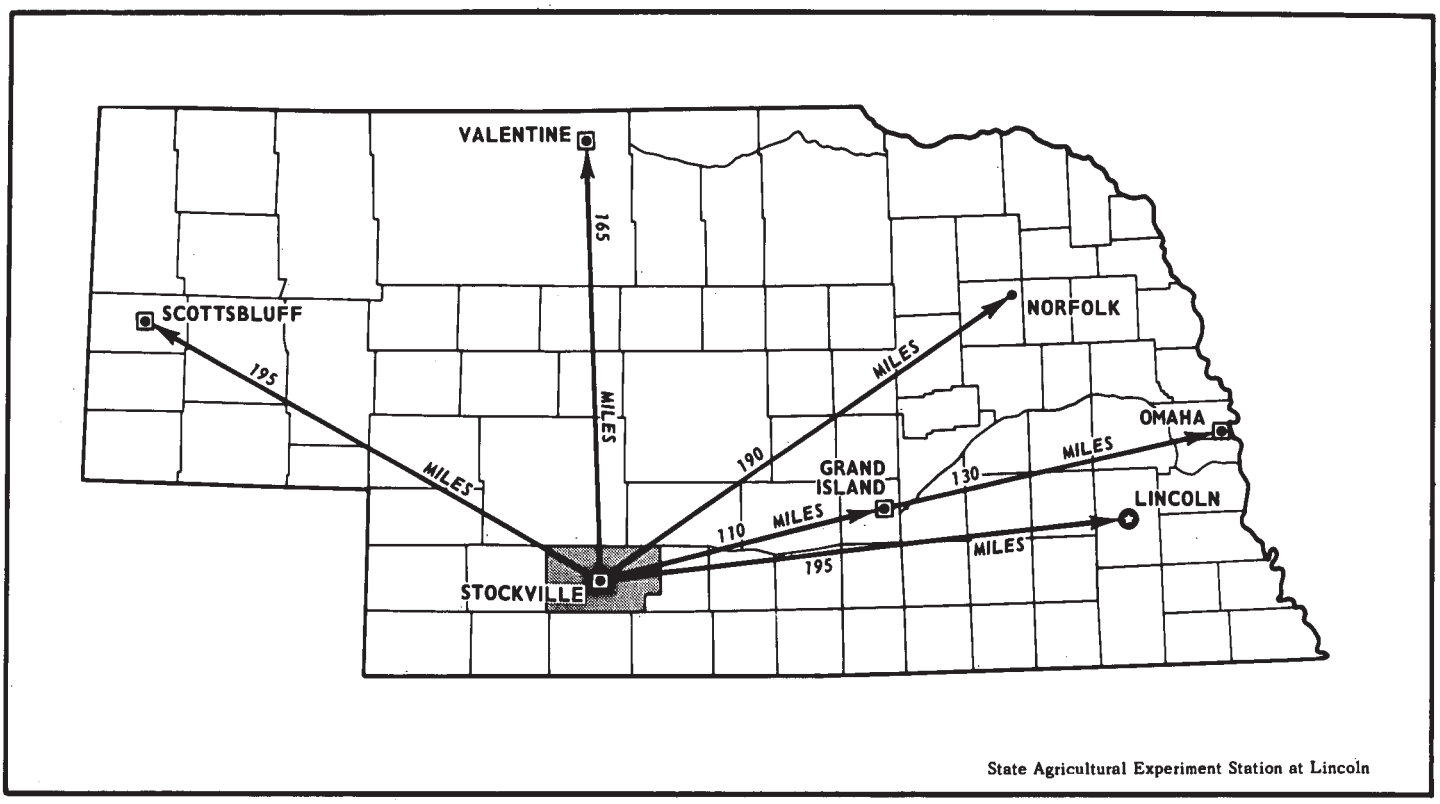

Location of Frontier County in Nebraska.

SOIL SURVEY OF FRONTIER COUNTY, NEBRASKA

By Ronald R. Hoppes and Norman W. Huber, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the University of Nebraska Conservation and Survey Division

FRONTIER COUNTY is in south-central Nebraska (see facing page). Stockville, the county seat, is near the center of the county and is about 200 miles west of Lincoln. Curtis is the largest town in Frontier County. It is in the north-central part of the county. Other principal towns are Eustis, Maywood, and Moorefield.

The county is nearly rectangular in shape. It is 42 miles from east to west on the north boundary and 36 miles from east to west on the south boundary. It is 24 miles from north to south. The total area of the county is 966 square miles, or 618,240 acres. The average elevation is 2,600 feet above sea level. Stockville is at an elevation of 2,482 feet. The general slope of Frontier County is southeastward.

Nearly all of Frontier County is well drained, and over a large part runoff is rapid. Poorly drained areas occur in a few upland basins, in marshy tracts on the flood plains, and around some manmade lakes. Except for a small area in the northeast corner of the county, which drains to the Platte River through Plum Creek, surface drainage moves through tributaries of the Republican River. Major tributaries are Medicine, Red Willow, Deer, and Muddy Creeks.

Frontier County is in the "Dissected Plains" topographic region of Nebraska. It consists of nearly level and gently sloping divides that are separated by numerous deeply entrenched drainageways. The parent material is loess, and the soil material is dominantly silty. A small area of sandhills fringes the west-central edge of the county. This area is characterized by hummocky topography. The soils are moderately coarse to coarse textured. Bottom land areas make up only a small part of the county. Larger drainageways, such as those along Medicine Creek, contain both coarse and fine textured material, but along the smaller drainageways the alluvium is predominantly medium textured. Lower areas in these drainageways are susceptible to flooding.

The first permanent settlement in Frontier County was made along Medicine Creek in the early 1870's. In 1872, the county was organized, and its original boundaries have remained unchanged. Settlers came mostly from Iowa, Illinois, Missouri, and other States to the east. Farming in Frontier County was of little importance before 1879, when, according to the Federal Census, only about 600 acres had been plowed. Only about 104,000 acres of plowed land was reported in 1889, and this amount increased to 425,000 acres in 1929. Since then most of the steeper part of this acreage has been reseeded to native grass.

Farming is the principal enterprise. Wheat, corn, and grain sorghum are the main crops under both dryland and irrigation management. A small acreage is in alfalfa. A considerable part of the feed grain and forage is fed to livestock. Wheat is the major cash crop. More than half the acreage in the county is in native grass. Raising beef cattle is the major livestock enterprise.

Much information has been accumulated on the different kinds of soils in Frontier County. Improved methods of tillage, grass management, applying irrigation water, and maintaining fertility, along with newly adapted crops and improved varieties of grass and trees, have increased production and helped stabilize farming. The identification and location of the different kinds of soils in this survey area along with their morphological and interpretive descriptions and groupings will insure continued progress.

An older survey of Frontier County was published in 1939 (*5*).[1] The present survey updates the earlier survey and provides additional information and larger maps that show the soils in greater detail.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Frontier County, where they are located, and how they can be used. The soil scientists observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer,

[1] Italic numbers in parentheses refer to References, page 62.

all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Holdrege and McCook, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or in 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, Holdrege silt loam, 1 to 3 percent slopes, is one of several phases within the Holdrege series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some 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 is shown on the soil map of Frontier County. It is called an undifferentiated soil group.

An undifferentiated soil group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils joined by "and." Coly and Uly silt loams, 8 to 30 percent slopes, is an undifferentiated soil group in Frontier County.

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 as a 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. Broken alluvial land is a land type in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of 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 kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when they are used as a growing medium 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 failure to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a 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 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 the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The five soil associations in this survey area are described on the pages that follow.

1. *Holdrege-Hall association*

Deep, nearly level to gently sloping, well drained silty soils on broad divides of loess uplands

This soil association on the loess upland consists mainly of broad divides that are generally oriented in a northwest-southwest direction and have long, smooth slopes. In places the divides are dissected by canyons that have steep sides.

This association makes up about 41 percent of the county. It is about 66 percent Holdrege soils (fig. 1), 22 percent Hall soils, and 12 percent minor soils.

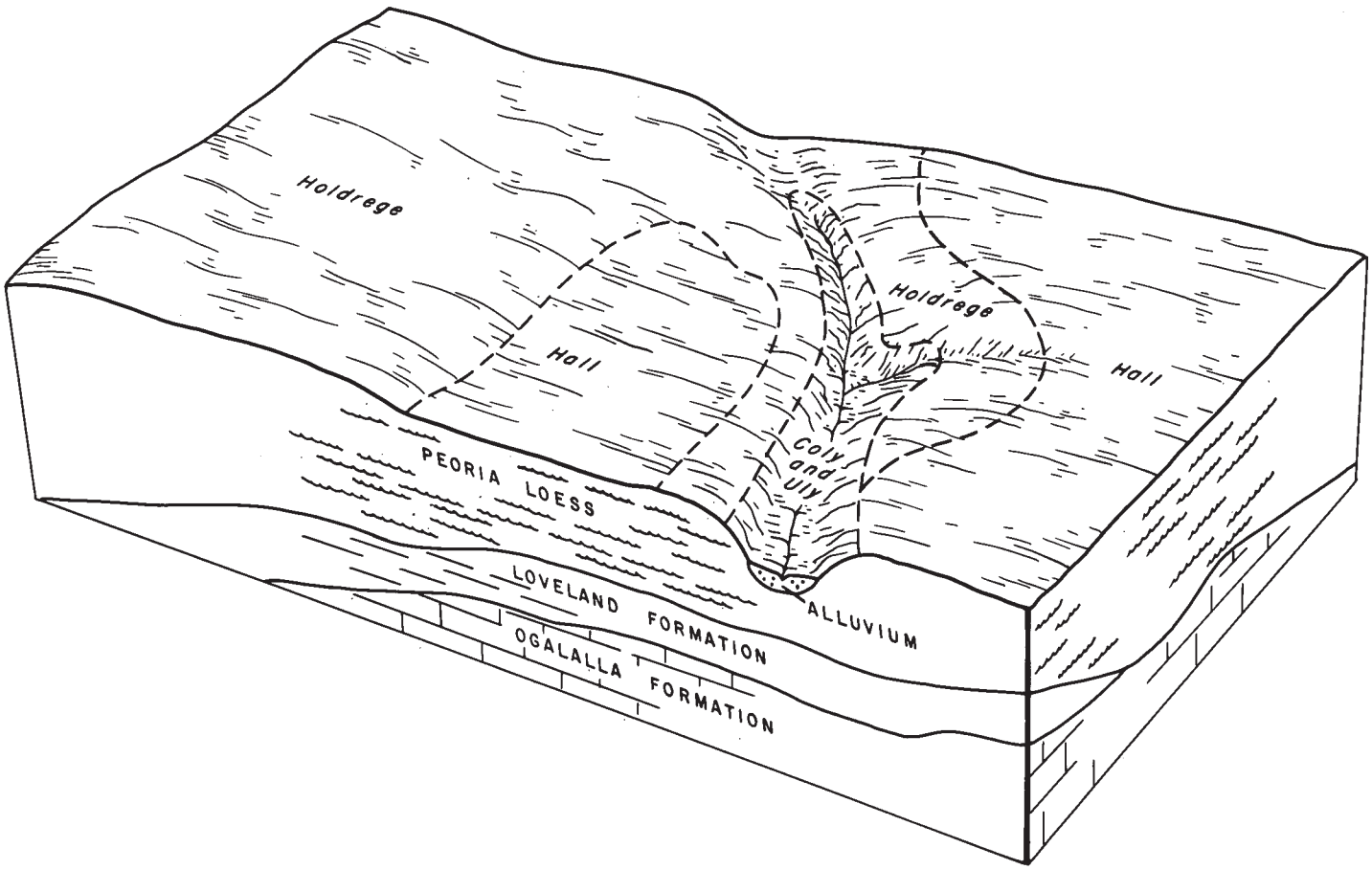

Figure 1.—**Pattern of soils and parent material in Holdrege-Hall association.**

The nearly level to gently sloping, well drained Holdrege soils are on the divides. Typically the surface layer is very friable, dark grayish brown silt loam about 11 inches thick. In sequence downward the subsoil is dark grayish brown heavy silt loam, grayish brown light silty clay loam, and light brownish gray silt loam. At a depth of 24 inches is the light gray silt loam underlying material.

The nearly level to gently sloping, well drained Hall soils are also on the divides. They occupy similar positions as Holdrege soils in the northern part of the county, but in the southern part they are in lower, concave positions. The surface layer is very friable, dark gray and dark grayish brown silt loam about 10 inches thick. The subsoil is dark grayish brown and grayish brown silty clay loam. A buried soil is common in the subsoil. At a depth of 30 inches is the light gray silt loam underlying material.

Minor in this association are Fillmore, Coly, and Uly soils. Fillmore soils are in upland depressions. Coly soils are on the steepest sides of canyons. Uly soils are along the rims of canyons between areas of Holdrege and Coly soils.

Farms on this association are mainly diversified. The nearly level to gently sloping soils are used for cash grain crops or feed grains, chiefly wheat, corn, and grain sorghum. If water is available, many areas are irrigated by gravity or by sprinklers. Corn stalks and other crop residue are utilized by livestock during winter. On some farms the feed grain is used to fatten cattle or hogs.

Water erosion, soil blowing, and lack of adequate rainfall are the main hazards on cultivated dryfarmed soils. Proper irrigation and water management, crop residue management, and maintenance of fertility are particularly important in managing the irrigated land.

Farms on this association average about 960 acres. Gravel or improved dirt roads are on some section lines. Because of the deep canyons that dissect the county, most roads extend from north to south. Hard surfaced highways dissect this association. Farm produce and livestock are marketed mainly within the county, but some are delivered to towns in adjacent counties.

2. *Uly-Coly-Holdrege association*

Deep, gently sloping to steep, well drained to somewhat excessively drained silty soils on narrow divides and side slopes of loess uplands

This soil association on the loess upland consists of narrow divides and smooth, strongly sloping to steep side slopes.

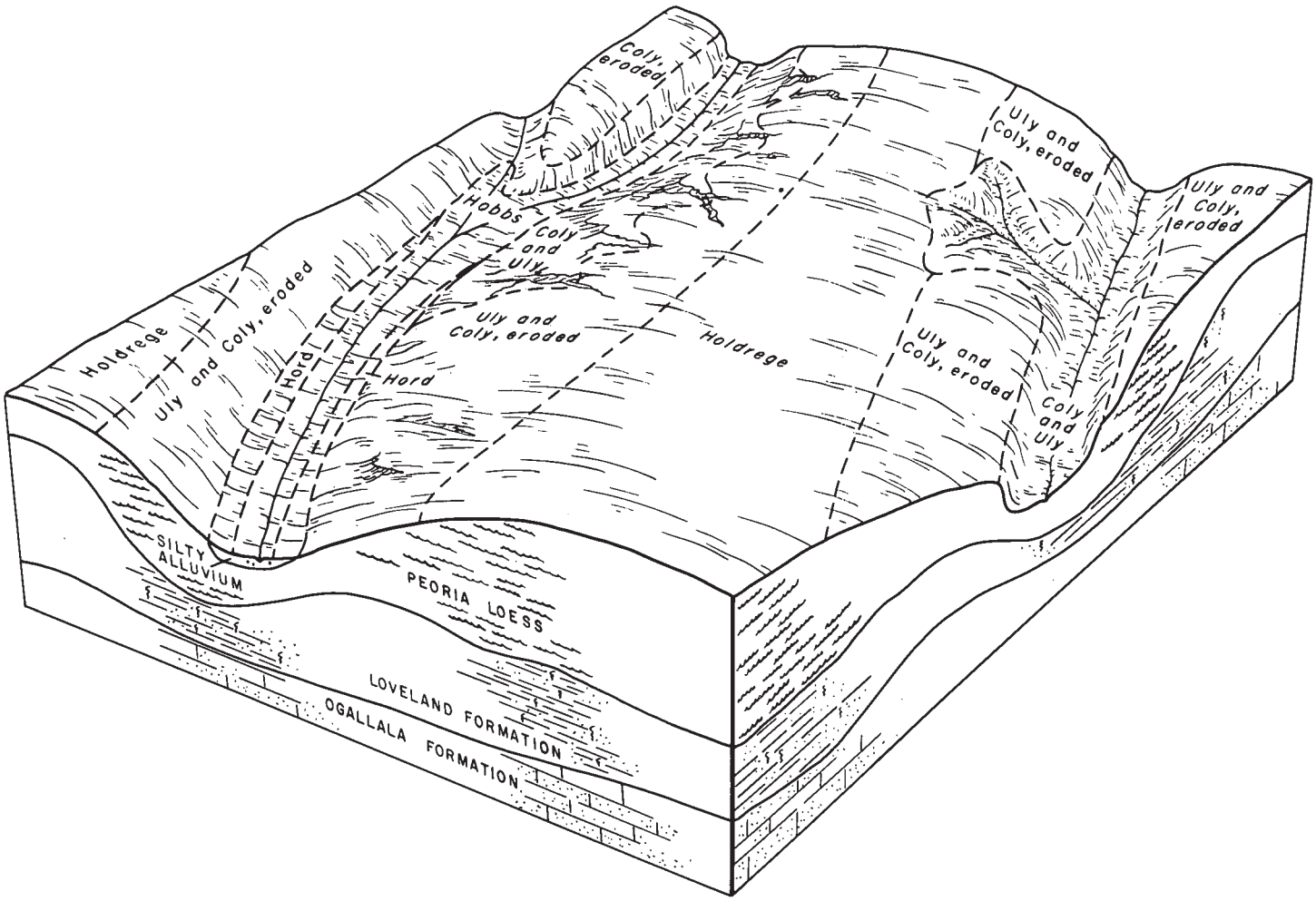

Figure 2.—**Pattern of soils and parent material in Uly-Coly-Holdrege association.**

This association makes up about 2 percent of the county. It is about 40 percent Uly soils (fig. 2), 25 percent Coly soils, 15 percent Holdrege soils, and 30 percent minor soils and land types.

The gently sloping to strongly sloping, well drained Uly soils are on the smooth side slopes. The surface layer is moderately thick, very friable, grayish brown silt loam. The subsoil is light brownish gray silt loam. At a depth of about 16 inches is the very pale brown and light gray silt loam underlying material.

The stongly sloping to steep, well drained to somewhat excessively drained Coly soils are on the steepest side slopes. The surface layer is thin, very friable, grayish brown silt loam. Beneath this is a transition layer of light brownish gray silt loam. At a depth of about 10 inches is the light gray silt loam underlying material.

The gently sloping, well drained Holdrege soils are on the narrow divides. The surface layer is thin, very friable, dark grayish brown silt loam. The subsoil is dark grayish brown silt loam in the upper part, grayish brown silty clay loam in the middle part, and light brownish gray silt loam in the lower part. At a depth of about 16 inches is the light gray silt loam underlying material.

Minor in this association are Hord and Hobbs soils and Broken alluvial land. Hord soils are on foot slopes below areas of Uly or Coly soils. Hobbs soils are on the occasionally flooded bottoms of small drainageways. Broken alluvial land is in the bottoms of larger drainageways where flooding is frequent or where there are deep, meandering channels.

Farms on this association are diversified. They are mainly of the cash grain–livestock type. Soils on the divides and the smoother areas on side slopes are used mainly for dryland crops. Wheat, corn, and grain sorghum are the chief crops. Many of the steep areas have been cultivated, but the trend is toward reseeding these areas to native grass. Beef cattle graze the rangeland.

Water erosion, soil blowing, and drought are the main hazards on cultivated soils. Proper range management, planned grazing systems, and control of water erosion are needed on rangeland.

Farms on this association average about 1,200 acres. Gravel or improved dirt roads are on most section lines. Hard surfaced highways cross the area in places. Farm produce and livestock are marketed mainly within the county, but some are delivered to towns in adjacent counties.

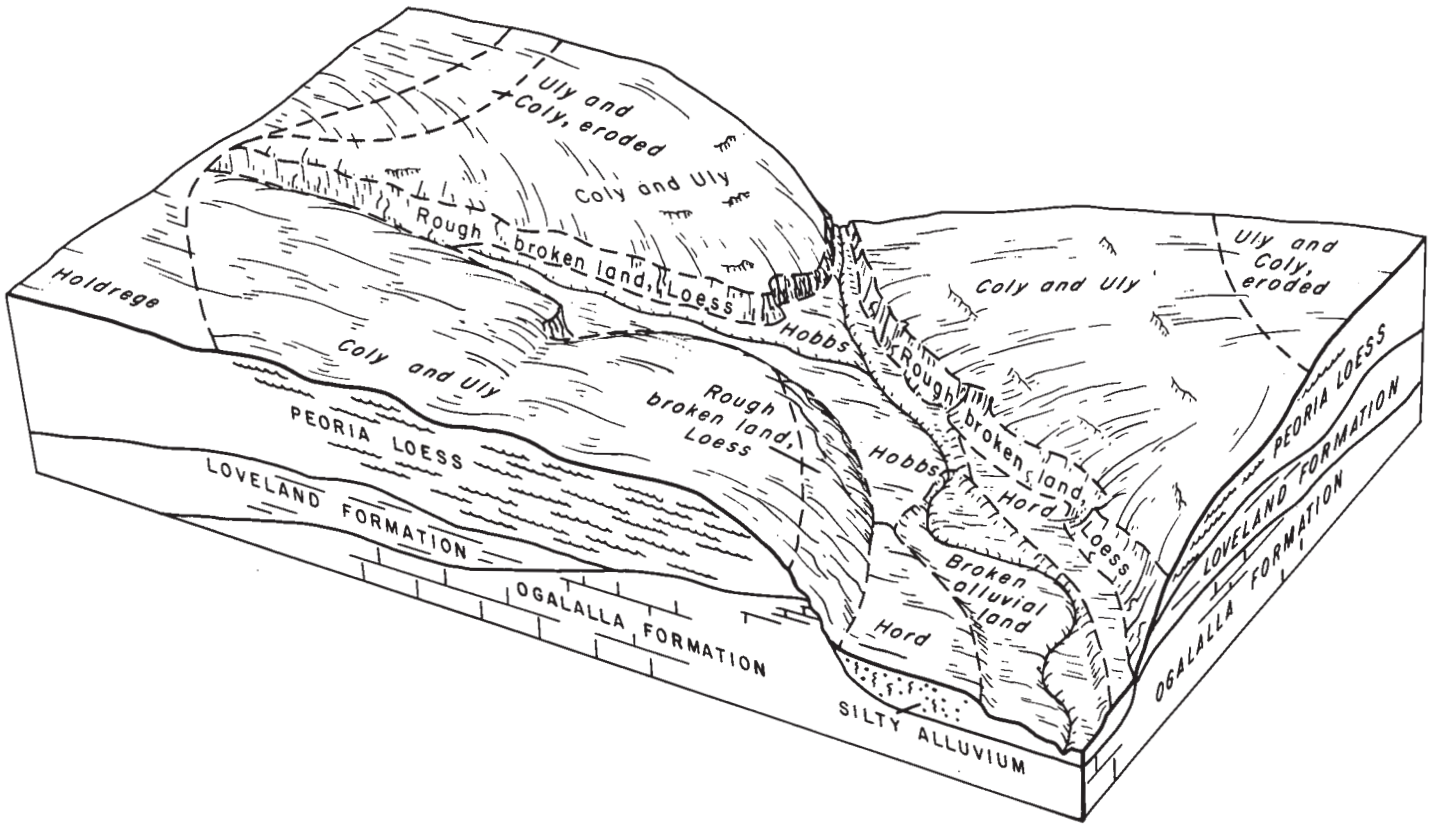

Figure 3.—**Pattern of soils and parent material in Coly-Uly-Rough broken land, loess association.**

3. *Coly-Uly-Rough broken land, loess association*

Deep, strongly sloping to very steep, well drained to excessively drained silty soils on narrow divides and canyons of loess uplands

This soil association is in strongly sloping to very steep canyons and on hillsides along drainageways. It makes up about 53 percent of the county. It is about 58 percent Coly soils (fig. 3), 20 percent Uly soils, about 16 percent Rough broken land, loess, and 6 percent minor soils and other land types.

The strongly sloping to steep, well drained to somewhat excessively drained Coly soils are on the sides of canyons. The surface layer is thin, very friable grayish brown silt loam. Beneath this is a transition layer of light brownish gray silt loam. At a depth of 10 inches is the light gray silt loam underlying material.

The strongly sloping to moderately steep, well drained Uly soils are on the smoother slopes of the canyons and hillsides. The surface layer is moderately thick grayish brown silt loam, and the subsoil is light brownish gray silt loam. At a depth of 16 inches is the very pale brown and light gray silt loam underlying material.

The very steep and excessively drained Rough broken land, loess, is on the steepest parts of the canyons. Catsteps, or small and abrupt vertical escarpments, are common.

Minor in this association are McCook, Hobbs, Holdrege, Hall, and Hord soils and Rough broken land, caliche; Rough broken land, sandy; and Broken alluvial land. McCook, Hobbs, and Hord soils are in the bottoms of the canyons. Holdrege and Hall soils are on the narrow divides between the canyons. Rough broken land, caliche, is mainly near the base of the canyon walls. Rough broken land, sandy, is only along the western edge of the county on very steep walls of canyons. Broken alluvial land is in the bottom of the larger drainageways where there are deep, meandering channels.

Most of this association is in native grass and is used for grazing livestock. Raising beef cattle is the main livestock enterprise. In a few of the smoother areas on the canyon slopes and at the base of canyons, the grass is left ungrazed and is cut for hay. Strongly sloping areas along the rim of the canyons are commonly planted in forage crops used as winter feed for livestock. Some of the narrow divides between the canyons are dryfarmed. Wheat, sorghum, and summer fallow is the main cropping sequence in these areas. Proper range management and planned grazing systems are needed on rangeland.

Farms on this association average about 1,280 acres. Gravel and improved dirt roads generally follow the bottoms of canyons or are on the narrow divides. Curtis is the only market for cattle in the county. A few cattle are sold at markets in adjoining counties at McCook or at Lexington.

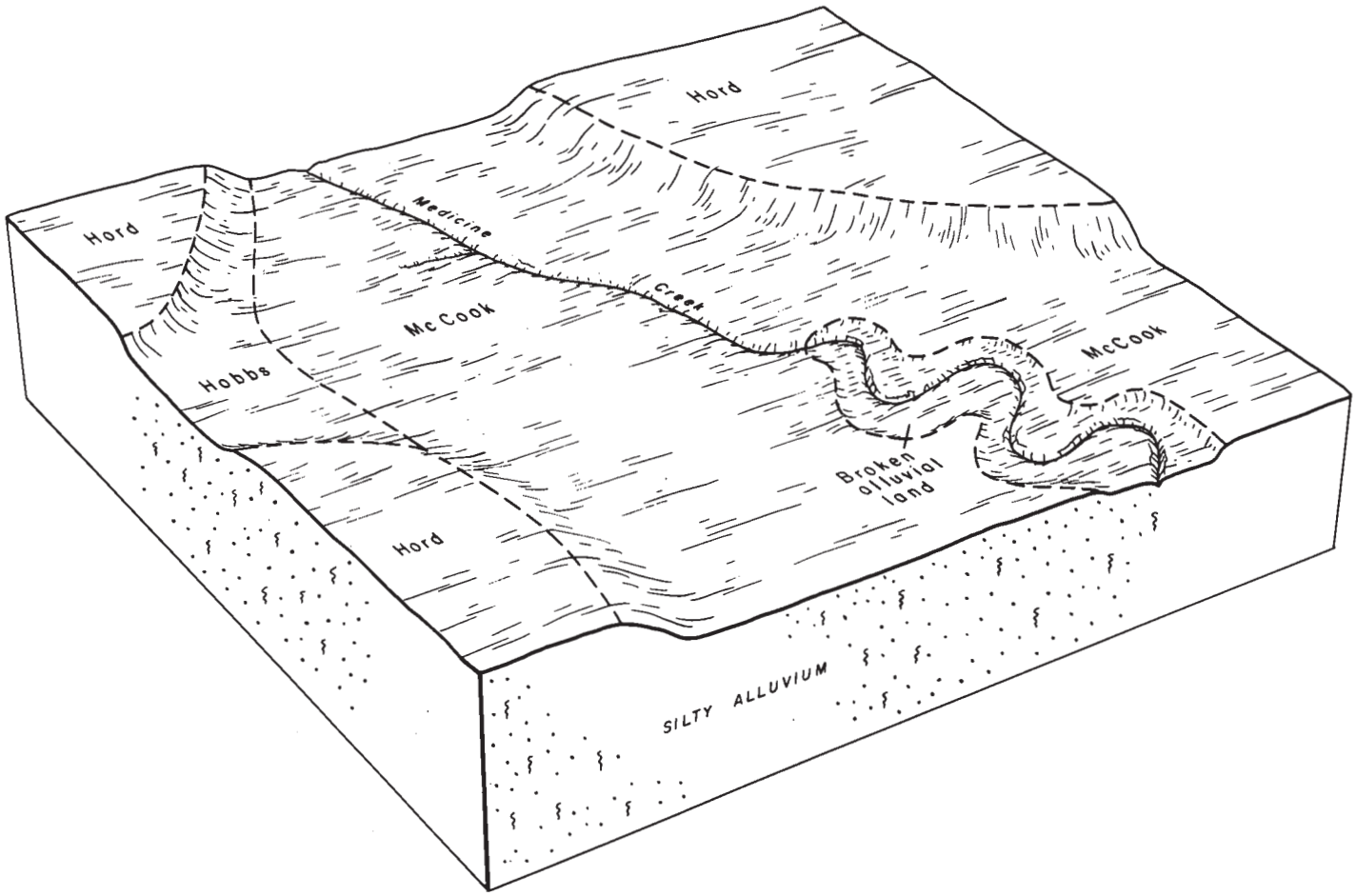

Figure 4.—**Pattern of soils and parent material in McCook-Hord-Hobbs association.**

4. McCook-Hord-Hobbs association

Deep, nearly level to gently sloping, well drained silty soils on bottom land, stream terraces, and foot slopes

This association is in valleys, which include the bottom land, stream terraces, and foot slopes along Medicine, Red Willow, and Plum Creeks. It makes up about 3 percent of the county. It is about 47 percent McCook soils (fig. 4), 30 percent Hord soils, 9 percent Hobbs soils, and 14 percent minor soils and land types.

The nearly level to gently sloping, well drained McCook soils are on the occasionally flooded bottom land and on colluvial foot slopes adjacent to the sides of canyons. The surface layer is very friable, grayish brown silt loam about 11 inches thick. The underlying material is stratified light gray, very pale brown, or light brownish gray silt loam and very fine sandy loam.

The nearly level to gently sloping, well drained Hord soils are on stream terraces above the flood plain and on colluvial foot slopes. The surface layer is very friable, grayish brown silt loam about 13 inches thick. The subsoil also is grayish brown silt loam. At a depth of 27 inches is the light gray silt loam underlying material.

The nearly level to very gently sloping Hobbs soils are on the bottom land. They are occasionally flooded, but are well drained. The surface layer is very friable, dark grayish brown silt loam about 6 inches thick. The underlying material is finely stratified, grayish brown, very dark grayish brown, and dark gray silt loam.

Minor in this association is McCook silt loam, wet, a somewhat poorly drained soil on bottom land. Broken alluvial land is at the bottom of the larger drainageways where flooding is frequent or where there are deep meandering channels. Wet alluvial land, which is very poorly drained, is on bottom land.

Most farms on this association are diversified, mainly combination cash grain and livestock. Much of the acreage is cultivated and is well suited to irrigation. Water for irrigation is pumped from shallow wells or perennial streams. Corn is the major crop under both irrigation and dryland management. Wheat, sorghum, and alfalfa are also grown. Small, hard to cultivate areas are commonly in native grass and are used for grazing livestock. Raising beef cattle is the most common livestock enterprise. Corn stalks and other crop residue and alfalfa provide winter feed for livestock.

The bottom land is subject to flooding. Floods are

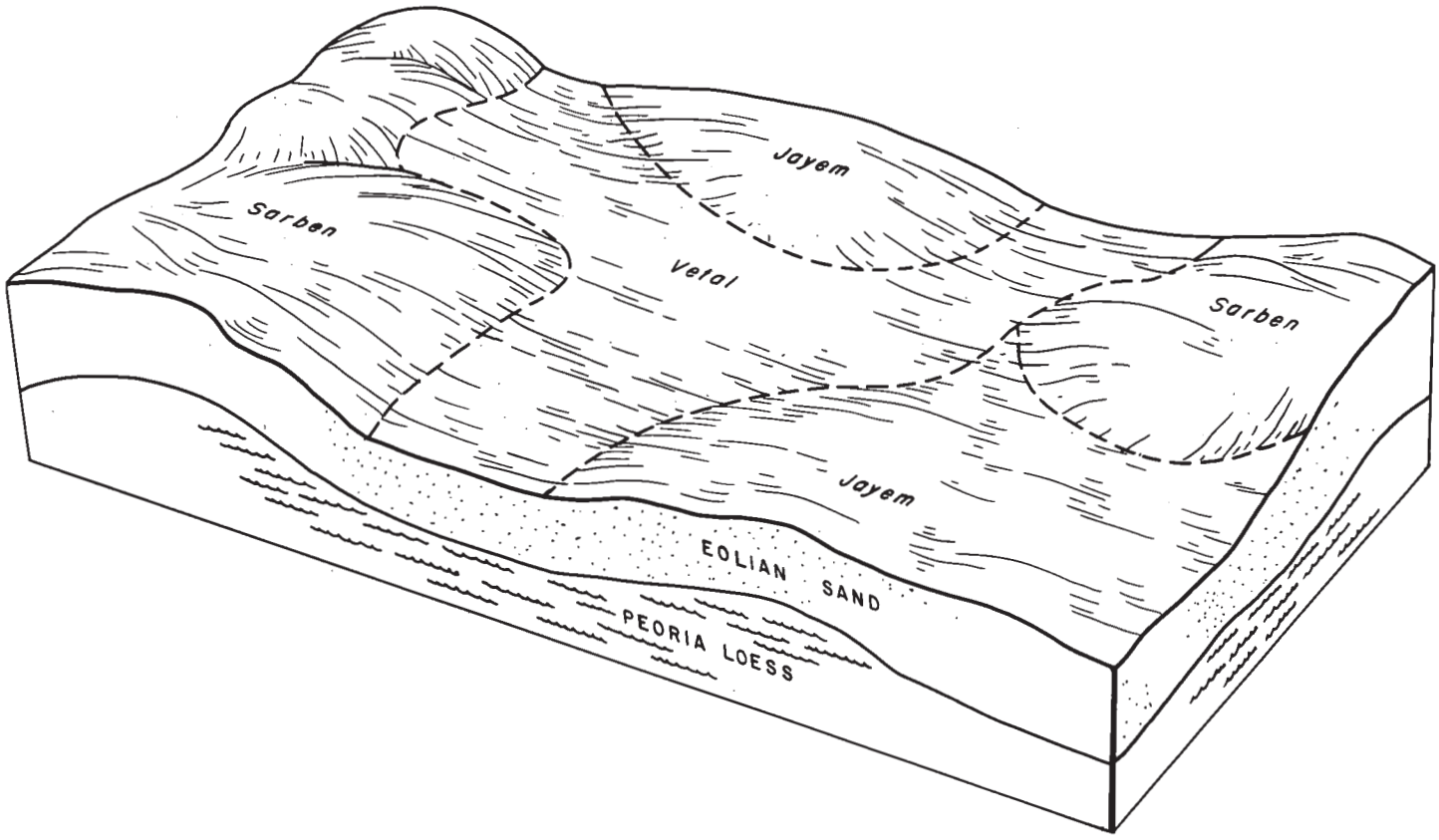

Figure 5.—**Pattern of soils and parent material in Sarben-Vetal-Jayem association.**

usually intense but of short duration. Watershed dams and conservation practices on the uplands reduce the hazard of flooding. Maintaining fertility is an important concern in irrigated areas.

Farms on this association average about 960 acres. Most farmsteads are on dirt roads but have access to gravel or hard surfaced roads within a few miles. Bridge crossings on the major creeks are at approximately 4-mile intervals. Farm produce and livestock are marketed mainly in towns within the county.

5. *Sarben-Vetal-Jayem association*

Deep, nearly level to strongly sloping, well drained sandy soils on uplands

This soil association has a hummocky topography shaped and formed by the wind. It makes up less than 1 percent of the county. It is about 44 percent Sarben soils (fig. 5), 35 percent Vetal soils, and 21 percent Jayem soils.

The gently sloping to strongly sloping Sarben soils are well drained. The surface layer is very friable, light brownish gray loamy very fine sand 6 inches thick. Beneath this is a transition layer of light brownish gray loamy very fine sand. At a depth of 18 inches is the pale brown loamy very fine sand and very pale brown very fine sand underlying material.

The nearly level to gently sloping, well drained Vetal soils are in plane to concave positions on the landscape. The surface layer is very friable, grayish brown loamy very fine sand and very fine sandy loam about 22 inches thick. Beneath this is a transition layer of grayish brown very fine sandy loam. At a depth of 36 inches is the light brownish gray loamy very fine sand underlying material.

The gently undulating, well drained Jayem soils are on uplands. The surface layer is very friable, grayish brown loamy very fine sand about 6 inches thick. The subsoil is grayish brown and pale brown very fine sandy loam. At a depth of 18 inches is the very pale brown loamy very fine sand underlying material.

Farms on this association are diversified, mainly combination cash grain and livestock. Crops are mainly dryfarmed. Corn is the principal crop, but sorghum, wheat, rye, and alfalfa are also grown. A small acreage is irrigated, commonly by self-propelled, center-pivot sprinklers. Corn is the crop generally grown when these areas are irrigated. Most farms also have small areas of native grass. These areas are the steepest parts of the landscape. Some farms extend into adjoining associations. Raising beef cattle is the most common livestock enterprise.

Soil blowing is the main hazard in cultivated areas. Lack of soil moisture and medium to low natural fertility limit crop production. The trend is toward irrigating larger acreages where sufficient underground water is available.

Farms on this association average about 960 acres. Gravel or improved dirt roads are on most section

lines. Farm produce and livestock are marketed mainly in adjacent counties.

Descriptions of the Soils

This section describes the soil series and mapping units in Frontier County. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is 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 more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

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

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the "Glossary" 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 (*4*).

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Some soil boundaries may not match adjoining areas. Such differences result from changes in concepts of soil classification that have occurred since publication.

Broken Alluvial Land

Ba—Broken alluvial land is on low bottom land in valleys formed by the major creeks and some intermittent streams. In most areas it is deeply entrenched by meandering stream channels and is subject to frequent overflow. Abruptly sloping channel banks and uneven topography adjacent to the channels are characteristic features. Areas are long and narrow and range from 50 to 1,000 acres.

Broken alluvial land formed in highly stratified, light and dark colored silty material that is mostly alluvium. Included in mapping were small areas of Hobbs and McCook soils. Also included were a few small areas of sandy alluvial material on the bottom land of Medicine Creek.

Permeability is moderate. Moisture is released readily to plants. Available water capacity is high. The organic matter content is moderate, and natural fertility ranges from medium to high.

Frequent flooding is the main hazard. Floods are usually intense but of short duration. Stream channels meandering across these bottom lands have cut the areas into many small plots that are difficult to reach with farming equipment.

Most areas are in native grass and trees and are used for grazing. A few nearly level areas have been cleared and are in cultivated crops, mainly alfalfa and forage sorghum. Because of frequent flooding, these areas are generally not suited to the cultivated crops commonly grown. Capability unit VIw–7 dryland; lower parts in Silty Overflow range site, higher parts in Silty Lowland range site; windbreak suitability group 10.

Coly Series

The Coly series consists of deep, well drained to somewhat excessively drained silty soils that formed in loess. These are strongly sloping to steep soils on uplands.

In a representative profile (fig. 6) the surface layer is very friable, grayish brown silt loam about 4 inches thick. The transitional layer is light brownish gray silt loam 6 inches thick. The underlying material is light gray silt loam to a depth of 60 inches. Free carbonates are at or near the surface.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content and natural fertility are low.

Coly soils are well suited to range. In areas where the slope is no more than 9 percent, they can be used for limited tillage. They are marginal for cultivated crops. They are suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Coly silt loam, in area of Coly and Uly silt loams, 9 to 30 percent slopes, in native range 260 feet south and 260 feet west of northeast corner sec. 34, T. 7 N., R. 26 W.

A1—0 to 4 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; strong effervescence; neutral; clear smooth boundary.

AC—4 to 10 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; strong effervescence; mildly alkaline; clear smooth boundary.

C—10 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; strongly effervescence; mildly alkaline.

In areas of native grass, the A horizon is grayish brown

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Broken alluvial land	5,965	1.0	McCook silt loam, 1 to 3 percent slopes	1,795	0.3
Coly silt loam, 5 to 9 percent slopes, eroded	9,215	1.5	McCook silt loam, occasionally flooded, 0 to 2 percent slopes	4,895	.8
Coly silt loam, 9 to 20 percent slopes, eroded	4,120	.7	McCook silt loam, wet, 0 to 1 percent slopes	785	.1
Coly and Uly silt loams, 9 to 30 percent slopes	277,550	44.9	Rough broken land, caliche, 30 to 60 percent slopes	725	.1
Fillmore silt loam, 0 to 1 percent slopes	330	(1)	Rough broken land, loess, 30 to 60 percent slopes	23,230	3.8
Hall silt loam, 0 to 1 percent slopes	22,235	3.6	Rough broken land, sandy, 30 to 60 percent slopes	985	.2
Hall silt loam, 1 to 3 percent slopes	36,340	5.9	Sarben loamy very fine sand, 3 to 9 percent slopes	735	.1
Hall silt loam, 3 to 6 percent slopes	3,575	.6	Uly silt loam, 3 to 6 percent slopes, eroded	1,710	.3
Hobbs silt loam, occasionally flooded, 0 to 2 percent slopes	2,150	.4	Uly silt loam, 6 to 9 percent slopes	1,020	.2
Holdrege silt loam, 0 to 1 percent slopes	4,085	.7	Uly and Coly silt loams, 6 to 9 percent slopes, eroded	4,575	.7
Holdrege silt loam, 1 to 3 percent slopes	110,435	17.9	Uly and Coly silt loams, 9 to 20 percent slopes	27,220	4.4
Holdrege silt loam, 1 to 3 percent slopes, eroded	28,670	4.7	Vetal loamy very fine sand, 0 to 3 percent slopes	580	.1
Holdrege silt loam, 3 to 6 percent slopes	3,650	.6	Wet alluvial land	505	.1
Holdrege silt loam, 3 to 6 percent slopes, eroded	30,570	5.0	Borrow pit	30	(1)
Hord silt loam, 3 to 6 percent slopes	545	.1	Total land area	615,680	100.0
Hord silt loam, terrace, 0 to 1 percent slopes	3,400	.6	Water area greater than 40 acres	2,560	
Hord silt loam, terrace, 1 to 3 percent slopes	2,105	.3	Total	618,240	
Jayem loamy very fine sand, 1 to 3 percent slopes	345	(1)			
McCook silt loam, 0 to 1 percent slopes	1,605	.3			

[1] Less than 0.05 percent.

and ranges from 4 to 7 inches in thickness. In cultivated areas it is light brownish gray. The AC horizon is 4 to 8 inches thick. Free carbonates are typically at the surface but range to a depth of 7 inches.

Coly soils are near Uly and Holdrege soils. In contrast with these soils, they have a thinner A horizon, lack a B horizon, and have free carbonates nearer the surface.

CoD2—Coly silt loam, 5 to 9 percent slopes, eroded. This soil is on ridgetops and side slopes of loess uplands. Areas range from 5 to 80 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the original surface layer. The present surface layer is light brownish gray. Free carbonates are at the surface and throughout the profile. Included in mapping were a few small areas of Uly soils, generally on ridgetops.

This soil is very friable and is easy to work. Erosion by water is a very severe hazard in cultivated areas. Runoff is medium. Soil blowing can also be a problem unless the surface is protected. Lack of soil moisture and low soil fertility limit crop production. Conserving moisture and improving fertility and organic-matter content are important concerns of management.

Most of the acreage is cultivated. A few areas have been reseeded to native or tame grasses. Wheat, alfalfa, and forage sorghum are the principal crops. Capability units IVe–9 dryland, IVe–6 irrigated; Limy Upland range site; windbreak suitability group 5.

CoF2—Coly silt loam, 9 to 20 percent slopes, eroded. This soil is on side slopes of the smoother canyons that dissect the loess uplands. Areas range from 5 to 100 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed most of the original surface layer. The present surface layer is light brownish gray. Free carbonates occur at the surface and throughout the profile.

Erosion by water is the principal hazard in cultivated areas. In places rills and gullies form. Runoff is rapid. Conserving rainfall and preventing erosion are the principal concerns.

Many areas are cultivated. A few steep areas where the hazard of erosion is too severe for cultivated crops have been reseeded to native grasses or revegetated through natural propagation. Capability unit VIe–9 dryland; Limy Upland range site; windbreak suitability group 10.

CuF—Coly and Uly silt loams, 9 to 30 percent slopes. This mapping unit is on the sides of canyons that dissect the loess uplands. Both soils occur in most areas, but the proportion of each varies from one area to another. The Coly soil is generally dominant. A few areas are entirely Coly soil. Slopes are complex. The Coly soil is steep and has convex slopes. The Uly soil is less steep and has plane to concave slopes. Areas range from 10 to several thousand acres in size.

The Coly soil has the profile described as representative of the Coly series. Included in mapping were small areas of Holdrege soils on upper side slopes; areas of Hord, McCook, and Hobbs soils in narrow valleys; and areas of Rough broken land on the steepest side slopes.

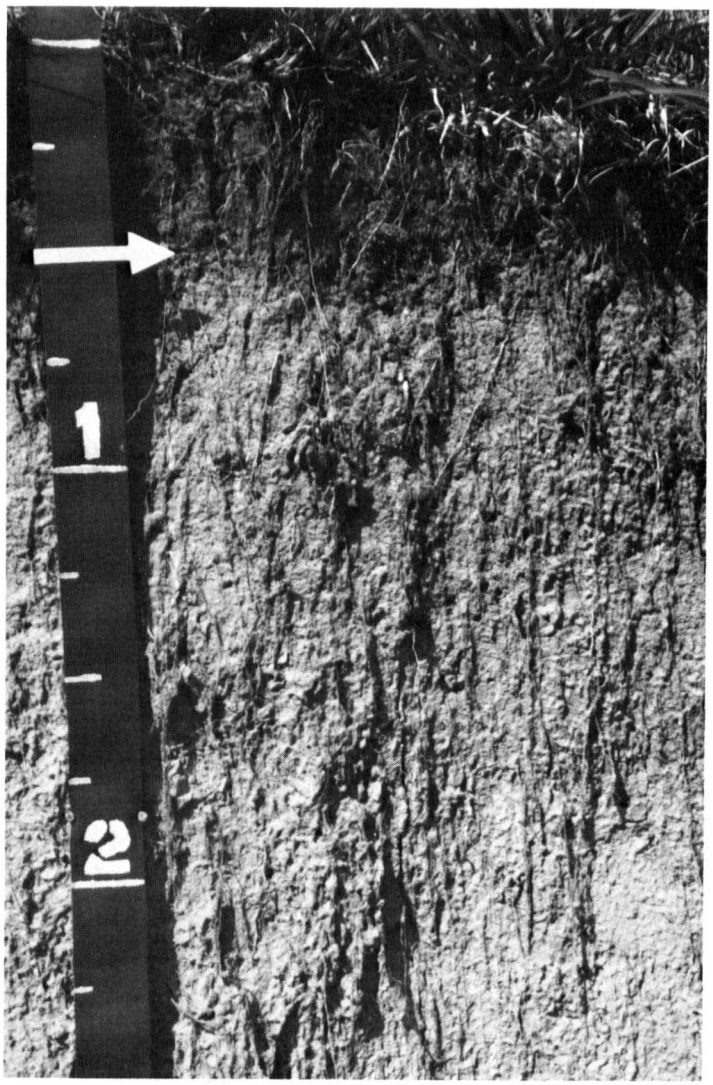

Figure 6.—**Profile of Coly silt loam. This immature soil is calcareous at the surface.**

Also included were small outcrops of Loveland Loess on the lowest side slopes and outcrops of limy sandstone.

Erosion by water is the principal hazard. Runoff is rapid. Lack of adequate soil moisture commonly limits production. Providing a grass cover to protect the soil against erosion and maintaining the most desirable kinds of grass are important concerns of management.

Most of the acreage is used for range. Some areas in the northern part of the county have a sparse stand of redcedar. Capability unit VIe–9 dryland; Coly soil in Limy Upland range site, Uly soil in Silty range site; windbreak suitability group 10.

Fillmore Series

The Fillmore series consists of deep, poorly drained silty soils that formed in loess. These are nearly level soils in basinlike depressions of the loess uplands. They have a claypan subsoil.

In a representative profile the surface layer is friable, gray and light gray silt loam 7 inches thick. The subsoil is about 33 inches thick. It is gray silty clay loam in the upper part, gray silty clay in the middle part, and grayish brown silty clay loam in the lower part. The underlying material is light brownish gray silt loam to a depth of 60 inches.

Permeability is very slow. Available water capacity is moderate. The content of organic matter is moderate, and natural fertility is medium. Moisture is absorbed slowly and released slowly to plants.

Fillmore soils are suited to cultivated crops under either dryland or irrigation management. They are also suited to grass, trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Fillmore silt loam, 0 to 1 percent slopes, in cultivated field 1,200 feet south and 1,000 feet west of the northeast corner sec. 31, T. 5 N., R. 30 W.

Ap—0 to 4 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A2—4 to 7 inches; light gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; weak very fine platy structure; slightly hard, friable; medium acid; abrupt smooth boundary.

B21t—7 to 16 inches; gray (10YR 5/1) silty clay loam, black (10YR 2/1) moist; moderate medium subangular blocky structure; very hard, very firm; medium acid; clear smooth boundary.

B22t—16 to 24 inches; gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) moist; strong medium subangular blocky structure; very hard, very friable; slightly acid; clear smooth boundary.

B23t—24 to 32 inches; gray (10YR 5/1) silty clay, very dark grayish brown (10YR 3/2) moist; strong medium subangular blocky structure; very hard, very firm; slightly acid; clear smooth boundary.

B3t—32 to 40 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; hard, firm; slightly acid; clear smooth boundary.

C—40 to 60 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The Ap horizon is 3 to 5 inches thick, and the A2 horizon is 2 to 4 inches thick. In the Fillmore soils in Frontier County, the A horizon is thinner than is defined in the range for the series. This difference, however, does not affect the use and management of the soils.

Fillmore soils are near Holdrege and Hall soils. In contrast with those soils, they have more clay in the B22t horizon and have an A2 horizon.

Fm—Fillmore silt loam, 0 to 1 percent slopes. This soil is in shallow depressions of the loess uplands. Areas are round or oblong and range from 3 to 25 acres. Areas less than 3 acres in size are indicated by spot symbols on the map.

Included with this soil in mapping were a few areas where the surface layer is thinner than described as representative of the series. Also included were a few areas where the surface layer is silty clay loam.

Flooding is the main hazard. Excessive wetness caused by heavy rainfall in spring results in ponding and limits the use of this soil. Planting and tillage are often delayed. Later in summer and fall when rainfall is low, this soil can be droughty if dryfarmed. Moisture penetrates the claypan slowly and is released slowly to plants. Controlling runoff from surrounding areas is an important concern of management. This soil can

be properly tilled within only a narrow range of moisture content.

Most of the acreage is cultivated. Some areas are irrigated. Corn, grain sorghum, and wheat are the principal crops. If irrigated, this soil is best suited to corn. Capability units IIIw–2 dryland, IIIw–2 irrigated; Clayey Overflow range site; windbreak suitability group 2.

Hall Series

The Hall series consists of deep, well drained silty soils that formed in loess. These are nearly level to gently sloping soils on uplands and high stream terraces.

In a representative profile the surface layer is very friable, dark gray and dark grayish brown silt loam 10 inches thick. The subsoil is about 20 inches thick. In sequence downward, it is dark grayish brown silt loam, very dark brown silty clay loam, and grayish brown silty clay loam. The underlying material is calcareous light gray silt loam to a depth of 60 inches or more. The middle part of the subsoil is a buried, darkened layer that is uniformly present in these soils in the northern part of the county.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate, and natural fertility is high.

Hall soils are well suited to dryland or irrigated crops. They are also suited to grass, trees, habitat for wildlife and for recreation.

Representative profile of Hall silt loam, 1 to 3 percent slopes, in cultivated field 200 feet west and 30 feet south of northeast corner sec. 11, T. 8 N., R. 27 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.

A12—6 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

B21—10 to 16 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; soft, very friable; neutral; clear smooth boundary.

B22t—16 to 24 inches; grayish brown (10YR 5/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium and coarse subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

B3t—24 to 30 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; neutral; clear smooth boundary.

C1ca—30 to 37 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable; thin mycelia of carbonates; strong effervescence; mildly alkaline; clear smooth boundary.

C2—37 to 60 inches; light gray (10YR 7/2) silt loam, pale brown (10YR 6/3) moist; massive; soft, very friable; strong effervescence; mildly alkaline.

The A horizon is silt loam or very fine sandy loam 6 to 24 inches thick. A buried soil is present in these soils in the northern part of the county, but generally does not occur in the southern part.

Hall soils are near Holdrege soils on the upland divides and Hord soils on the high stream terraces. They have a darker colored B3 horizon than Holdrege soils. In Hall soils, the very dark grayish brown color in the B horizon extends to a greater depth than in Holdrege soils. Hall soils have a more clayey B horizon than Hord soils.

Ha—Hall silt loam, 0 to 1 percent slopes. This soil is on broad divides of the loess uplands. In one place, it is on a stream terrace. Areas range from 5 to more than 1,000 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker and carbonates are leached deeper in the profile. Included in mapping were areas of Fillmore soils in small depressions.

This soil is very friable and is easy to till. Runoff is slow. Lack of soil moisture is the major limitation for dryfarmed crops. A few areas receive additional moisture as runoff from higher elevations. Soil blowing is a hazard unless the surface is protected.

Most of the acreage is cultivated. Wheat and grain sorghum are the principal dryfarmed crops. A few areas are irrigated. In irrigated areas corn is the principal crop. Capability units IIc–1 dryland, I–4 irrigated; Silty range site; windbreak suitability group 4.

HaB—Hall silt loam, 1 to 3 percent slopes. This soil is on the broad divides of the loess uplands. Areas range from 5 to more than 1,000 acres. This soil has a profile described as representative of the series. In some small areas the surface layer is very fine sandy loam and the subsoil is not so clayey. Included with this soil in mapping were small areas of uneroded Holdrege soils and Fillmore soils in small depressions.

This soil is very friable and is easy to till. Erosion by water is the principal hazard. Runoff is slow. Soil blowing is a problem unless the surface is protected. In dryfarmed areas, lack of soil moisture commonly limits crop production.

Most of the acreage is cultivated. A small acreage is irrigated. Wheat and grain sorghum are principal crops in dryfarmed areas. Corn is the principal crop in irrigated areas. Capability units IIe–1 dryland, IIe–4 irrigated; Silty range site; windbreak suitability group 4.

HaC—Hall silt loam, 3 to 6 percent slopes. This soil is on loess uplands. Areas range from 5 to 200 acres.

This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner and free carbonates are higher in the profile. A buried soil in the subsoil is characteristic of this soil in the northern part of the county.

This soil is very friable and is easy to work. Erosion by water is the main hazard. Runoff is medium. Soil blowing is also a hazard unless the surface is protected. Lack of moisture is a common limitation where this soil is dryfarmed. Unless the soil is protected, rills and gullies form as a result of runoff during heavy rainfall.

Most of the acreage is cultivated, but none is irrigated. Wheat and grain sorghum are the principal crops. Capability units IIIe–1 dryland, IIIe–4 irrigated; Silty range site; windbreak suitability group 4.

Hobbs Series

The Hobbs series consists of deep, well drained silty soils that formed in alluvial sediments. These are nearly level or very gently sloping soils on bottom lands of intermittent drainageways.

In a representative profile the surface layer is very friable, dark grayish brown silt loam about 6 inches thick. Beneath this is the underlying material, which is stratified very dark grayish brown, grayish brown, and dark gray silt loam to a depth of 60 inches.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate, and natural fertility is high.

Hobbs soils are suited to cultivated crops, both dryland and irrigated. They are also suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Hobbs silt loam, occasionally flooded, 0 to 2 percent slopes, in cultivated field 1,320 feet west and 100 feet south of northeast corner sec. 2, T. 8 N., R. 26 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

C1—6 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure with thin stratification of light and dark colored layers; soft, very friable; neutral; abrupt smooth boundary.

C2—10 to 16 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable; neutral, abrupt smooth boundary.

C3—16 to 25 inches; stratified very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) heavy silt loam, very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; soft, very friable; neutral; abrupt smooth boundary.

C4—25 to 55 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable; neutral; abrupt smooth boundary.

C5—55 to 60 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral.

The A horizon ranges from dark gray or dark grayish brown to grayish brown silt loam or loam and ranges from 6 to 10 inches in thickness. Thin strata of very fine sand occur throughout the profile in places. This soil is generally noncalcareous to a depth of about 48 inches, but in some places it is noncalcareous throughout the profile.

Hobbs soils are near McCook and Hord soils. They are darker colored below a depth of 20 inches and have lime leached to a greater depth than McCook soils. They have less profile development, are noncalcareous to a greater depth, and are more stratified than Hord soils.

Hb—Hobbs silt loam, occasionally flooded, 0 to 2 percent slopes. This soil is on bottom lands of intermittent drainageways that are occasionally flooded. Areas are typically long and narrow and range from 50 to 200 acres.

In some small areas the surface layer is loam and in others the soil is calcareous to the surface.

This soil is very friable and is easy to work unless it is too wet. Flooding is the main hazard. Floods are usually intense but of short duration. Runoff is slow. Crop damage occurs about 1 year in 4, mainly in June or July.

Most of the acreage is cultivated. A few areas are irrigated. Corn and grain sorghum are the main crops. A few areas are in native grass and are used for grazing. Capability units IIw–3 dryland, IIw–6 irrigated; Silty Overflow range site; windbreak suitability group 1.

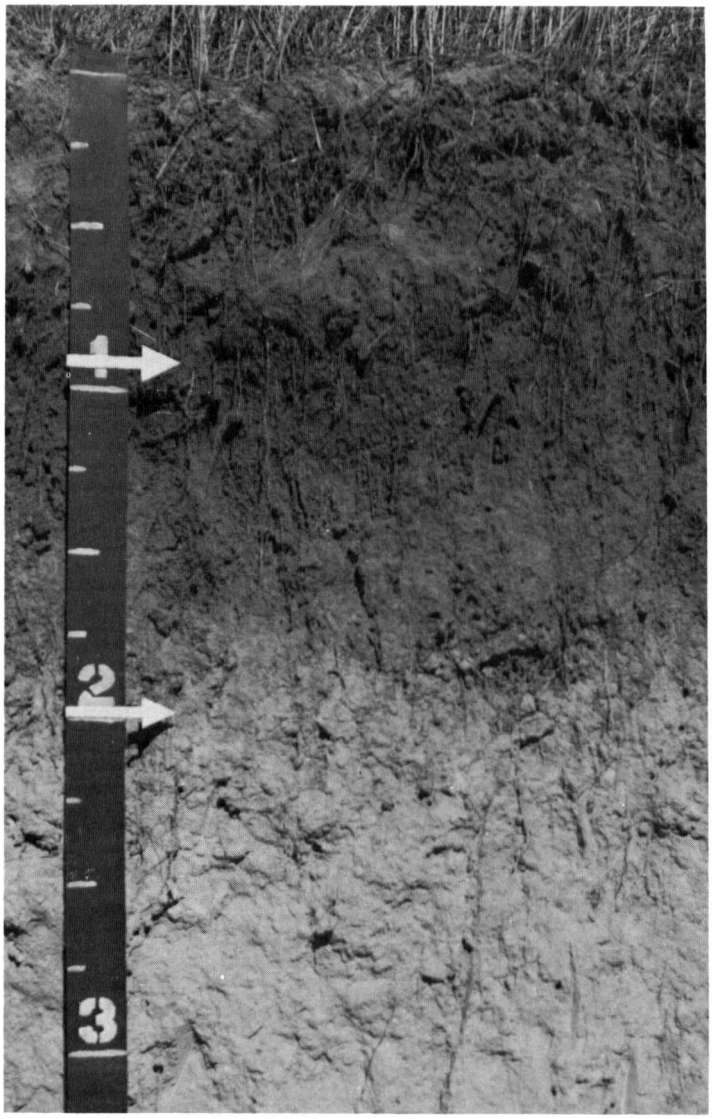

Figure 7.—**Profile of Holdrege silt loam. This deep, silty soil formed in windblown material. Arrows indicate lower boundaries of the major horizons.**

Holdrege Series

The Holdrege series consists of deep, well drained silty soils that formed in loess. These are nearly level to gently sloping soils on uplands.

In a representative profile (fig. 7) the surface layer is very friable, dark grayish brown silt loam 11 inches thick. The subsoil is about 13 inches thick. In sequence downward, it is dark grayish brown heavy silt loam, grayish brown light silty clay loam, and light brownish gray silt loam. Beneath this is underlying material of light gray silt loam to a depth of 60 inches or more. Free carbonates are at a depth of 28 inches.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high.

The organic-matter content is moderate, and natural fertility is high.

Holdrege soils are well suited to cultivated crops under dryland or irrigated management. They are suited to grass, trees, and shrubs, habitat for wildlife, and recreation.

Representative profile of Holdrege silt loam, 1 to 3 percent slopes, in native grass 1,848 feet south and 150 feet east of northwest corner sec. 19, T. 7 N., R. 28 W.

A1—0 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

B1t—11 to 14 inches; dark grayish brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; soft, very friable; slightly acid; clear smooth boundary.

B2t—14 to 18 inches; grayish brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, firm; neutral; clear smooth boundary.

B3—18 to 24 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; soft, very friable; neutral; clear smooth boundary.

C1—24 to 28 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; neutral; abrupt smooth boundary.

C2—28 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; strong effervescence; mildly alkaline.

The A horizon ranges from 4 to 14 inches in thickness. The B2t horizon is heavy silt loam or light silty clay loam. Depth to free carbonates ranges from 15 to 36 inches.

Holdrege soils are near Hall, Uly, and Coly soils. In Holdrege soils, the very dark grayish brown color in the B horizon does not extend to as great a depth as in Hall soils. Holdrege soils have a thicker solum and more clay in the B horizon than Uly soils. In contrast with Coly soils, they have a B horizon and free carbonates are leached deeper in the profile.

Ho—Holdrege silt loam, 0 to 1 percent slopes. This soil formed in loess on uplands. Slopes are plane. Areas range from 5 to 600 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer is generally slightly thicker. Included in mapping were a few small areas of Hall soils at slightly lower elevations.

This soil is very friable and is easy to work. Lack of sufficient moisture is the principal limitation in dryfarmed areas. Runoff is slow. Soil blowing is a hazard unless the surface is adequately protected. Maintaining high fertility and adequate moisture are the major concerns of management.

Nearly all the acreage is cultivated. Most areas are dryfarmed. Wheat, grain sorghum, and corn are the principal crops. A small acreage is irrigated. Corn is the main crop in irrigated areas. Capability units IIc–1 dryland, I–4 irrigated; Silty range site; windbreak suitability group 4.

HoB—Holdrege silt loam, 1 to 3 percent slopes. This deep, silty soil is on divides of the loess uplands. Slopes are long. They are plane or somewhat convex. Areas range from 5 to 2,000 acres.

This soil has a profile described as representative of the series. Included in mapping were a few small moderately eroded or severely eroded areas.

This soil is very friable and is easy to work. Erosion by water and soil blowing are moderate hazards. Runoff is slow or moderate, depending on the amount of plant cover. Lack of soil moisture, mainly late in summer, limits crop production.

Most of the acreage is cultivated. Wheat, grain sorghum, and corn are the principal crops. Some alfalfa is grown in the crop sequence. Corn is the principal crop in irrigated areas. Capability units IIe–1 dryland, IIe–4 irrigated; Silty range site; windbreak suitability group 4.

HoB2—Holdrege silt loam, 1 to 3 percent slopes, eroded. This soil is on ridgetops and convex side slopes of the upland divides. Areas range from 5 to about 500 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner. In places water erosion and soil blowing have removed much of the darkened surface layer. Tillage has mixed the remaining soil material from the surface layer with the upper part of the subsoil. In only a few small areas the soil is not appreciably eroded.

Included with this soil in mapping were small areas where erosion has removed all of the original surface layer and the grayish brown subsoil is exposed. Also included were small areas of Uly soils, generally on ridgetops.

Workability is fair. Because of the position of this soil on the landscape, erosion by wind and water is hazardous. Natural fertility and organic matter are slightly lower than in noneroded Holdrege soils. In areas where the silty clay loam subsoil is mixed with the surface layer, the water intake rate is lower than in uneroded areas. Runoff is medium.

Most of the acreage is cultivated. Wheat and grain sorghum are the principal crops. A smaller acreage is in corn and alfalfa.

A few areas are irrigated. Capability units IIe–1 dryland, IIe–4 irrigated; Silty range site; windbreak suitability group 4.

HoC—Holdrege silt loam, 3 to 6 percent slopes. This soil is on plane to convex side slopes of the upland divides. Areas range from 5 to 60 acres.

This soil has a profile similar to the one described as representative for the series, but the surface layer and subsoil are slightly thinner. Included in mapping were a few small moderately eroded or severely eroded areas.

This soil is friable and is easy to till. Erosion by water is a severe hazard in cultivated areas. Runoff is medium or rapid, depending on the amount of plant cover. Soil blowing can be a problem unless the surface is adequately protected.

Most of the acreage is in native grass or has been cultivated for only a short period of time. Wheat and grain sorghum are the main crops in cultivated areas. Capability units IIIe–1 dryland, IIIe–4 irrigated; Silty range site; windbreak suitability group 4.

HoC2—Holdrege silt loam, 3 to 6 percent slopes, eroded. This soil has convex slopes and is on upland divides. Areas range from 5 to 300 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and free carbonates are not so deeply leached. The surface layer is less than 7 inches thick.

Figure 8.—**Landscape of Hord soils on stream terrace above Medicine Creek.**

Included with this soil in mapping were small areas that are not appreciably eroded and a few small areas that are severely eroded.

Erosion by water is a severe hazard in cultivated areas. Soil blowing is a hazard unless the surface is adequately protected. Soil fertility and organic matter content are lower than in the noneroded Holdrege soils. Since the organic matter content is lower, precautions should be taken in applying herbicides in proper amounts. Where tillage has mixed the upper part of the subsoil with the plow layer, the water intake rate is lower than in uneroded areas and tillage is more difficult. Runoff is medium or rapid, depending on the amount of plant cover.

Nearly all the acreage is cultivated. Wheat and grain sorghum are the main crops. A smaller acreage is in corn and alfalfa. A few areas are irrigated. Corn is the main crop in irrigated areas. Capability units IIIe–1 dryland, IIIe–4 irrigated; Silty range site; windbreak suitability group 4.

Hord Series

The Hord series consists of deep, well drained silty soils that formed in silty alluvium. These are nearly level to gently sloping soils on stream terraces (fig. 8) and colluvial foot slopes at the base of the loess hills.

In a representative profile the surface layer is very friable, grayish brown silt loam 13 inches thick. The subsoil is also grayish brown silt loam and is about 14 inches thick. The underlying material is light gray silt loam to a depth of 60 inches. Free carbonates are below a depth of 31 inches.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderate, and natural fertility is high.

Hord soils are suited to dryland and cultivated crops. They are suited to grass, trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Hord silt loam, terrace, 0 to 1 percent slopes, in cultivated field 2,150 feet west and 530 feet south of northeast corner sec. 31, T. 6 N., R. 25 W.

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

A12—6 to 13 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

B1—13 to 21 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft; very friable; neutral; clear smooth boundary.

B2—21 to 27 inches; grayish brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; soft, very friable; neutral; clear smooth boundary.
C1—27 to 31 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; neutral; clear smooth boundary.
C2—31 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; slight effervescence; mildly alkaline.

The A horizon ranges from 10 to 24 inches in thickness. Depth to carbonates ranges from 20 to 48 inches. There is a buried soil in places.

Hord soils are near McCook soils on colluvial foot slopes. In contrast with those soils, they have a B horizon and free carbonates are leached to a greater depth.

HpC—Hord silt loam, 3 to 6 percent slopes. This soil is on colluvial foot slopes near the base of the loess hills. Areas range from 5 to 70 acres.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker. In a few areas free carbonates are leached below a depth of 48 inches.

This soil is very friable and is easy to work. Erosion by water can be a problem. Runoff is medium. Because the soil is on foot slopes, it receives runoff that can deposit alluvium on the surface.

Nearly all of the acreage is cultivated and dryfarmed. Corn, grain sorghum, wheat, and alfalfa are the principal crops. Capability units IIIe–1 dryland, IIIe–6 irrigated; Silty range site; windbreak suitability group 4.

Hr—Hord silt loam, terrace, 0 to 1 percent slopes. This soil is on stream terraces along the major drainageways. Areas range from 5 to 130 acres.

This soil has the profile described as representative of the series. In a few areas free carbonates are leached to below a depth of 48 inches. In some areas there is a recent accumulation of light colored silty material on the surface.

This soil is very friable and is easy to work. Lack of soil moisture is the principal limitation if this soil is dryfarmed. Runoff is slow. Soil blowing is a hazard unless the surface is protected.

Most of the acreage is cultivated, and many areas are irrigated. Corn and grain sorghum are the principal crops grown under irrigated or dryland management. Wheat and alfalfa are also grown. A few small areas are in native grass. This soil is suited to trees and shrubs, habitat for wildlife, and recreation. Capability units IIc–1 dryland, I–6 irrigated; Silty Lowland range site; windbreak suitability group 1.

HrB—Hord silt loam, terrace, 1 to 3 percent slopes. This soil is on stream terraces along the major drainageways. Areas range from 5 to 130 acres in size.

This soil has a profile similar to the one described as representative of the series, but the subsoil is thinner and free carbonates are not so deeply leached. In a few areas the soil is noncalcareous to a depth of 48 inches, and in a few areas one or more buried soils are in the profile.

Erosion by water can be a hazard on this soil. Runoff from higher lying areas can cause erosion or deposit a layer of fresh alluvium on the surface. Runoff is slow to medium.

Most of the acreage is cultivated, and a few areas are irrigated. Corn, grain sorghum, and alfalfa are the main crops. Capability units IIe–1 dryland, IIe–6 irrigated; Silty Lowland range site; windbreak suitability group 1.

Jayem Series

The Jayem series consists of deep, well drained sandy soils formed in material that was mainly wind deposited very fine sand mixed with a small amount of silt. These are gently undulating soils on uplands.

In a representative profile the surface layer is very friable, grayish brown loamy very fine sand 6 inches thick. It is grayish brown in the upper part and pale brown in the lower part. The underlying material is very pale brown loamy very fine sand to a depth of 60 inches or more.

These soils release moisture readily to plants. Permeability is moderately rapid. Available water capacity is moderate. The organic-matter content is moderately low, and natural fertility is medium.

Jayem soils are suited to dryland or irrigated crops, trees or shrubs, grass, habitat for wildlife, and recreation.

Representative profile of Jayem loamy very fine sand, 1 to 3 percent slopes, in seeded native grass 2,430 feet east and 100 feet north of southwest corner sec. 18, T. 7 N., R. 30 W.

A1—0 to 6 inches; grayish brown (10YR 5/2) loamy very fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; loose, very friable; slightly acid; clear smooth boundary.
B2—6 to 13 inches; grayish brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and coarse, prismatic structure parting to weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.
B3—13 to 18 inches; pale brown (10YR 6/3) very fine sandy loam, dark grayish brown (10YR 4/2) moist; weak medium and coarse prismatic structure parting to weak fine granular; soft, very friable; slightly acid; gradual smooth boundary.
C—18 to 60 inches; very pale brown (10YR 7/3) loamy very fine sand, brown (10YR 5/3) moist; single grained; loose, very friable; neutral.

The A horizon ranges from 5 to 9 inches in thickness. It is loamy very fine sand, sandy loam, or very fine sandy loam. The B horizon ranges from 6 to 14 inches in thickness. The C horizon is loamy very fine sand, very fine sand, or fine sandy loam.

Jayem soils are near Vetal and Sarben soils. They have a darker A horizon than Sarben soils and a thinner A horizon than Vetal soils.

JmB—Jayem loamy very fine sand, 1 to 3 percent slopes. This soil is in the uplands. It is gently undulating. Slopes are concave and convex. Areas range from 5 to 100 acres. Included in mapping were small areas of Vetal loamy very fine sand in low concave positions.

This soil is very friable and is easily tilled. Soil blowing is the main hazard. Runoff is slow. In dryfarmed areas, an inadequate supply of moisture commonly limits production.

Most of the acreage is cultivated. Nearly all of this is dryfarmed. A few areas are in native grass. Corn is best suited and is the crop most commonly grown. Grain sorghum, wheat, and other small grains are also

grown. Capability units IIIe–5 dryland, IIIe–8 irrigated; Sandy range site; windbreak suitability group 3.

McCook Series

The McCook series consists of deep, well drained and somewhat poorly drained silty soils that formed in medium textured alluvium. These are nearly level or very gently sloping soils on bottom lands or colluvial foot slopes along the larger drainageways.

In a representative profile the surface layer is very friable, grayish brown silt loam 11 inches thick. Beneath this is a transition layer of light brownish gray silt loam 6 inches thick. The underlying material extends to a depth of 60 inches or more. It is very pale brown very fine sandy loam in the upper part and light gray silt loam in the lower part.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high.

McCook soils are well suited to cultivated crops under both dryland or irrigated management. They are also suited to trees and shrubs and grass. A small part of the acreage is idle but provides excellent habitat for wildlife. It can also be used for recreation.

Representative profile of McCook silt loam, occasionally flooded, 0 to 2 percent slopes, in cultivated field 792 feet west and 264 feet north of center of sec. 35, T. 8 N., R. 28 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slight effervescence; neutral; abrupt smooth boundary.

A12—7 to 11 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; strong effervescence; neutral; clear smooth boundary.

AC—11 to 17 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; strong effervescence; neutral; clear smooth boundary.

C1—17 to 22 inches; very pale brown (10YR 7/3) very fine sandy loam, grayish brown (10YR 5/3) moist; massive; soft, very friable; strong effervescence; mildly alkaline; clear smooth boundary.

C2—22 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; thin stratification; strong effervescence; mildly alkaline.

The A horizon ranges from 8 to 15 inches in thickness. It is dominantly silt loam but ranges to loam and very fine sandy loam. In places there is light colored, stratified material deposited on the surface by recent floods. In places the AC and C horizons contain thin strata of coarser textured material. Buried soils are common. Depth to free carbonates ranges from the surface to 20 inches. McCook silt loam, wet, 0 to 1 percent slopes, is wetter than is defined in the range for the series. This difference, however, does not affect the use and management.

McCook soils are near Hobbs and Hord soils. In contrast with these soils, they have free carbonates nearer the surface. McCook soils lack the B horizon characteristic of Hord soils and are more stratified.

Mc—McCook silt loam, 0 to 1 percent slopes. This deep, medium textured soil occupies areas on bottom land and stream terraces that are not subject to flooding. These areas are higher in elevation than the flood plain, or they are protected from flooding by large dams, channel straightening, or dikes. They range from 5 to 100 acres.

Included with this soil in mapping were small areas where the texture is very fine sandy loam and small areas of deep sandy soils. In areas on stream terraces free carbonates are commonly leached to below a depth of 15 inches.

This soil is very friable and is easy to work. It is an excellent soil for cultivated crops and has few limitations. Runoff is slow. Lack of adequate moisture late in summer can limit crop production if this soil is dryfarmed.

Most of the acreage is cultivated, and the larger areas are commonly irrigated. Inaccessible areas are in grass or are idle. Corn is the main crop under both irrigated or dryfarmed management. Grain sorghum, forage sorghum, wheat, and alfalfa are also grown. Capability units I–1 dryland, I–6 irrigated; Silty Lowland range site; windbreak suitability group 1.

McB—McCook silt loam, 1 to 3 percent slopes. This deep, medium textured soil occupies areas on high bottom land and foot slopes along the major drainageways. Areas range from 5 to 50 acres.

This soil has a profile similar to the one described as representative of the series, but free carbonates are normally leached to a depth of 15 inches. In a few small areas the surface layer is lighter colored.

This soil is very friable and is easy to work. Runoff is slow to medium. Runoff from higher lying areas can cause erosion or deposit a layer of fresh alluvium on the surface. In dryfarmed areas an inadequate supply of moisture commonly limits production. Maintaining fertility is a concern of management, especially if the soil is irrigated or if it has been severely cut in land leveling. Zinc and iron deficiencies are common in the cut areas. Organic-matter content is moderately low.

Most of the acreage is cultivated, and only a few areas are irrigated. Corn, wheat, grain sorghum, and alfalfa are the principal crops. Small areas are commonly in the native grass. Capability units IIe–1 dryland, IIe–6 irrigated; Silty Lowland range site; windbreak suitability group 1.

Md—McCook silt loam, occasionally flooded, 0 to 2 percent slopes. This soil is on bottom land along Medicine, Red Willow, and Brushy Creeks. In places it is in narrow valleys at the base of the steep canyons that dissect the county. Areas are typically long and narrow and range from 5 to several thousand acres.

This soil has the profile described as representative of the series. In a few small areas a light colored surface layer has been deposited by recent floods.

Included with this soil in mapping were a few small areas where the surface layer is sandy and small areas of Hobbs soils.

This soil is very friable and is easy to work. Organic-matter content is moderate, and natural fertility is medium. Runoff is slow to medium. Flooding is the main hazard. It is usually intense but of short duration. Crop damage (fig. 9) occurs about 1 year in 4, mainly in June or July.

Nearly all the acreage is cultivated, and many areas are irrigated. Corn is the main crop, but all crops commonly grown in the county can be grown successfully on this soil. Such deep rooted crops as alfalfa benefit from the water table, which is at a depth of about 15 feet. Inaccessible areas are in grass or are idle. Capability units IIw–3 dryland, IIw–6 irrigated;

Figure 9.—**Stream overflow on McCook silt loam, occasionally flooded, 0 to 2 percent slopes. New growth of forage sorghum has been washed or drowned out.**

Silty Overflow range site; windbreak suitability group 1.

Me—McCook silt loam, wet, 0 to 1 percent slopes. This somewhat poorly drained soil is on bottom land along Red Willow Creek and Medicine Creek. Natural and manmade dams on these creeks have created conditions for seepage. As a result, the water table is at a depth of 3 to 6 feet.

This soil has a profile similar to the one described as representative of the series, but some parts of the underlying material are grayer and mottled. These features are a result of the wetness associated with this soil.

This soil dries out and warms up more slowly in spring than better drained soils. It is occasionally flooded after heavy rainfall. Runoff is slow. The main limitation is wetness, a result of the moderately high water table. Organic-matter content is moderate, and natural fertility is medium.

About half of the acreage is cultivated. The rest is in cool season grasses and is used for grazing. Corn is the main cultivated crop. Forage sorghum, sudan, and other forage crops are also grown. Capability units IIw–4, IIw–6 irrigated; Subirrigated range site; windbreak suitability group 2.

Rough Broken Land, Caliche

RaG—Rough broken land, caliche, 30 to 60 percent slopes, occurs in canyons that have very steep broken slopes and numerous outcrops of limy sandstone of the Ogallala Formation. The largest areas are near the base of slopes bordering the valleys of Medicine and Red Willow Creeks. Areas are long and narrow and range from 5 to 200 acres. Areas of less than 5 acres are identified by spot symbols on the soil map.

Rough broken land, caliche, is 30 to 70 percent outcrop of limy sandstone and 20 to 40 percent unconsolidated limy soil material. The rest is mainly shallow soils. The limy sandstone is hard rock that is several feet thick in places and is interbedded with layers of sand and gravel loosely cemented with carbonates. The unconsolidated limy material, which is on foot slopes and in pockets between the rock outcrop, ranges from fine sandy loam to sandy clay. It is only a few inches to 40 inches deep over limy sandstone. Included in mapping were small areas of silty loesslike material.

The limited depth of soil material over the bedrock and the very steep broken slopes are the main limitations for plant growth. The soil material has a very low available water capacity because it is so shallow. Runoff is very rapid. Vegetation is sparse, and the very steep slopes make it difficult for cattle to graze.

All areas are in native grass, and most areas are used for grazing. These areas also provide excellent habitat for wildlife and have esthetic value for recreation. A few areas have been used for quarrying gravel, but the quality of the gravel is commonly poor. Ca-

pability unit VIIs–3 dryland; Shallow Limy range site; windbreak suitability group 10.

Rough Broken Land, Loess

RbG—Rough broken land, loess, 30 to 60 percent slopes, is on the sides of deep canyons that dissect the uplands. Slopes are very steep and "catsteps," short vertical breaks in the native sod exposing the loess, are common. Longer vertical escarpments are near the base of the canyons.

Rough broken land, loess, is 60 to 90 percent light colored, silty soil material on broken slopes. The rest consists of Coly soils on smoother, less broken slopes and McCook and Hobbs soils on the occasionally flooded bottoms of canyons. Included in mapping were a few small outcrops of limy sandstone that are identified by spot symbols on the soil map.

Erosion by water is the main hazard. Runoff is very rapid, and gully erosion is active in areas where vegetation is sparse. Overfalls frequently develop at the heads of intermittent drains where runoff from cultivated fields drains into the canyons. Controlling runoff from adjoining tablelands and proper use of the grass are important concerns of management.

All the acreage is in native grass and is used for grazing. Some areas have an overgrowth of redcedar. These areas provide excellent habitat for deer and other forms of rangeland wildlife. They also have esthetic value for recreational purposes. Capability unit VIIe–7 dryland; Thin Loess range site; windbreak suitability group 10.

Rough Broken Land, Sandy

RcG—Rough broken land, sandy, 30 to 60 percent slopes, is in deep, loess canyons that have a cover of sand. Areas along the rim of the canyons are smooth, but the lower slopes are rough. This mapping unit commonly occurs as a 3-mile strip near the western county line.

Windblown sand blankets this unit to a depth of several feet. The surface layer on the smoothest parts ranges from loamy very fine sand to very fine sandy loam. On the roughest parts, it ranges from loamy very fine sand to very fine sand. The underlying material is very fine sand.

Included with this unit in mapping were a few areas where only a thin cover of sand overlies the silty loess material, which is generally at a depth of 3 or 4 feet.

Permeability is moderately rapid or rapid, depending on the coarseness of the sandy material. Available water capacity, organic-matter content, and natural fertility are low. This porous material absorbs most of the precipitation and there is little or no runoff.

Soil blowing is the main hazard unless the surface is protected. Cultivated crops are not suited. All areas are in native grass and are used for grazing. They also provide good habitat for wildlife. Capability unit VIIe–5 dryland; rough part in Sands range site, smooth part in Sandy range site; windbreak suitability group 10.

Sarben Series

The Sarben series consists of deep, well drained soils that formed in sandy material deposited by wind. These are gently sloping to strongly sloping soils on uplands.

In a representative profile the surface layer is very friable, light brownish gray loamy very fine sand 6 inches thick. Beneath this is a transition layer of light brownish gray loamy very fine sand about 12 inches thick. The underlying material extends to a depth of 60 inches or more. It is pale brown loamy very fine sand in the upper part and very pale brown very fine sand in the lower part.

These soils release moisture readily to plants. Permeability is moderately rapid. Available water capacity is low. The organic matter content and natural fertility are low. Sarben soils are marginal for dryland and irrigated crops. They are excellent for grass. They are also suited to trees and shrubs, habitat for wildlife, and recreation.

Representative profile of Sarben loamy very fine sand, 3 to 9 percent slopes, in native grass range 792 feet north and 70 feet east of southwest corner sec. 18, T. 7 N., R. 30 W.

A1—0 to 6 inches; light brownish gray (10YR 6/2) loamy very fine sand, dark grayish brown (10YR 4/2) moist; weak fine granular structure; loose, very friable; slightly acid; abrupt smooth boundary.

AC—6 to 18 inches; light brownish gray (10YR 6/2) loamy very fine sand, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak fine granular; loose, very friable; slightly acid; gradual wavy boundary.

C1—18 to 23 inches; pale brown (10YR 6/3) loamy very fine sand, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to weak fine granular; loose, very friable; slightly acid; clear smooth boundary.

C2—23 to 60 inches; very pale brown (10YR 7/3) very fine sand, brown (10YR 5/3) moist; single grained; loose, very friable; neutral.

The A horizon ranges from 4 to 7 inches in thickness. the AC horizon ranges from 6 to 12 inches in thickness. The AC and C1 horizons are typically loamy very fine sand but range to very fine sandy loam.

Sarben soils are near Jayem and Vetal soils. They have a lighter colored A horizon than Jayem soils and a thinner, lighter colored A horizon than Vetal soils.

SaD—Sarben loamy very fine sand, 3 to 9 percent slopes. This undulating to rolling soil is in the uplands. Areas range from 10 to 600 acres.

Included in mapping were areas of soils that have a very fine sand texture. In a few places there are small blowouts or winnowed areas. Also included were small areas of Jayem and Vetal soils near the base of slopes or in swales.

Soil blowing is a very severe hazard unless the surface is protected by a plant cover. Lack of sufficient moisture on this droughty soil limits production. Maintaining fertility and improving organic-matter content are important concerns of management. Blowouts and winnowed areas need special management.

Nearly all the acreage has been cultivated, but about half the cultivated acreage is now reseeded to native grass. Nearly all cultivated areas are dryfarmed. A limited acreage is irrigated. Center pivot sprinklers are used for irrigating. Corn, wheat, and other small grains are the principal crops. Capability units IVe–5 dryland, IVe–8 irrigated; Sandy range site; windbreak suitability group 3.

Figure 10.—**Profile of Uly silt loam showing moderately thick surface layer and rapid gradation to light colored underlying material.**

Uly Series

The Uly series consists of deep, well drained silty soils that formed in loess. These are gently sloping to moderately steep soils at the edges of upland divides and on the smooth sides of canyons.

In a representative profile the surface layer is very friable, grayish brown silt loam 10 inches thick (fig. 10). The subsoil is light brownish gray silt loam about 6 inches thick. The underlying material is silt loam to a depth of 60 inches or more. It is very pale brown in the upper part and light gray in the lower part.

These soils release moisture readily to plants. Permeability is moderate. Available water capacity is high. The organic-matter content is moderately low, and natural fertility is medium.

Uly soils are suited to grass, trees and shrubs, habitat for wildlife, and recreation. In areas where the slope is no more than 9 percent, they are suited to cultivated crops.

Representative profile of Uly silt loam in area of Uly and Coly silt loams, 9 to 20 percent slopes, in native grass range 50 feet south and 50 feet east of northwest corner sec. 27, T. 6 N., R. 26 W.

A11—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

A12—7 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak fine granular; soft, very friable; neutral; abrupt smooth boundary.

B2—10 to 16 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium prismatic structure parting to weak fine subangular blocky; soft, very friable; strong effervescence; mildly alkaline; clear smooth boundary.

C1—16 to 26 inches; very pale brown (10YR 7/3) silt loam; brown (10YR 5/3) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; soft, very friable; many medium white mycelia of lime; violent effervescence; mildly alkaline; clear smooth boundary.

C2—26 to 60 inches; light gray (10YR 7/2) silt loam; brown (10YR 5/3) when moist; massive; soft, very friable; violent effervescence; mildly alkaline.

The A horizon ranges from 4 to 10 inches in thickness. The B2 horizon is 4 to 7 inches thick and is grayish brown or light brownish gray. The C horizon ranges from light gray to very pale brown. Depth to free carbonates ranges from 6 to 15 inches.

Uly soils are near Holdrege and Coly soils. In contrast with Holdrege soils, they have a thinner B horizon that contains less clay and lime is not so deeply leached. In contrast with Coly soils, they have a B horizon and free carbonates are leached to a greater depth.

UaC2—Uly silt loam, 3 to 6 percent slopes, eroded. This soil is on ridgetops and side slopes of upland divides. Areas range from 5 to 45 acres. The profile of this soil is similar to the one described as representative of the series, but the surface layer is thinner and free carbonates are nearer the surface. Included in mapping were small areas of Coly soils, mainly on ridgetops.

This soil is very friable and is easily worked. Erosion by water is the main hazard. Runoff is medium. Soil blowing is also a problem unless the surface is protected. Improving organic-matter content and maintaining a high level of fertility are important concerns of management.

Nearly all the acreage is cultivated. A few areas have been reseeded to native grasses. Wheat, corn, grain sorghum, and alfalfa are the principal crops. Capability units IIIe–1 dryland, IIIe–6 irrigated; Silty range site; windbreak suitability group 4.

UaD—Uly silt loam, 6 to 9 percent slopes. This soil is on the sides of canyons in the uplands where slopes are smooth. Areas range from 15 to 120 acres. The profile of this soil is similar to the one described as representative of the series, but the surface layer is generally slightly thicker. Included in mapping were small areas of Holdrege soils at lower elevations and Coly soils at higher elevations.

This soil is very friable and is easily worked. Erosion by water is a severe hazard if it is cultivated. Runoff is medium.

All the acreage is in native grass and is used for

grazing. Short and mid grasses are dominant. Capability units IVe–1 dryland, IVe–6 irrigated; Silty range site; windbreak suitability group 4.

UcD2—Uly and Coly silt loams, 6 to 9 percent slopes, eroded. This mapping unit is on side slopes of the loess uplands and on the upland divides adjacent to steep canyons. Both soils occur in most areas, but the proportion of each varies from one area to another. The Uly soil is generally dominant. A few small areas are entirely Uly soil. The Uly soil has plane or concave slopes. The Coly soil has convex slopes. Areas range from 5 to 150 acres.

The profiles of the Uly and Coly soils in this mapping unit are similar to those described as representative of their respective series, but the surface layer of both soils is thinner and lighter colored. Also, free carbonates are not so deeply leached in the areas of Uly soil. Small areas of a darker colored soil occur at the base of intermittent drains in the areas mapped.

These soils are very friable and are easily tilled. Erosion by water is a serious hazard if these soils are cultivated. Soil blowing is also a problem unless the surface is protected. The organic-matter content ranges from moderately low in the Uly soil to low in the Coly soil. Soil fertility is medium in the Uly soil and low in the Coly soil. Increasing the organic-matter content and the level of fertility are important concerns of management.

Most of the acreage is cultivated. A few areas have been reseeded to native or tame grasses. Wheat, grain sorghum, and alfalfa are the main crops. Capability units IVe–1 dryland, IVe–6 irrigated; Uly soil in Silty range site, Coly soil in Limy Upland range site; windbreak suitability group 4.

UcF—Uly and Coly silt loams, 9 to 20 percent slopes. This mapping unit is in canyons of the loess uplands. Both soils occur in most areas, but the proportion of each varies from one area to another. The Uly soil is generally dominant. A few areas are entirely Uly soil. The Uly soil is at lower positions where slopes are smooth and concave. The Coly soil is on the crests and canyon sides where slopes are steeper and convex. The Uly soil has a profile described as representative of the series. The Coly soil has a profile similar to the one described of the series. Areas range from 10 to 200 acres.

Included with these soils in mapping were small areas of Holdrege soils on the lower parts of slopes. Also included were areas of Hobbs soils in narrow bottoms; Rough broken land, loess, on the steepest parts of the canyon sidewalls; and small outcrops of limy sandstone.

Erosion by water is the main hazard. Runoff is rapid because of the moderately steep to steep slopes.

All the acreage is in native grass. Most areas are used for grazing. A few are mowed for native hay. Capability unit VIe–1 dryland; Uly soil in Silty range site, Coly soil in Limy Upland range site; windbreak suitability group 10.

Vetal Series

The Vetal series consists of deep, well drained nearly level or very gently sloping sandy soils on foot slopes and swales in the uplands. These soils formed in mixed sandy and loamy material deposited by wind. They also have been influenced locally by material deposited by water.

In a representative profile the surface layer is 22 inches thick. It is very friable, grayish brown loamy very fine sand in the upper 6 inches and grayish brown very fine sandy loam in the lower 16 inches. The transition layer is grayish brown very fine sandy loam about 16 inches thick. Below this to a depth of 60 inches is pale brown loamy very fine sand.

Permeability is moderately rapid. Available water capacity is moderate. The organic-matter content is moderate, and natural fertility is high. These soils readily release moisture to plants.

Vetal soils are well suited to cultivated crops under dryland or irrigation management. They are also suited to grass, trees, and shrubs. In addition, they provide good habitat for wildlife and are suited to recreation.

Representative profile of Vetal loamy very fine sand, 0 to 3 percent slopes, in cultivated field 792 feet west and 1,584 feet north of center of sec. 31, T. 7 N. R. 30 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loamy very fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; loose, very friable; slightly acid; abrupt smooth boundary.

A12—6 to 22 inches; grayish brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak fine granular; soft, very friable; slightly acid; gradual wavy boundary.

AC—22 to 36 inches; grayish brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium and fine subangular blocky structure parting to weak fine granular; soft, very friable; slightly acid; clear smooth boundary.

C—36 to 60 inches; pale brown (10YR 6/3) loamy very fine sand, dark brown (10YR 4/3) moist; weak fine granular structure; loose, very friable; slightly acid.

The A horizon is dark gray, dark grayish brown, or grayish brown and ranges from 10 to 48 inches in thickness. The AC horizon is grayish brown or light brownish gray and ranges from 6 to 18 inches in thickness. The C horizon is light brownish gray or pale brown loamy very fine sand or very fine sand.

Vetal soils are near Jayem and Sarben soils. They have a thicker A horizon than Jayem soils and a thicker, darker colored A horizon than Sarben soils.

VeB—Vetal loamy very fine sand, 0 to 3 percent slopes. This soil is on low parts of the upland. It occupies foot slopes or swales in the sand-loess transition area. Areas range from 10 to 200 acres. Included in mapping were soils in depressions that are silt loam below a depth of 42 inches.

This is the most productive soil in the sand-loess transition area. It absorbs moisture easily and releases it readily to plants. It is very friable and is easy to till. Soil blowing is a serious hazard. Runoff from adjacent areas is generally beneficial except in depressions where ponding occurs.

Most of the acreage is cultivated and dryfarmed. A small acreage is irrigated by center-pivot sprinklers. Corn, the most commonly grown crop, is well suited, particularly under irrigation. Grain sorghum, wheat, and other small grains are also grown. A few areas are in native grass. Capability units IIIe–5 dryland,

IIIe–8 irrigated; Sandy range site; windbreak suitability group 3.

Wet Alluvial Land

Wx—Wet alluvial land is on low bottom land at the upper end of Medicine Creek where it enters Frontier County. It also occurs above Harry Strunk and Red Willow Lakes. This land is very poorly drained. The water table fluctuates from the surface in spring to a depth of about 30 inches late in summer or in fall. Areas range from 5 to 400 acres.

Wet alluvial land formed in alluvial sediments. Sediments are gray or light gray with varying degrees of mottling. The texture ranges from loam to silty clay loam. Included in mapping were a few small areas where the water table is at the surface throughout the year.

Permeability is moderate. The organic-matter content is moderate or high, and natural fertility is high.

The high water table limits the use of this soil material. Runoff is very slow. Flooding is frequent. Internal drainage is difficult because there are no suitable outlets.

This land is too wet for the commonly grown cultivated crops. It is used for grazing. It also provides habitat for wetland wildlife and suitable areas for recreation. The natural vegetation is primarily prairie cordgrass and other plants that thrive in water. Capability unit Vw–7; Wet Land range site; windbreak suitability group 10.

Use and Management of the Soils

The following pages define general principles of management that apply to all soils used for cultivated crops in Frontier County. They explain the irrigated and dryland capability classification and list estimated yields per acre of the principal crops under a high level of management. Also on the pages that follow is information on range sites, native woodland and windbreaks, wildlife and recreation, and engineering.

Crops and Pasture [2]

If well managed, approximately 45 percent of the total land area in Frontier County is well suited to cultivated crops. The principal concerns of management for the soils in Frontier County are controlling water erosion and soil blowing, maintaining soil moisture, and maintaining or increasing organic-matter content and soil fertility. Some soils on bottom land are susceptible to flooding or excessive wetness as a result of a high water table.

The principal dryfarmed crops in Frontier County in order of decreasing importance are winter wheat, grain sorghum, corn, and alfalfa. Only minor amounts of oats, barley, rye, and soybeans are grown. Summer fallow and wheat followed by 1 year of spring grain or grain sorghum is a common crop sequence on upland soils. Alfalfa and corn are grown mostly on the stream terraces and bottom land.

[2] WILLIAM E. REINSCH, conservation agronomist, helped prepare this section.

According to the Nebraska Agriculture Statistics, 45,300 acres in Frontier County was irrigable in 1973. Water for irrigation is obtained from approximately 379 registered irrigation wells, and surface water is obtained from Red Willow and Medicine Creeks. The irrigated acreage could be increased if a suitable quantity of underground water should become available. The major irrigated crop is corn. Smaller acreages of grain sorghum, alfalfa, and cool-season grass pastures are also irrigated.

Only a small acreage in Frontier County is dryland pasture. Such pasture is planted to cool-season grasses and is grazed mainly during spring and fall. For the most part, cattle graze the large areas of native rangeland and the smaller areas of irrigated pasture.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The grouping is according to the limitations of the soils when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. It 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 horticultural crops, or other crops requiring special management.

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

In the capability system, all kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are defined 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, defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, or wildlife habitat.

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

Class VII soils have very severe limitations that make them unsuited to cultivated crops and

that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, or water supply or to esthetic purposes.

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, although they have other limitations that restrict their use.

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–1 or IIIe–6. 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 capability unit designation for each soil in Frontier County can be found in the "Guide to Mapping Units."

Dryfarmed crops

Planning a cropping system, or the sequence of crops and practices needed to manage and conserve the soil, is essential on each field in Frontier County. Rainfall is limited, and soil blowing is a hazard.

On dryfarmed soils, the cropping system should preserve tilth and fertility, maintain a plant cover that protects the soil against erosion, and control weeds, insects, and diseases. Cropping systems vary according to the soils. For example, the crop sequence on an eroded, moderately sloping Sarben soil should include a high percentage of grass and legume crops. On Holdrege silt loam, 0 to 1 percent slopes, a lower percentage of grass and legume crops is needed.

In dryland farming, soils are tilled to prepare a seedbed and control weeds. Excessive tillage breaks down the granular structure in the surface layer that is needed for good soil tilth. The till-plant method is well suited to row crops. Grasses can be established by drilling into a cover of stubble without further seedbed preparation. Wheat is usually planted in fall on land that has been summer fallowed.

As protection against soil blowing and erosion by water during the fallow period and during the initial growth stage of the wheat, part of the previous crop residue can be retained on the surface. Tilling the soil and leaving residue on the surface during the fallow period is called stubble mulching. The amount of residue needed to protect the soil depends on the kind of residue, the erodibility of the soil, the prevailing wind direction, and the climate.

Crop residue can be retained to protect the soil against blowing and erosion by water and to provide organic matter. Cropping systems should include crops that produce a good supply of long-lasting residue, for example, wheat, sorghum, and corn stubble. Proper residue management is needed on all soils. It is particularly important on such moderately coarse textured soils as the Jayem and Sarben fine sandy loams. The removal of crop residue by burning is not a desirable practice.

Level terraces can be constructed across the slope to control water erosion and to conserve moisture that would otherwise be lost on very gentle to moderately sloping soils. The resulting channels hold rainwater and thus decrease runoff and the risk of erosion. The additional water is absorbed by the soil to be used for crop production.

Two main tvpes of level terraces are used in Frontier County. The conventional terrace has a V-shaped channel. The newly developed flat channel terrace has a wide flat-bottomed channel. The flat channel terrace is popular with farmers because it absorbs more moisture over a wider cross section in less time than the conventional terrace.

Terraces also serve as guidelines in tilling and planting. Cultivating across the slope is known as contour farming. In large drainage areas where runoff has to be diverted, large grassed terraces called "diversions" are used. Grassed waterways are needed in disposing of surplus water.

In sandy areas soil blowing is commonly a problem. Stripcropping, a practice that consists of planting crops of different heights and kinds in alternating strips, reduces the speed of the wind across a field. Stripcropping used with stubble mulching or similar control is more effective than if it is used alone.

Field windbreaks also reduce soil blowing, or they can be used along with stubble mulching and stripcropping. These narrow belts of trees provide protection for a distance equal to about 10 times the height of the tree.

A few areas in Frontier County have poor drainage as a result of a high water table. Open drainage ditches and underground tile systems can be used to lower the water table if suitable outlets at low elevations can be located. Where the water table cannot be lowered sufficiently for good crop growth, crops tolerant of wetness can be planted.

Dryfarmed crops do not require as much fertilizer as irrigated crops. Most crops require nitrogen for highest yields. On some soils, particularly those that are limy at the surface, crops benefit from an application of phosphorus. Most soils do not require lime because the surface layer is neutral or is only slightly acid.

Trace elements of iron, zinc, and magnesium have been used on the soils of Frontier County. Small applications of iron and zinc are commonly needed in se-

verely eroded areas. The kind and amount of fertilizer needed should be determined by soil tests, field trials, and the needs of the crop to be grown.

Using herbicides is an excellent way to control weeds. Care should be taken, however, to apply the correct kind of herbicide at the proper rate to correspond with soil conditions. The colloidal clay and humus fraction of the soil is responsible for the greatest part of the chemical activity of the soil. Crop damage from herbicides, therefore, can occur on sandy sites, which are low in colloidal clay and areas where the organic-matter content is moderately low to low. Consequently, application rates of herbicides are correspondingly lower on such soils.

Use and management of the dryfarmed soils in Frontier County is suggested on the pages that follow. The capability unit to which each soil is assigned is shown in the Guide to Mapping Units.

CAPABILITY UNIT I–1 DRYLAND

The one soil in this unit, McCook silt loam, 0 to 1 percent slopes, is a deep, well drained, nearly level soil on bottom lands that are not subject to flooding. It is mainly silt loam throughout the profile.

This soil is friable and easy to work. Permeability is moderate. Available water capacity is high. The intake rate is moderate, and moisture is released readily to plants. Runoff is slow. Organic-matter content is moderate, and natural fertility is medium.

This soil has few limitations when cultivated. In years of below normal rainfall, limited moisture late in summer can limit crop production. Deep rooted crops, such as alfalfa, can obtain moisture from the water table. Maintaining or building up soil fertility is the main concern of management.

This soil is suited to all crops commonly grown in the county, but it is especially suited to row crops, such as corn and grain sorghum. Row crops can be grown year after year if adequate amounts of fertilizer are added and if weeds, diseases, and insects are controlled. Minimum tillage and proper use of crop residue maintains adequate soil moisture for crop growth. Periodic use of legumes and green manure crops maintains high soil fertility and good soil structure. Use of commercial fertilizers, especially those containing nitrogen and phosphorus, maintains high fertility.

CAPABILITY UNIT IIe–1 DRYLAND

In this unit are very gently sloping, deep, well drained soils on uplands, foot slopes, and stream terraces. The surface layer is silt loam. The subsoil is mainly silt loam or silty clay loam, and the underlying material is silt loam.

All but the eroded soils are easy to work. Soils that are eroded tend to clod if tilled when wet. All but the eroded soils absorb moisture easily. In eroded areas where the silty clay loam subsoil is mixed with the surface layer, soils absorb moisture at a moderately low rate. All release moisture readily to plants. Runoff is slow to medium. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate, and natural fertility is medium or high.

Water erosion and soil blowing are the principal hazards in cultivated areas. Lack of sufficient moisture can limit crop production in dryfarmed areas. Maintaining the organic-matter content and the fertility, especially on eroded soils, is a concern of management. Higher rates of fertilizer are generally needed on eroded soils. Care is needed in applying herbicides. The application must not be too heavy in areas where the organic-matter content is moderately low.

These soils are suited to all crops commonly grown in the county. Most commonly grown are wheat, grain sorghum, corn, and alfalfa. Fallow for 1 year and then wheat and either another small grain or grain sorghum is a common cropping sequence. Summer fallow stores needed moisture for the crop that follows.

Contour tillage during fallow effectively controls wind and water erosion, conserves moisture, and adds organic matter to the soil. Terracing with contour farming also helps control erosion and conserve moisture. Level terraces that have flat channels are best suited because they have a greater storage capacity to handle runoff during the heavier rains, in addition to spreading the water over a larger area for absorption into the soil. Periodic use of legumes and green manure crops helps maintain high soil fertility and good soil structure. Use of commercial fertilizers also helps maintain high fertility. Nitrogen and phosphorus are the most common elements needed. In places, eroded areas need additions of trace elements.

CAPABILITY UNIT IIc–1 DRYLAND

In this unit are deep, well drained, nearly level soils on uplands and stream terraces. The surface layer is silt loam. The subsoil is silt loam or silty clay loam, and the underlying material is silt loam.

These soils are easy to work and have good tilth. They absorb moisture easily and release it readily to plants. Runoff is slow. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate, and natural fertility is high.

These are among the best soils in the county for cultivated crops. The limited rainfall is the principal limitation in dryfarmed areas. Conserving soil moisture is an important concern of management. Soil blowing is a hazard unless the surface is protected.

These soils are well suited to wheat and other small grain, grain sorghum, and corn. A cropping system that alternates wheat with fallow conserves moisture and maintains fertility. In a 3-year cropping system, a suitable sequence is 1 year fallow, a wheat crop, and then either another small grain or grain sorghum.

Crop residue should be left on the surface during tillage. Stubble mulch tillage during fallow is effective in conserving water, adding organic matter, and preventing soil blowing. Periodic use of legumes and green manure crops maintains high soil fertility and good soil structure. Use of commercial fertilizers maintains high soil fertility. Nitrogen and phosphorus are the elements most commonly needed.

CAPABILITY UNIT IIw–3 DRYLAND

In this unit are deep, well drained, nearly level or very gently sloping soils on bottom land that is occasionally flooded. They are mainly silt loam throughout the profile.

Unless wet, these soils are easy to work. They absorb moisture easily and release it readily to plants. Runoff is slow. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate, and natural fertility is medium or high.

Occasional flooding is the principal hazard. Flooding is usually intense but of short duration. Crop damage occurs about 1 year in 4, mainly during June or July. Plants are scoured out or covered with alluvial silt.

All crops commonly grown in the county are suitable. Corn or grain sorghums are the usual crops grown. In areas where the water table is at a depth of about 15 feet, deep-rooted crops, such as alfalfa, can obtain moisture through subirrigation.

Controlling runoff from the uplands reduces the risk of overflow on bottom land. Proper tillage and terraces in cultivated areas, proper range management, and flood detention dams in the major drainageways are suggested. Dikes to divert floodwater may be useful on some bottom land fields. High fertility can be maintained by the use of fertilizer and by returning crop residue to the soil as a mulch.

CAPABILITY UNIT IIw–4 DRYLAND

The one soil in this unit, McCook silt loam, wet, 0 to 1 percent slopes, is a somewhat poorly drained soil on bottom land along Red Willow and Medicine Creeks. It is entirely alluvial material. Textures are mainly silt loam and very fine sandy loam.

This soil is very friable and, unless wet, is easy to work. It absorbs moisture easily and releases it readily to plants. Runoff is slow. Permeability is moderate. Available water capacity is high. Certain crops, such as alfalfa, benefit from the additional moisture they receive from the water table. Organic-matter content is moderate, and natural fertility is medium.

Wetness is the principal hazard. The water table fluctuates from a depth of 3 feet in spring to a depth of 6 feet in fall. Damaging floodwater occurs on an average of once in every 4 years.

Corn is the most commonly grown crop. Alfalfa and other forage crops are also suited. Some areas are in cool season grasses and are used for grazing.

Where suitable outlets are available, tile drains can lower the water table in wet years and control wetness. Proper management of drainage areas above these soils reduces the hazard of flooding. Alfalfa in a cropping system and the addition of commercial fertilizer help in maintaining soil fertility.

CAPABILITY UNIT IIIe–1 DRYLAND

In this unit are gently sloping, deep, well drained soils on uplands and foot slopes. The surface layer is silt loam. The subsoil is silt loam or silty clay loam, and the underlying material is silt loam.

These soils are easy to work unless the silty clay loam subsoil is mixed with the surface layer. Permeability is moderate. Available water capacity is high. All but the eroded soils absorb moisture easily. In eroded areas moisture is absorbed at a moderately low rate. All release moisture readily to plants. Runoff is medium. Organic-matter content is moderate or moderately low, and natural fertility is medium or high. Soil fertility and organic-matter content are lower in eroded areas. Special care is needed to apply herbicides at the proper rate in these areas.

Erosion by water is the main hazard. Soil blowing can be a hazard unless the surface is protected. Conservation of water is an important concern of management. Rainfall is commonly inadequate to meet crop needs.

These soils are suited to all crops commonly grown in the county. Most commonly grown are wheat, grain sorghum, corn, and alfalfa. Under dryland conditions, row crops should be limited to not more than 2 years in succession. One year of fallow, a wheat crop, and either another small grain or grain sorghum is a common crop sequence on these soils.

Cover crops and emergency tillage protect the soil against blowing in dry years when crops fail. Contour stripcropping, contour tillage, and terracing are beneficial in controlling wind and water erosion and conserving moisture. A legume or legume-grass mixture in the crop sequence maintains or improves soil fertility and content of organic matter, especially in eroded areas where the organic-matter content and fertility level are lower. Commercial fertilizer also maintains soil fertility. Nitrogen and phosphorus are the elements most commonly needed. In some eroded areas additions of trace elements are needed.

CAPABILITY UNIT IIIe–5 DRYLAND

In this unit are nearly level and very gently sloping, deep, well drained soils on uplands. The surface layer is loamy very fine sand. The subsoil or transition layer is very fine sandy loam, and the underlying material is loamy very fine sand.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Runoff is slow. Permeability is moderately rapid. Available water capacity is moderate. Organic-matter content is moderate or moderately low, and natural fertility is medium or high.

Soil blowing is the principal hazard in cultivated areas. In dryfarmed areas, an inadequate supply of moisture commonly limits crop production.

These soils are suited to corn, alfalfa, wheat, sorghum, and grass. A suitable cropping system consists of crops that provide a protective cover most of the year, especially in fall and winter. Corn is one of the main crops, but a cover crop can be planted in the cornfield.

Stripcropping, contour tillage, and field windbreaks are beneficial in controlling soil blowing and conserving moisture. Growing legumes in the cropping system provides cover throughout the year. It also protects the soil against erosion, improves fertility, and increases the content of organic matter. Nitrogen fertilizer is needed for all crops but legumes.

CAPABILITY UNIT IIIw–2 DRYLAND

The one soil in this unit, Fillmore silt loam, 0 to 1 percent slopes, is a deep, poorly drained, nearly level soil in upland depressions. The surface layer is silt loam. The subsoil is silty clay and silty clay loam, and the underlying material is silt loam.

This soil is commonly difficult to work because of wetness. It absorbs moisture slowly and releases it slowly to plants. Runoff ponds. Permeability is very slow. Available water capacity is moderate. Organic-matter content is moderate, and natural fertility is medium.

Wetness as a result of the very slow internal drainage and the excess moisture that occurs as run-in water from higher lying soils is the principal hazard. Droughtiness is a slight hazard late in summer and in fall.

This soil is fairly well suited to the more commonly grown crops in the county, especially during years of low rainfall when runoff from adjacent soils is low. The soil is usually too wet for alfalfa unless drainage is provided. In areas of pasture or hayland, grasses that will tolerate some flooding can be seeded.

Terraces and diversions and proper tillage on higher elevations prevent runoff from covering this soil and damaging crops. Chiseling when the soil is dry temporarily increases intake.

CAPABILITY UNIT IVe–1 DRYLAND

In this unit are deep, strongly sloping, well drained soils on uplands. They are silt loam throughout the profile.

These soils are easy to work. They absorb moisture easily and release it readily to plants. Runoff is medium. Permeability is moderate. Available water capacity is high. Organic-matter content is moderately low or low, and natural fertility is medium or low. Some soils in this unit are eroded.

Water erosion is the principal hazard in cultivated areas. Soil blowing is also a hazard unless the surface is protected. Much of the rainfall is lost through runoff and is not available for plant growth. The moderately low to low organic-matter content is a management concern in applying herbicides. Both fertility and organic-matter content need to be improved.

Wheat, alfalfa, forage sorghums, and grass are well suited. Row crops, such as corn or grain sorghum, can be grown if terraces, contour farming, and conservation tillage are used. Summer fallow and stubble mulching can be used when growing wheat. Legumes or a grass-legume mixture in the cropping sequence increases fertility and organic-matter content. Because these soils are marginal for cultivated crops, many areas are reseeded to native grass. Nitrogen, phosphorus, and trace elements, such as iron and zinc, are commonly needed.

CAPABILITY UNIT IVe–5 DRYLAND

The one soil in this unit, Sarben loamy very fine sand, 3 to 9 percent slopes, is a deep, well drained, gently sloping to strongly sloping soil on uplands. The surface layer and transition layer are loamy very fine sand. The underlying material is loamy very fine sand in the upper part, but it grades to very fine sand in the lower part.

This soil has poor tilth and is difficult to work because of the loose consistence of the surface layer. It absorbs moisture easily and releases it readily to plants. Runoff is slow to medium. Permeability is moderately rapid. Available water capacity is low. Organic-matter content and natural fertility are low.

Soil blowing is a severe hazard unless the surface is protected. Both organic-matter content and fertility need to be improved. Because of the low available water capacity and possible loss of moisture through runoff, this soil can be droughty. Erosion by water may also be a problem on the steeper areas.

Close grown crops, such as wheat, barley, and rye, are suited. The soil, however, is marginal for crops. It is best suited to grass and legumes since they build up the organic-matter content and protect the soil against blowing.

The risk of soil blowing can be reduced by using a cropping system that maintains a cover of crops, grass, or residue. All residue should be returned to the soil. Stripcropping and conservation tillage are also effective in controlling soil blowing. If feasible, terraces and contour farming can be used to protect these soils against erosion by water. Additions of barnyard manure increase fertility and organic-matter content. Most crops respond to additions of nitrogen, phosphorus, iron, and zinc.

CAPABILITY UNIT IVe–9 DRYLAND

The one soil in this unit, Coly silt loam, 5 to 9 percent slopes, eroded, is a deep, strongly sloping, well drained soil on upland breaks. It is silt loam throughout the profile. The surface layer is thin, and the soil is calcareous to the surface.

This soil is easy to work. It absorbs moisture easily and releases it readily to plants. Runoff is medium. Permeability is moderate. Available water capacity is high. Natural fertility and organic-matter content are low.

Water erosion is the principal hazard in cultivated areas. Soil blowing is also a problem. The low organic-matter content is a concern in management especially if herbicides are used. The level of fertility and the organic-matter content should be increased. Moisture is often inadequate since much of the rainfall is lost through runoff.

Close grown crops are best suited since they reduce the hazard of erosion. Wheat, forage sorghum, and alfalfa are the usual crops grown. A cover of permanent vegetation, such as grass or trees, is often best because the soil is marginal for cultivation.

Contour farming and terracing conserve moisture and control runoff. Stubble mulching and returning residue to the soil help in controlling soil blowing. They also maintain or increase the organic-matter content. Crops respond well to barnyard manure and commercial fertilizer. Nitrogen, phosphorus, iron, and zinc are the most commonly needed elements.

CAPABILITY UNIT Vw–7 DRYLAND

Only Wet alluvial land is in this unit. It is on bottom land that is very poorly drained. It is stratified throughout the profile with sediments ranging from loam to silty clay loam.

This land is too wet to be tilled. Permeability is moderate unless the soil material is saturated. Runoff is very slow. Organic-matter content is moderate or high, and natural fertility is high.

Wetness is a severe hazard. The water table is at the surface early in spring and rarely fluctuates below a depth of 30 inches. Frequent flooding is a hazard.

The vegetation is mostly prairie cordgrass and other grasses that can tolerate a high degree of wetness.

Wet alluvial land is best suited to grazing or to habitat for wildlife. During seasons of heavy rainfall it is even too wet for grazing. A tile drainage system to lower the water is usually impossible because adequate outlets are not available.

CAPABILITY UNIT VIe–1 DRYLAND

This unit consists only of Uly and Coly silt loams, 9 to 20 percent slopes. These are deep, moderately steep, well drained soils on uplands. They are silt loam throughout the profile.

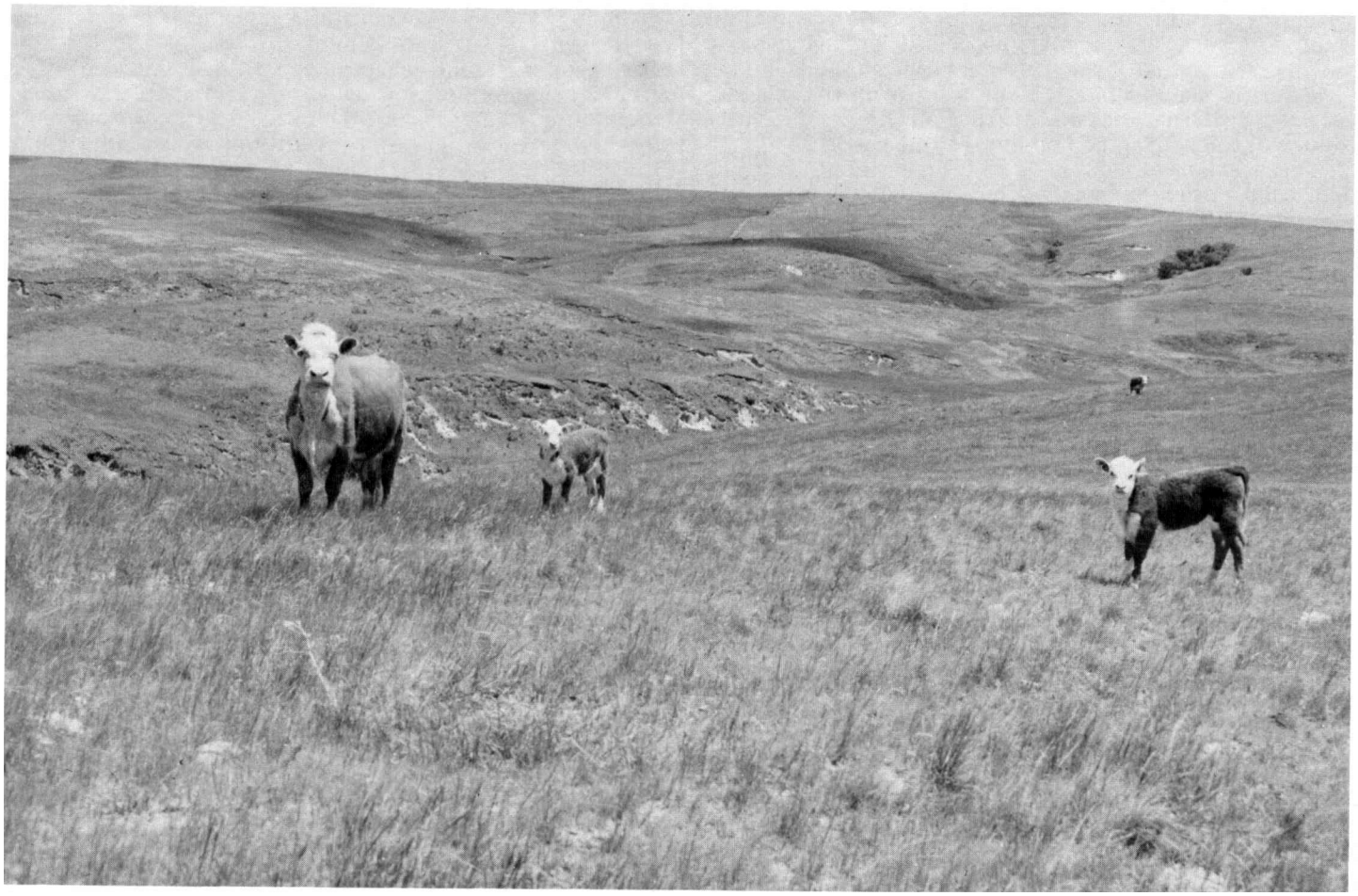

Figure 11.—This kind of landscape is generally used as rangeland. The range is in good condition. The soil is Coly and Uly silt loams, 9 to 30 percent slopes.

These soils absorb moisture easily and release it readily to plants. Runoff is rapid. Permeability is moderate. Available water capacity is high. Organic-matter content is low or moderately low, and natural fertility is low or medium.

Erosion by water is the principal hazard. Conserving moisture is important for high production of grass.

These soils are generally unsuited to cultivated crops because they are too steep and the erosion hazard is too severe. They are best suited to native grass for grazing or hay. They also provide wildlife habitat and recreation areas.

Leaving sufficient growth to prevent erosion and conserve moisture is needed in grazed areas. Proper grazing use and a planned system of grazing are important.

CAPABILITY UNIT VIe–9 DRYLAND

In this unit are deep, moderately steep to steep, well drained to somewhat excessively drained soils on uplands that are silt loam throughout the profile.

These soils absorb moisture easily and release it readily to plants. Runoff is rapid. Permeability is moderate. Available water capacity is high. Organic-matter content is low or moderately low, and natural fertility is low or medium.

Erosion by water is the principal hazard. The narrow bottoms of canyons are flooded for short duration following heavy rainfall. Gullies have formed along the sides and at the heads of drains in some canyons. Maintaining an adequate grass cover prevents serious water erosion.

These soils are generally unsuited to cultivated crops because they are so easily eroded. Most areas are in native grass and are used for grazing cattle (fig. 11). A few are cultivated but should be reseeded to native grass.

Proper grazing, deferred grazing, and planned grazing maintain or improve the range condition and thus prevent serious water erosion. Overfalls at the heads of deep gullies can be controlled by constructing terraces and diversions on the adjacent cropland areas. Sites for stockwater dams, grade control structures, and flood detention dams are readily available.

CAPABILITY UNIT VIw–7 DRYLAND

Only Broken alluvial land is in this unit. It is deep soil material on bottom land. It is basically silt loam,

but in some areas it is sandy. In most areas it is deeply entrenched by meandering stream channels. Abrupt sloping channel breaks and uneven topography adjacent to the channels are characteristic features.

In most areas permeability is moderate and available water capacity is high. Runoff is slow to rapid, depending on the slope. Moisture is easily absorbed and readily realeased to plants. Organic-matter content is moderate, and natural fertility is medium or high.

Frequent flooding is a severe hazard. Streambank erosion, flood sediment, and debris are the principal hazards. Most areas are difficult to reach with farm equipment and are too small to economically farm.

Broken alluvial land is best suited to grass or trees. Wooded or brushy areas that are not used for grazing provide excellent habitat for wildlife.

Thinning or removing trees and brush can greatly improve the native grass vegetation for grazing. Keeping the stream channels clear of rubbish and fallen trees lessens the overflow hazard.

CAPABILITY UNIT VIIe–5 DRYLAND

Only Rough broken land, sandy, 30 to 60 percent slopes, is in this unit. This land, which is windblown sand deposited over loess, has canyon type topography. The surface layer is very fine sand, loamy very fine sand, or very fine sand. The underlying material is very fine sand.

Permeability is moderately rapid or rapid. Available water capacity is low. There is little runoff in areas of this porous material. Moisture is absorbed readily and is released easily to plants. Organic-matter content and natural fertility are low.

Soil blowing is the principal hazard. Low fertility and low available water capacity are concerns in management. In places overgrazing causes blowouts.

This land is best suited to grazing. The entire acreage is in native grass. In many areas, it is difficult for cattle to graze because slopes are too steep. Proper range management that leaves half the vegetation after grazing maintains a plant cover and prevents soil blowing and blowouts.

CAPABILITY UNIT VIIe–7 DRYLAND

Only Rough broken land, loess, 30 to 60 percent slopes, is in this unit. This is deep loess material that has a silt loam texture. Slopes are very steep and catsteps caused by soil slippage are common.

Permeability is moderate. Available water capacity is high. Runoff is rapid on the very steep slopes. Moisture is released readily to plants. The organic-matter content and natural fertility are both low. The slopes are too steep to be tilled.

Erosion by water is the principal hazard. Overfalls caused by gully erosion at the heads of canyons and in the bottoms of canyons are a serious concern in management.

This land is suitable for grazing or as habitat for wildlife. The plant cover is native grass and a few redcedars.

Range management that maintains a good cover of grass reduces the hazard of erosion and conserves moisture. Controlling runoff from adjoining cropland areas by using terraces, diversions, and conservation tillage controls gully erosion at the heads of canyons. Many areas provide suitable sites for stockwater dams, grade control structures, and flood detention reservoirs. Reseeding the very steep slopes with ordinary field equipment is usually not possible.

CAPABILITY UNIT VIIs–3 DRYLAND

Only Rough broken land, caliche, 30 to 60 percent slopes, is in this unit. It consists of numerous limy sandstone outcrops and thin deposits of unconsolidated limy material in pockets between the rock outcrops. It occurs in canyons where slopes are very steep.

Permeability is moderate or moderately rapid between the rock outcrops. Available water capacity is very low. Runoff is very rapid.

Controlling erosion, preventing runoff, and protecting the grass are the main concerns in management. This land is suitable for grazing, habitat for wildlife, or recreation. A good cover of grass in areas between the bedrock reduces runoff and prevents erosion. Proper grazing reduces erosion and conserves moisture. Most areas are too steep and rough for the use of machinery and the seeding of grasses.

Stockwater dams can be built in some areas to provide water for livestock and wildlife.

Irrigated crops

The irrigated soils of Frontier County are in valleys and in upland areas where irrigation water is available. Water for irrigation is derived almost entirely from deep wells. Power for pumping is supplied mainly by electricity or natural gas.

The kind of crop grown commonly determines the kind of irrigation. For example, the method used to irrigate a row crop generally differs from that used to irrigate a close-sown or a pasture crop. Furrow irrigation is most common for row crops. The water is applied to furrows between the rows by gated pipe or by siphon tubes. Furrow irrigation works well on nearly level to very gently sloping soils. Where the furrow slope is 1.5 percent or more, soil erosion is likely to be excessive, and other irrigation systems should be considered.

In border irrigation, flooding is controlled by borders or small dikes along the sides of narrow strips. Irrigation water flows as a thin uniform sheet and is absorbed by the soil as it advances across the strip. The strips need to be leveled and of uniform grade. Border irrigation is well suited to such soils as Hall silt loam, 0 to 1 percent slopes, and Holdrege silt loam, 1 to 3 percent slopes.

In sprinkler irrigation a series of small sprinklers is spaced along distribution pipes. Sprinklers apply water at a rate that the soil can absorb. They can be used on the more sloping soils as well as on the nearly level soils. Sprinklers can also be adapted to sandy soils where the intake rate is so high that furrows are not practical. Such soils as Jayem loamy very fine sand, 1 to 3 percent slopes, are well suited to sprinkler irrigation. Because the water can be carefully controlled, sprinkler systems have special uses in conservation farming, such as establishing pastures on moderately steep slopes and irrigating sandy or steep soils in areas where other systems are not suitable. In summer, how-

ever, some water is lost through evaporation, and wind drift can cause an uneven application of water under some sprinkler systems.

Sprinkler systems are of two general types. One type operates in sets. The sets operate at certain locations until a specified amount of water is applied. The other type is a center pivot system, which is a moving system that revolves around a central pivot.

A soil can hold only a limited amount of water. Irrigation water, therefore, is applied at intervals that will keep the soil moist at all times. The interval varies according to the crop and to the time of the year. Water should be applied only as fast as the soil can absorb it. A deep, irrigated soil, such as McCook silt loam, 0 to 1 percent slopes, holds about 2 inches of available water per foot of soil depth. Thus, a soil that is 4 feet deep and is planted to a crop that sends its roots to that depth can hold about 8 inches of available water for that crop.

The best efficiency is obtained if irrigation is begun when about half of the stored water has been used by the plants. Thus, if a soil holds 8 inches of available water, irrigation should generally be started when about 4 inches has been removed.

The management needed would control or regulate the application of water in such a way that a good crop growth is obtained without wasting water and without eroding the soil. Adjusting the size of the furrow streams or the sprinkler rate is needed in order to apply the water thoroughly and to moisten the soil without causing excessive runoff or erosion. An irrigation re-use system offers an opportunity to recycle the runoff water back into the system to irrigate the same or other nearby fields.

Assistance in the planning and layout of an irrigation system is available through the local office of the Soil Conservation Service or the county agricultural agent. Estimates concerning the cost of equipment can be obtained from local irrigation equipment dealers and manufacturers.

Irrigated soils generally produce higher yields than dryfarmed soils. More plant nutrients, especially nitrogen and phosphorus, are removed when irrigated crops are harvested. Returning all crop residue to the soil and adding manure and commercial fertilizer help supply plant nutrients. An adequate supply of nitrogen is needed. Soils disturbed during land leveling, particularly when topsoil has been removed, will generally respond to an application of phosphorus, zinc, and iron. The kind and amount of fertilizer needed for specific irrigated crops should be determined by soil tests.

The principal crops irrigated in Frontier County are corn, alfalfa, and sorghums, both grain and forage varieties. Small acreages of pasture grasses are also irrigated. The cropping sequence on soils well suited to irrigation consists mainly of row crops. A change from corn to alfalfa controls disease and the insects commonly present when the same crop is grown year after year on the same soil. Very gently sloping soils, such as Jayem loamy very fine sand, 1 to 3 percent slopes, and Holdrege silt loam, 1 to 3 percent slopes, are subject to water erosion if row crops are planted up and down the hill. Such soils are best suited to a cropping sequence that includes several years of row crops followed by 3 to 5 years of hay and pasture. Close grown crops, such as alfalfa or a mixture of alfalfa and grass, can be grown and used for hay. Such soils as Uly silt loam, 3 to 6 percent slopes, eroded, and Sarben loamy very fine sand, 3 to 9 percent slopes, are better suited to close sown crops than to row crops.

Use and management of the irrigated soils in Frontier County is suggested by capability unit on the pages that follow. The soils in each unit require similar management and have similar limitations.

The names of all the soils in any given capability unit can be found in the Guide to Mapping Units at the back of the survey. All soils in Nebraska are assigned to irrigation design groups, which are described in the Irrigation Guide for Nebraska. The arabic number in the capability unit indicates the design group. A copy of the Irrigation Guide is available in each field office of the Soil Conservation Service in Nebraska.

CAPABILITY UNIT I–4 IRRIGATED

In this unit are nearly level, deep, well drained soils on uplands. The surface layer is silt loam, and the subsoil is silt loam or silty clay loam. The underlying material is silt loam.

These soils are easy to work and have good tilth. The water intake rate is moderately low. Runoff is slow. Permeability is moderate or moderately slow. Available water capacity is high. Organic-matter content is moderate, and natural fertility is high.

These soils have few limitations under irrigation. Tailwater and runoff from excessive rainfall after irrigation can be a problem.

These soils are well suited to corn, sorghum, and alfalfa. They are also suited to all other crops commonly grown in the county. Borders, furrows, and sprinklers are suitable for irrigating. Some land leveling is generally needed for satisfactory operation of border and furrow systems. The rate of water application must not exceed the intake rate of the soil. An irrigation re-use system can lessen runoff and return excess water back into the irrigation system.

CAPABILITY UNIT I–6 IRRIGATED

In this unit are nearly level, deep, well drained soils on stream terraces and bottom land. The surface layer and subsoil are silt loam. The underlying material is silt loam or very fine sandy loam.

These soils are easily worked and have good tilth. The water intake rate is moderate, and moisture is readily released to plants. Runoff is slow. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate, and natural fertility is high or medium.

These soils have few limitations under irrigation. Maintaining or improving the organic-matter content and level of fertility is a concern of management.

These soils are suited to all crops commonly grown in the county, but they are best suited to corn, sorghum, or alfalfa. Deep rooted crops, such as alfalfa, obtain moisture from the water table.

The organic-matter content and fertility level can be maintained by returning crop residue to the soil and applying fertilizer. A cropping sequence that includes alfalfa builds up the organic-matter content and fertility and helps control plant diseases. Some land

leveling may be needed to evenly distribute water if border or furrow irrigation is used. Sprinkler irrigation is also suited to these soils. The rate of water application must not exceed the intake rate of the soil.

CAPABILITY UNIT IIe–4 IRRIGATED

In this unit are deep, well drained, very gently sloping soils on uplands. The surface layer is silt loam, and the subsoil is silt loam or silty clay loam. The underlying material is silt loam.

These soils are easy to work and have good tilth. The water intake rate is moderately low, and water is released readily to plants. Runoff is slow to medium. Permeability is moderate or moderately slow. Available water capacity is high. Organic-matter content is moderate, and natural fertility is high.

Water erosion is the principal hazard. The water intake rate is slightly lower in eroded areas where the subsoil is mixed with the surface layer. Tailwater and runoff from excessive rainfall after irrigation can be a problem. Carryover of herbicides can be a problem in eroded areas where the organic-matter content is lower.

These soils are suited to all crops commonly grown in the county. Corn, grain sorghum, and alfalfa are usually grown under irrigation.

Selecting the proper irrigation system according to the type of crop and the slope is especially important in controlling water erosion. Border and furrow irrigation can be used if the slope and the length of run can be adjusted to minimize erosion. Land leveling or benching to reduce the hazard of erosion and to allow a more uniform distribution of water should be considered. An irrigation re-use system can lessen runoff and return excess water back into the irrigation system. Sprinkler irrigation is also suited to these soils. The rate of water application must not exceed the intake rate of the soil.

Returning crop residue to the soil and applying fertilizer maintain fertility. Including a legume or a grass-legume mixture in the cropping system maintains fertility as well as tilth. Rotating crops controls diseases and insects. Care is needed in applying herbicides. The application must not be too high in eroded areas.

CAPABILITY UNIT IIe–6 IRRIGATED

In this unit are very gently sloping, deep, well drained soils on foot slopes and stream terraces. The surface layer and subsoil are silt loam. The underlying material is silt loam and very fine sandy loam.

These soils are easy to work and have good tilth. The intake rate is moderate, and moisture is released readily to plants. Runoff is slow to medium. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate or moderately low, and natural fertility is medium or high.

Erosion by water is the principal hazard. Runoff from higher lying areas can erode these soils or deposit layers of silt on the surface. Maintaining the organic-matter content and fertility is a concern in management.

These soils are suited to most crops commonly grown in the county. Corn, grain sorghum, and alfalfa are usually grown under irrigation.

Borders, furrows, and sprinklers are suitable for irrigating. If borders or furrows are used, the slope and length of the row must be considered to minimize erosion. Contour furrowing or contour bench leveling helps in controlling erosion and allows better water distribution. Runoff from fields above these soils can be controlled by diversions and terraces in those fields.

Fertility can be maintained or improved by commercial fertilizer and barnyard manure. A cropping sequence that includes legumes or grasses increases the organic-matter content and maintains good tilth. Care is needed in applying herbicides. The application must not be too high in areas where the organic-matter content is moderately low.

CAPABILITY UNIT IIw–6 IRRIGATED

In this unit are nearly level, deep soils on bottom land. They are subject to a moderately high water table or are occasionally flooded. The surface layer is silt loam. The underlying material is silt loam or very fine sandy loam.

Unless wet, these soils are easily worked. The water intake rate is moderate, and moisture is released readily to plants. Runoff is slow. Permeability is moderate. Available water capacity is high. Organic-matter content is medium, and natural fertility is medium or high.

In some areas the water table fluctuates from a depth of 3 feet in spring to 6 feet in fall, and wetness is the principal hazard. In others, the principal hazard is caused by damaging floods that occur about 1 year in 4, mainly in June or July.

These soils are suited to corn, grain or forage sorghum, alfalfa, and grass.

Irrigation is not always beneficial in areas where the water table is moderately high because it raises the water table. Where suitable outlets are available, tile drains help to lower the water table and control wetness. All areas in this unit are subject to occasional flooding. Flooding is best controlled by preventing runoff from the uplands. This can be done through proper tillage, terracing cultivated fields, proper range management, and flood detention dams in the major drainageways. Dikes are beneficial on some bottom land fields. Border, furrow, and sprinkler irrigation are suitable. Some land leveling may be needed for furrow or border systems.

CAPABILITY UNIT IIIe–4 IRRIGATED

This unit consists of deep, gently sloping, well drained soils on uplands. The surface layer is silt loam, and the subsoil is silt loam or silty clay loam. The underlying material is silt loam. Some of these soils are eroded.

These soils are easy to work, but the eroded soils tend to clod if tilled when wet. The intake rate is moderately low, but moisture is released readily to plants. Runoff is medium. Permeability is moderate or moderately slow. Available water capacity is high. Organic-matter content is moderate, and natural fertility is high.

Water erosion is the principal hazard in cultivated areas. Soil blowing is only a minor hazard. Maintaining fertility and improving organic-matter content, especially in eroded areas, is a concern of management.

Care is needed in applying herbicides. The application must not be too high, especially in eroded areas.

These soils are suited to all crops commonly grown in the county. Legumes or grass-legume mixtures should be included in the cropping system.

Under gravity irrigation, contour furrows supplemented with terraces is beneficial in irrigating row crops. Bench leveling can be used to shape the surface of the soil so that any type of gravity system can be used. Under sprinkler irrigation, terracing and contour farming are needed to control water erosion. Under all kinds of irrigation, however, the rate of water application must not exceed the intake rate of the soil. Conservation tillage that keeps sufficient crop residue on the surface helps to control both wind and water erosion. Returning crop residue to the soil and applying fertilizer help in maintaining fertility. Applying barnyard manure in eroded areas improves organic-matter content and tilth.

CAPABILITY UNIT IIIe–6 IRRIGATED

In this unit are gently sloping, deep, well drained soils on uplands and foot slopes. They are silt loam throughout the profile. Some areas are eroded.

These soils are easy to work. The intake rate is moderate, and moisture is released readily to plants. Runoff is medium. Permeability is moderate. Available water capacity is high. Organic-matter content is moderate or moderately low, and natural fertility is medium to high.

Erosion by water is the principal hazard in irrigated areas. Some areas receive runoff from higher lying areas. Soil blowing can be a hazard unless the surface is protected. Maintaining the organic-matter content and fertility is a concern of management.

Corn, grain or forage sorghum, alfalfa, and grass are suited to these soils. On upland sites where the soils are eroded, close grown crops are best suited.

Under sprinkler irrigation, terracing, conservation tillage, and contour farming are needed to control water erosion. Sprinkler irrigation is best suited unless the soils are bench leveled. Bench leveling alters the surface of the land so that furrow directions are at a low grade and thus help in controlling water erosion. In some higher areas, diversions and terraces are needed to control runoff. Fertilizer and barnyard manure maintain or improve fertility. Legumes and grasses build up the organic-matter content and improve soil tilth. Care is needed in applying herbicides to eroded areas. The application must not be too high in areas where the organic-matter content is moderately low.

CAPABILITY UNIT IIIe–8 IRRIGATED

In this unit are nearly level and very gently sloping, deep, well drained soils on uplands. The surface layer is loamy very fine sand, and the subsoil or transition layer is very fine sandy loam. The underlying material is loamy very fine sand.

These soils are easy to work. The intake rate is moderately high, and moisture is released readily to plants. Runoff is slow. Permeability is moderately rapid. Available water capacity is moderate. Organic-matter content is moderate or moderately low, and natural fertility is medium or high.

Soil blowing is the principal hazard. Water erosion is a hazard if heavy rainfall occurs after the soil is already saturated with irrigation water. Maintaining soil fertility and organic-matter content is a concern of management.

Crops that leave a large amount of crop residue are best suited to these soils. Corn, sorghum, alfalfa, and grass are usually grown.

Sprinkler irrigation is well suited to these soils because of the moderately high intake rate and uneven topography. Areas that have been leveled can be irrigated by border, furrow, or corrugation systems. Short runs, large streams, and frequent irrigation are needed in any gravity system. Including a legume or a legume-grass mixture in the cropping system, making use of crop residue, stripcropping in a narrow field pattern, and conservation tillage help in controlling erosion. Barnyard manure or commercial fertilizer is needed to maintain soil fertility.

CAPABILITY UNIT IIIw–2 IRRIGATED

The one soil in this unit, Fillmore silt loam, 0 to 1 percent slopes, is a deep, poorly drained, nearly level soil in upland depressions. The surface layer is silt loam, and the subsoil is silty clay and silty clay loam. The underlying material is silt loam.

This soil is difficult to work because of wetness. The intake rate is low, and moisture is released slowly to plants. Runoff is ponded. Permeability is very slow. Available water capacity is moderate. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused by very slow internal drainage and run-in water from higher lying areas is the principal hazard.

Because areas of this soil are small and isolated, they are sometimes farmed in fields of surrounding good cropland. Corn and sorghum are the main crops in irrigated areas. This soil is also suited to alfalfa and grass.

Controlling runoff on the adjacent higher slopes by using terraces and diversions is the best way to protect this soil against flooding. Where suitable outlets are available, drainage ditches can be provided to keep water from ponding. Wetness can also be controlled by leveling and filling the depressions. Gravity and sprinkler systems can be adapted to this soil. The rate of water application can be adjusted so that it does not exceed the intake rate of the soil. Barnyard manure, alfalfa or grass legume mixtures, and conservation tillage to keep crop residue on the surface improve soil tilth and the intake rate. This soil should not be worked when wet.

CAPABILITY UNIT IVe–6 IRRIGATED

In this capability unit are strongly sloping, deep, well drained soils on uplands. They are silt loam throughout the profile. Many areas are eroded and have a calcareous surface layer.

These soils are easy to work. The intake rate is moderate, and moisture is released readily to plants. Runoff is medium. Permeability is moderate. Available water capacity is high. Organic-matter content is moderately low or low, and natural fertility is medium or low.

Water erosion is a very serious hazard in cultivated areas. Soil blowing can also be a hazard unless the surface is protected. The moderately low to low organic-

matter content and the low fertility are concerns of management.

Small grains, alfalfa, and tame grass are the crops best suited to irrigation. Row crops are not suitable.

The sprinkler system is a well suited method of irrigation. Terraces, diversions, and conservation tillage are needed to control water erosion. Grassed waterways carry away excess water. Returning crop residue to the soil and growing grass and legumes help in controlling soil blowing and increase organic-matter content and fertility.

Nitrogen and phosphorus are generally needed on these soils. Care is needed in applying herbicides. The application must not be too high in areas where the organic-matter content is moderately low.

CAPABILITY UNIT IVe–8 IRRIGATED

The one soil in this unit, Sarben loamy very fine sand, 3 to 9 percent slopes, is a deep, well drained, gently sloping to strongly sloping soil on uplands. The surface layer and transition layer is loamy very fine sand. The underlying material is loamy very fine sand in the upper part and very fine sand in the lower part.

This soil is difficult to work. Tilth is generally poor because of the loose consistence of the surface layer. The intake rate is moderately high, and moisture is released readily to plants. Runoff is medium. Permeability is moderately rapid. Available water capacity is low. Organic-matter content and natural fertility are low.

Soil blowing is a serious hazard unless the surface is protected. Erosion by water can also be a hazard, especially if there is excessive rainfall after irrigation. Increasing the supply of organic matter and the level of fertility is needed.

Alfalfa, grass, and small grain are suited to this soil.

Sprinkler irrigation is well suited to this soil because of the moderately high intake rate and strong slopes. Because of the low available water capacity, frequent irrigation is needed. Maintaining a cover of crops, grass, or crop residue reduces the risk of soil blowing. Grass or legumes are best suited to this soil because they reduce the hazards of wind and water erosion and build up the organic-matter content and fertility. Barnyard manure and commercial fertilizer also increase fertility.

Predicted yields

Crop yield predictions are an important interpretation that can be made from a soil survey. The predicted yields per acre for the principal crops in Frontier County are given in table 2. These predictions are based on average yields for seeded acres over the most recent 5-year period. They do not represent anticipated yields that might be obtained under a new and possibly different technology.

Yields for various crops were derived from information obtained from interviews with farmers, directors of the Natural Resource Districts, representatives of the Soil Conservation Service and Agriculture Extension Service, and others familiar with the soils and agriculture of the county. Yield information from the Agriculture Stabilization and Conservation Service and research data from Agricultural Experiment Stations were also used. Yield records, trends, research, and experience were considered.

Crop yields are influenced by many factors. Some of the most influential soil features are depth, texture, slope, and drainage. Erosion, available water capacity, permeability, and fertility are also important. Management practices, such as the cropping pattern, timely fieldwork, plant population, and crop variety affect crop yields. Weather is significant both on a day to day basis, and for longer seasonal or yearly fluctuations. All were considered in preparing table 2.

The yields listed are those predicted where a high level of management is used. Under high level management, fertility is maintained and fertilizer or lime is applied at rates indicated by soil tests and field experiments; crop residue is returned to the soil to improve tilth and maintain or increase the organic-matter content; adapted varieties of seed are used, and plant populations are optimum; weeds, insects, and diseases are well controlled. In irrigated areas, water is applied at the proper time and in the proper amounts. Water erosion and soil blowing are controlled. If needed, drainage is provided. Tillage and seeding practices are performed at the proper time and are adequate. The soil is protected from deterioration and farmed according to its capacity.

One of the best uses for the yield table is to compare the productivity of one soil with that of other soils in the county. The table in no sense recommends, and the yields listed do not apply to specific farms.

Yields in any one year on a particular soil may vary considerably from the figures listed, as a result of weather, sudden infestations of diseases or insects, or other unpredictable hazards. By using long-time averages, it is possible to consider such hazards in predicting crop yields.

Improved technology may make predictions in table 2 obsolete in a few years. Yield data will then need to be updated as knowledge is gained and improvements in technology show the need.

Range [3]

Range is approximately 55 percent of the agricultural acreage in Frontier County. It occurs as scattered areas throughout the county, but is mostly concentrated along the narrow divides and canyons of the loess uplands. It is generally land that is not suitable for cultivation. The major soil associations in range are Coly-Uly-Rough broken land, loess, and Uly-Coly-Holdrege.

Livestock, mainly cow and calf herds, is the largest agricultural industry in the county. Calves are sold in fall as feeders. The range is generally grazed from late in spring to early in fall. Livestock spend the rest of the year grazing grain sorghum or the corn aftermath in fall. They are fed hay or silage in winter.

Management practices that maintain or improve the range condition and are needed on all rangeland, include *proper grazing use,* or grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of desirable vegetation; *deferred grazing,* or postponing

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

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

[Absence of figure indicates that the crop is not suited to the soil, the crop is not commonly grown, or irrigation is not practical]

Mapping unit	Corn		Grain sorghum	Wheat [1]	Alfalfa hay	
	Irrigated	Dryland			Irrigated	Dryland
	Bu	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*
Broken alluvial land						
Coly silt loam, 5 to 9 percent slopes, eroded		15	24	20	3.0	0.8
Coly silt loam, 9 to 20 percent slopes, eroded						
Coly and Uly silt loams, 9 to 30 percent slopes						
Fillmore silt loam, 0 to 1 percent slopes	100	25	35	30	4.0	2.0
Hall silt loam, 0 to 1 percent slopes	140	35	45	40	5.5	2.3
Hall silt loam, 1 to 3 percent slopes	135	32	42	39	5.2	2.0
Hall silt loam, 3 to 6 percent slopes	120	28	37	35	4.5	1.8
Hobbs silt loam, occasionally flooded, 0 to 2 percent slopes	130	40	45	40	5.5	3.0
Holdrege silt loam, 0 to 1 percent slopes	140	33	42	40	5.5	1.8
Holdrege silt loam, 1 to 3 percent slopes	135	30	40	38	5.0	2.0
Holdrege silt loam, 1 to 3 percent slopes, eroded	130	27	38	35	4.8	1.8
Holdrege silt loam, 3 to 6 percent slopes	120	25	35	33	4.0	1.5
Holdrege silt loam, 3 to 6 percent slopes, eroded	110	23	32	30	3.7	1.2
Hord silt loam, 3 to 6 percent slopes	120	27	39	37	5.2	2.0
Hord silt loam, terrace, 0 to 1 percent slopes	140	40	53	40	5.5	2.8
Hord silt loam, terrace, 1 to 3 percent slopes	135	38	48	38	5.0	2.5
Jayem loamy very fine sand, 1 to 3 percent slopes	120	40	36	24	4.5	1.8
McCook silt loam, 0 to 1 percent slopes	140	45	60	40	5.5	3.0
McCook silt loam, 1 to 3 percent slopes	135	33	45	38	5.0	2.5
McCook silt loam, occasionally flooded, 0 to 2 percent slopes	140	40	45	40	5.5	3.5
McCook silt loam, wet, 0 to 1 percent slopes	140	90				5.0
Rough broken land, caliche, 30 to 60 percent slopes						
Rough broken land, loess, 30 to 60 percent slopes						
Rough broken land, sandy, 30 to 60 percent slopes						
Sarben loamy very fine sand, 3 to 9 percent slopes		15	20	20	3.0	.8
Uly silt loam, 3 to 6 percent slopes, eroded	100	22	35	28	3.5	1.2
Uly silt loam, 6 to 9 percent slopes		20	30	26	3.3	1.0
Uly and Coly silt loams, 6 to 9 percent slopes, eroded		18	25	23	3.0	.8
Uly and Coly silt loams, 9 to 20 percent slopes						
Vetal loamy very fine sand, 0 to 3 percent slopes	130	43	38	30	4.5	2.0
Wet alluvial land						

[1] Wheat is raised under a fallow system; yields are those obtained every 2 years.

grazing or resting grazing land for a prescribed period; and *planned grazing,* in which two or more grazing units are alternately rested from grazing in a planned sequence over a period of years. The rest period may be throughout the year or during the growing season of the key plants.

The proper distribution of livestock in a range area can be improved by the correct location of fences, livestock water developments, and salting facilities.

Range seeding, or the establishment by seeding or reseeding of native grasses, either wild harvest or improved strains, on land suited to range, improves range condition. Soils, such as Coly and Uly silt loams, 9 to 30 percent slopes, and Coly silt loam, 9 to 20 percent slopes, eroded, some areas of which are still cultivated, should be range seeded. The most important grasses in the seed mixture include big bluestem, little bluestem, indiangrass, switchgrass, side-oats grama, blue grama, and western wheatgrass.

Range sites and condition classes

Different kinds of rangeland produce different kinds and amounts of native grass. For proper range management, it is important to know the different kinds of rangeland, or range sites, and the native plants that can grow on each site. Management can then be used that will favor the growth of the best forage plants.

Range sites are distinctive kinds of rangeland that differ in their ability to produce a significantly different kind and proportion of climax, or original vegetation. A significant difference is one great enough to require some variation in management, such as a different stocking rate. Climax vegetation is the combination of plants that originally grew on a given site. The most productive combination of range plants on a site is generally the climax type of vegetation.

Range condition is classified according to the percent of vegetation on the site that is original or climax vegetation. This classification is used in comparing the kind and amount of present vegetation with that which the site can produce. Changes in range condition are mainly caused by the intensity of grazing and drought.

Climax vegetation may be altered by intensive grazing. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. Plants react to grazing by decreasing, increasing, or invading. Decreaser and increaser plants are climax plants. Generally, *decreasers* are the most heavily grazed and, consequently, the first to be injured by overgrazing. *Increasers* withstand grazing better or are less palatable to the livestock. They increase under grazing and replace the decreasers. *Invaders* are normally weeds that become established after the climax vegetation has been reduced by grazing.

Range condition is expressed in four range condition classes to show the present condition of the vegetation on a range site as related to the original vegetation. The condition is *excellent* if 76 to 100 percent of the vegetation is climax; *good* if 51 to 75 percent is climax; *fair* if 26 to 50 percent is climax; and *poor* if 0 to 25 percent is climax.

The range sites in Frontier County are described on the pages that follow. The descriptions include the topography of each site, a brief description of the soils in each site, the dominant vegetation on the site when in excellent range condition, and the total annual production in pounds per acre of air-dry herbage when growing conditions are favorable and unfavorable.

The names of the soils in the county and the given range site are listed on the "Guide to Mapping Units" at the back of this survey.

WET LAND RANGE SITE

Wet alluvial land, the only mapping unit in this site, is on bottom land. It is medium textured or moderately fine textured and very poorly drained. The high water table, which fluctuates between the surface and a depth of about 30 inches, primarily determines the kind of vegetation.

The climax plant cover is a mixture of at least 65 percent decreaser grasses, such as prairie cordgrass and reedgrasses, and 35 percent other perennial grasslike plants and forbs. Members of the sedge family are the principal increaser. If the site is in poor condition, the typical plant community is Kentucky bluegrass, red clover, redtop, asters, dandelion, sparse amounts of prairie cordgrass, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 5,000 pounds of air-dry herbage per acre in unfavorable years to 6,000 pounds per acre in favorable years.

SUBIRRIGATED RANGE SITE

The one soil in this range site, McCook silt loam, wet, 0 to 1 percent slopes, is on bottom land. It is deep, somewhat poorly drained, and medium textured. The moderately high water table, which fluctuates between depths of 2 and 6 feet, primarily determines the kind of vegetation.

The climax plant cover is at least 75 percent decreaser grasses, such as big bluestem, indiangrass, switchgrass, little bluestem, prairie cordgrass, and Canada wildrye, and 25 percent other perennial grasses and forbs. Kentucky bluegrass, western wheatgrass, green muhly, and sedges are the principal increasers. If the site is in poor condition, the typical plant community is Kentucky bluegrass, redtop, foxtail barley, dandelion, western ragweed, blue verbena, sparse amounts of western wheatgrass, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 4,500 pounds of air-dry herbage per acre in unfavorable years to 5,500 pounds per acre in favorable years.

SILTY OVERFLOW RANGE SITE

This occasionally flooded or frequently flooded range site is on bottom land. The soils are medium textured. Some areas are smooth and nearly level, whereas others have broken slopes caused by stream downcutting. The additional water received from periodic flooding or runoff, the deposits of silt, the high available water capacity, and the moderate infiltration rate primarily determine the kind of vegetation.

The climax plant cover is at least 70 percent decreaser grasses, such as big bluestem, little bluestem, switchgrass, slender wheatgrass, and Canada wildrye,

and 30 percent other perennial grasses and forbs. Western wheatgrass, side-oats grama, Kentucky bluegrass, and sedges are the principal increasers. If the site is in poor range condition, the typical plant community is western wheatgrass, blue grama, Kentucky bluegrass, common ragweed, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 3,500 pounds of air-dry herbage per acre in unfavorable years to 4,500 pounds per acre in favorable years.

CLAYEY OVERFLOW RANGE SITE

The one soil in this range site, Fillmore silt loam, 0 to 1 percent slopes, is in upland depressions. It is deep and nearly level. The surface layer is medium textured, and the claypan subsoil is fine and moderately fine textured. The very slow permeability and the ponding that occurs on this soil primarily determine the kind of vegetation.

The climax plant cover is at least 50 percent decreaser grasses, such as big bluestem, switchgrass, little bluestem, and Canada wildrye, and 50 percent other grasses and forbs. Western wheatgrass, blue grama, buffalograss, Kentucky bluegrass, and sedges are the principal increasers. If the site is in poor range condition, the typical plant community is Kentucky bluegrass, common ragweed, blue grama, buffalograss, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 2,500 pounds of air-dry herbage per acre in unfavorable years to 4,000 pounds per acre in favorable years.

SILTY LOWLAND RANGE SITE

This nearly level or very gently sloping range site is on bottom land, stream terraces, and foot slopes. The soils are deep and medium textured. The additional moisture received as runoff from adjoining higher areas, the high available water capacity, and the moderate infiltration rate primarily determine the kind of vegetation.

The climax plant cover is at least 70 percent decreaser grasses, such as big bluestem, little bluestem, switchgrass, and Canada wildrye, and 30 percent other grasses and forbs. Western wheatgrass, side-oats grama, blue grama, Kentucky bluegrass, and sedges are the principal increasers. If the site is in poor range condition, the typical plant community is Kentucky bluegrass, western wheatgrass, blue grama, common ragweed, and members of the sedge family.

If the site is in excellent range condition, the total annual production ranges from 3,000 pounds of air-dry herbage per acre in unfavorable years to 4,500 pounds per acre in favorable years.

SANDS RANGE SITE

Rough broken land, sandy, 30 to 60 percent slopes, is the only mapping unit in this range site. Slopes are very steep and broken. The material is coarse textured. The excessive drainage, the rapid infiltration rate, and the low available water capacity primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 60 percent decreaser grasses, such as sand bluestem, switchgrass, prairie junegrass, sand lovegrass, and Canada wildrye, and 40 percent other perennial grasses, forbs and shrubs. Little bluestem, prairie sandreed, needleandthread, blue grama, Scribner panicum, sand dropseed, and various sedges are the principal increasers. If the site is in poor range condition, the typical plant community is blue grama, hairy grama, sand dropseed, sand paspalum, Scribner panicum, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 1,500 pounds air-dry herbage per acre in unfavorable years to 2,500 pounds per acre in favorable years.

SANDY RANGE SITE

This nearly level to very steep range site is on uplands. The soils are deep. The surface layer and underlying material are coarse textured, and the subsoil is moderately coarse textured. The good to excessive drainage and the moderately rapid infiltration rate primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 65 percent decreaser grasses, such as sand bluestem, little bluestem, switchgrass, side-oats grama, and prairie junegrass, and 35 percent perennial grasses and forbs. Blue grama, needleandthread, prairie sandreed, sand dropseed, Scribner panicum, and various sedges are the principal increasers. If the site is in poor range condition, the typical plant community is blue grama, sand dropseed, Scribner panicum, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 1,500 pounds of air-dry herbage per acre in unfavorable years to 3,000 pounds per acre in favorable years.

SILTY RANGE SITE

This nearly level to steep range site is on foot slopes and uplands. The soils are deep. They have a medium textured surface layer, a medium textured or moderately fine textured subsoil, and medium textured underlying material. Lime is leached below a depth of 10 inches. The medium textured surface layer, the high available water capacity, and the good drainage primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 65 percent decreaser grasses, such as little bluestem, big bluestem, switchgrass, side-oats grama, and indiangrass, and 35 percent other perennial grasses, forbs, and shrubs. Blue grama, buffalograss, sand dropseed, western wheatgrass, and various sedges are the principal increasers. If the site is in poor range condition, the typical plant community is blue grama, buffalograss, sand dropseed, perennial three-awn, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 2,000 pounds of air-dry herbage per acre in unfavorable years to 3,500 pounds per acre in favorable years.

LIMY UPLAND RANGE SITE

This strongly sloping to steep range site is on uplands. The soils are deep and are medium textured throughout. They range from well drained to excessively drained. They are weakly developed and have lime at or near the surface. The limy soil condition,

the medium texture, and the high available water capacity primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 80 percent decreaser grasses, such as little bluestem, big bluestem, side-oats grama, plains muhly, switchgrass, and western wheatgrass, and 20 percent other perennial grasses, forbs, and shrubs. Blue grama, hairy grama, buffalograss, sand dropseed, and various sedges are the principal increasers. If the site is in poor range condition, the typical plant community is blue grama, buffalograss, sand dropseed, perennial three-awn, sedges, and western ragweed.

If the site is in excellent range condition, the total annual production ranges from 1,500 pounds of air-dry herbage per acre in unfavorable years to 3,000 pounds per acre in favorable years.

SHALLOW LIMY RANGE SITE

The only mapping unit in this range site, Rough broken land, caliche, 30 to 60 percent slopes, is near the base of canyon walls near Medicine and Red Willow Creeks. It consists of rock outcrop and very shallow soil material formed in the underlying caliche. Water penetration and root development are limited. The low available water capacity, the limy soil condition, and the very shallow and shallow soil material primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 70 percent decreaser grasses, such as little bluestem, big bluestem, side-oats grama, prairie junegrass, plains muhly, and western wheatgrass, and 30 percent other perennial grasses, forbs, and shrubs. Blue grama, hairy grama, buffalograss, sand dropseed, and various sedges are the principal increasers. The site is rarely in poor range condition because it is nearly inaccessible to livestock.

If the site is in excellent condition, the total annual production ranges from 1,500 pounds of air-dry herbage per acre in unfavorable years to 2,500 pounds per acre in favorable years.

THIN LOESS RANGE SITE

The only mapping unit in this range site is Rough broken land, loess, 30 to 60 percent. It is deep, medium textured, and calcareous. The very steep slopes and the medium textured soil material primarily determine the kind of vegetation.

The climax plant cover is a mixture of at least 75 percent decreaser grasses, such as little bluestem, big bluestem, side-oats grama, plains muhly, needleandthread, and western wheatgrass, and 25 percent other perennial grasses and forbs. Blue grama, hairy grama, sand dropseed, and various sedges are the principal increasers. If the site is in poor range condition, the typical plant community is blue grama, hairy grama, sand dropseed, Kentucky bluegrass, and broom snakeweed.

If the site is in excellent range condition, the total annual production ranges from 1,500 pounds of air-dry herbage per acre in unfavorable years to 2,250 pounds per acre in favorable years.

The following list provides the common name and respective scientific name for plants referred to in the range section.

Common name	*Scientific name*
Asters	*Aster spp. L.*
Big bluestem	*Andropogon gerardi Vitman*
Blue grama	*Bouteloua gracilis (H.B.K.) Lag. ex. Stend.*
Blue verbena	*Verbena hastata L.*
Broom snakeweed	*Gutierrezia sarothrae (Pursh) Britt. and Rusby*
Buffalograss	*Buchloe dactyloides (Nutt.) Engelm.*
Canada wildrye	*Elymus canadensis L.*
Common ragweed	*Ambrosia artemisiifolia L.*
Dandelion	*Taraxacum officinale Weber in Wiggers*
Foxtail barley	*Hordeum jubatum L.*
Green muhly	*Muhlenbergia racemosa (Mich.) B.S.F.*
Hairy grama	*Bouteloua hirsuta Lag.*
Indiangrass	*Sorghastrum nutans (L.) Nash*
Kentucky bluegrass	*Poa pratensis L.*
Little bluestem	*Andropogon scoparius Mischx.*
Needleandthread	*Stipa comata Trin. and Rupr.*
Perennial three-awn	*Aristida spp. L.*
Plains muhly	*Muhlenbergia cuspidata (Torr.) Rydb.*
Prairie cordgrass	*Spartina pectinata Link*
Prairie junegrass	*Koeleria cristata (L.) Pers.*
Prairie sandreed	*Calamovilfa longifolia (Hook.) Scribm.*
Red clover	*Trifolium pratense L.*
Reedgrasses	*Calamagrostis spp. Adans.*
Sand bluestem	*Andropogon hallii Hack.*
Sand dropseed	*Sporobolus cryptandrus (Torr.) A. Gray*
Sand paspalum	*Paspalum stramineum Nash*
Sand lovegrass	*Eragrostis trichodes (Nutt.) Wood*
Scribner panicum	*Panicum scribnerianum Nash*
Sedge family	*Cyperaceae*
Sedges	*Carex spp. L.*
Slender wheatgrass	*Agropyron trachycaulum (Link) Malte*
Side-oats grama	*Bouteoua curtipendula (Michx.) Torr.*
Switchgrass	*Panicum virgatum L.*
Western ragweed	*Ambrosia psilostachya DC.*
Western wheatgrass	*Agropyron smithii Rydb.*

Native Woodland and Windbreaks [4]

Native woodland in Frontier County is limited to narrow strips along the larger streams. The most extensive stands grow on bottom land along Medicine Creek. They are chiefly eastern cottonwood, American elm, willow, boxelder, green ash, and hackberry and some woody shrubs. They occur mainly on sandy alluvial land. In the northwestern part of the county, native stands also occur on the Rough broken land part of the Coly-Uly-Rough broken land, loess, association. These stands, mainly on north exposures, consist of eastern redcedar (fig. 12), skunkbush sumac, and western snowberry.

Early settlers in Frontier County planted trees for protection, shade, and fenceposts. Throughout the years, landowners have continued to plant trees to protect their buildings and livestock. Native trees and shrubs contribute much to the natural beauty of the landscape in Frontier County. They also provide food and cover for wildlife.

Kinds of windbreaks

Because of the scarcity of trees and the severe weather that prevails, windbreaks are needed for farmstead and livestock protection (fig. 13). Windbreaks reduce home heating costs, control snowdrifting, reduce soil erosion, provide shelter for livestock, improve habitat for wildlife, and beautify the home and countryside.

Narrow windbreaks or screen plantings are also useful in urban areas where they slow the windspeed,

[4] Prepared by JAMES W. CARR, JR., forester, Soil Conservation Service.

Figure 12.—Stand of eastern redcedar on Rough broken land, loess, 30 to 60 percent slopes, in the northwestern part of county.

settle the dust, and reduce the noise level. Although trees are not easily established every year, the observance of basic rules of tree culture can result in a high degree of tree survival. Healthy seedlings of adapted species properly planted in a well prepared soil and carefully tended after planting can survive and grow well.

Growth of trees

Table 3 lists the relative vigor and expected height of trees and shrubs at 20 years of age for species suited to windbreaks in Frontier County. Detailed measurements were taken for most tree and shrub species listed in this table. Some tree heights and vigor ratings however, are estimated. The soils in each group are similar in characteristics that affect the growth of trees.

The ratings in table 3 are based on observations of relative vigor and general condition of the trees. Some species that have a rating of good are best suited to windbreaks on soils of that particular group. A rating of *good* indicates that one or more of the following conditions generally apply. Leaves (or needles) are normal in color and growth; small amounts of deadwood (tops, branches, and twigs) occur in the live crown of the tree; and damage caused by disease, insects, and climate is limited. A rating of *fair* indicates one or more of the following conditions. Leaves (or needles) are normal in color and growth; substantial amounts of deadwood (tops, branches, and twigs) occur in the live crown; damage caused by disease, insects, and climate is moderate; and the current year's growth is obviously less than normal. A rating of *poor* indicates one or more of the following conditions. Leaves (or needles) are abnormal in color and growth; large amounts of deadwood (tops, branches, and twigs) occur within the live crown; and damage caused by disease, insects, and climate is extensive.

The conifers—cedar, pine, and Rocky Mountain juniper—are best suited as windbreaks. Measurement shows that these species, all native to Nebraska, are rated high in survival and vigor. These species hold their leaves through the winter, thus giving maximum protection when it is needed most. Table 3 also indicates several broadleaf tree species that are well suited as windbreaks in Frontier County.

Eastern redcedar can reach a height of 25 to 30 feet at maturity. Rocky Mountain juniper attains a slightly lower height. Ponderosa pine, Austrian pine, and Scotch pine grow slightly faster and are somewhat taller at maturity. The same is true of broadleaf trees.

Rate of growth in a windbreak depends on soil moisture conditions and soil fertility. Exposure and arrangement of trees in the planting also has a marked effect upon growth. Some species grow faster than others; some make an early fast growth but tend to die young. This is occasionally true of the eastern cot-

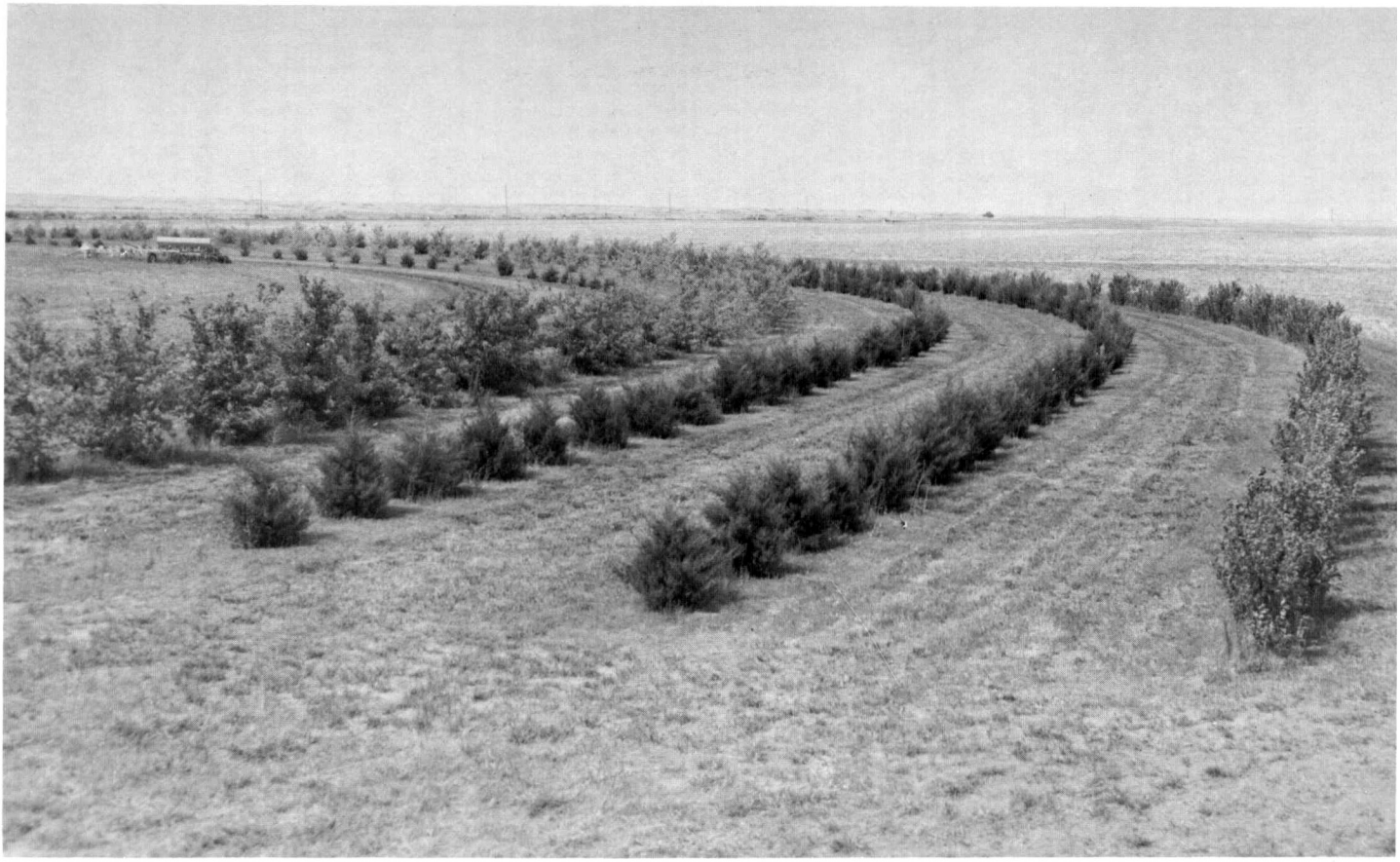

Figure 13.—**Newly established farmstead windbreak on Holdrege silt loam, 0 to 1 percent slopes.**

tonwood. Siberian elm and Russian-olive are vigorous early growers. They can, however, spread where they are not wanted and can be short lived. Boxelder and Russian mulberry commonly freeze back in severe winters, and green ash is susceptible to damage by borers.

Windbreak design, planting, and care

A good windbreak must be designed according to the soil in which it is to grow. The intended purpose of the planting needs to be considered. Specific information on design, establishment, and care of the windbreak is available from the Soil Conservation Service and the extension service forester serving Frontier County.

The soils of Frontier County are grouped according to characteristics that affect tree growth. The windbreak group for each soil in the county is shown in the "Guide to Mapping Units" at the back of this survey. Soils in a group produce similar growth and survival under average conditions of weather and care.

The soils of Nebraska are grouped into windbreak suitability groups according to a statewide system. Not all groups are in Frontier County. Following is a brief description of the windbreak suitability groups in Frontier County.

WINDBREAK SUITABILITY GROUP 1

This group consists of nearly level or very gently sloping soils on bottom land, stream terraces, and colluvial foot slopes. The soils are medium textured, deep, and well drained. Soils on most bottom land areas are occasionally flooded. Soils on stream terraces and colluvial foot slopes receive additional moisture as runoff from higher adjoining areas.

These soils generally provide good tree planting sites and capability for good survival and good growth of adapted species. Competition from weeds and grasses for moisture is the principal hazard. Cultivation with conventional equipment between the tree rows and hand hoeing or chemical herbicides in the tree rows can eliminate this hazard.

WINDBREAK SUITABILITY GROUP 2

This group consists of deep, poorly drained, and somewhat poorly drained soils on bottom land and in depressions. On bottom land, the water table fluctuates between depths of 2 and 6 feet. The soils have a medium textured surface layer and a medium to fine textured subsoil. They are subject to occasional flooding and ponding.

These soils provide good tree planting sites and capability for good survival and growth if species selected can tolerate occasional wetness. Species rated *good* or *fair* ordinarily have good survival and growth. The abundant and persistent herbaceous vegetation that grows on these sites is a concern of management.

TABLE 3.—*Suitability of specified trees and shrubs (dryland) for windbreaks and estimated height at 20 years of age, by windbreak suitability group*

[No height is listed if species is poorly suited. No data is listed for windbreak group 10 because the soils of this group are not generally suited to windbreaks]

Windbreak group	Conifer trees			Broadleaf trees			Shrubs		
	Species	Suitability	Height	Species	Suitability	Height	Species	Suitability	Height
			Feet			*Feet*			*Feet*
Group 1: Hb, Hr, HrB, Mc, McB, Md.	Austrian pine	Good	26	Black walnut	Good	24	American plum	Good	7
	Colorado blue spruce.	Good	20	Boxelder	Good	22	Amur honeysuckle	Good	8
	Eastern redcedar	Good	20	Bur oak	Good	24	Buffaloberry	Fair	6
	Ponderosa pine	Good	26	Eastern cottonwood	Good	50	Common chokecherry	Good	10
	Rocky Mountain juniper.	Good	15	Golden willow	Fair	28	Lilac	Good	6
	Scotch pine	Good	24	Green ash	Good	26	Peking cotoneaster	Good	6
				Hackberry	Good	24	Redosier dogwood	Good	6
				Honeylocust	Good	28	Sandcherry	Fair	4
				Russian mulberry	Good	20	Skunkbush sumac	Good	7
				Russian-olive	Good	22			
				Siberian elm	Good	36			
				White willow	Fair	28			
Group 2: Fm, Me.	Austrian pine	Fair	24	Black walnut	Poor	----	American plum	Fair	5
	Colorado blue spruce.	Fair	18	Boxelder	Good	18	Amur honeysuckle	Fair	6
	Eastern redcedar	Good	16	Bur oak	Poor	----	Buffaloberry	Good	6
	Ponderosa pine	Poor	----	Eastern cottonwood	Fair	55	Common chokecherry	Good	8
	Rocky Mountain juniper.	Fair	14	Golden willow	Good	25	Lilac	Fair	5
	Scotch pine	Fair	22	Green ash	Fair	24	Peking cotoneaster	Fair	4
				Hackberry	Fair	20	Redosier dogwood	Good	6
				Honeylocust	Good	22	Sandcherry	Poor	----
				Russian mulberry	Good	16	Skunkbush sumac	Poor	----
				Russian-olive	Poor	----			
				Siberian elm	Fair	25			
				White willow	Good	25			
Group 3: JmB, SaD, VeB.	Austrian pine	Good	25	Black walnut	Poor	----	American plum	Good	6
	Colorado blue spruce.	Poor	----	Boxelder	Fair	18	Amur honeysuckle	Fair	5
	Eastern redcedar	Good	18	Bur oak	Fair	18	Buffaloberry	Poor	----
	Ponderosa pine	Good	25	Eastern cottonwood	Good	48	Common chokecherry	Good	9
	Rocky Mountain juniper	Good	16	Golden willow	Poor	----	Lilac	Good	5
	Scotch pine	Fair	24	Green ash	Good	22	Peking cotoneaster	Fair	5
				Hackberry	Fair	19	Redosier dogwood	Poor	----
				Honeylocust	Good	22	Sandcherry	Good	4
				Russian mulberry	Fair	16	Skunkbush sumac	Good	6
				Russian-olive	Fair	18			
				Siberian elm	Good	32			
				White willow	Poor	----			

Group 4: Ha, HaB, HaC, Ho, HoB, HoB2, HoC, HoC2, HpC, UaC2, UaD, UcD2.	Austrian pine	Good	22	Black walnut	Poor		American plum	Good	6
	Colorado blue spruce.	Fair	16	Boxelder	Poor		Amur honeysuckle	Good	6
	Eastern redcedar	Good	17	Bur oak	Fair	18	Buffaloberry	Poor	
	Ponderosa pine	Good	22	Eastern cottonwood	Poor		Common chokecherry	Good	8
	Rocky Mountain juniper.	Good	16	Golden willow	Poor		Lilac	Good	6
	Scotch pine	Fair	20	Green ash	Fair	21	Peking cotoneaster	Poor	
				Hackberry	Fair	18	Redosier dogwood	Poor	
				Honeylocust	Good	24	Sandcherry	Poor	
				Russian mulberry	Fair	15	Skunkbush sumac	Good	6
				Russian-olive	Good	18			
				Siberian elm	Good	30			
				White willow	Poor				
Group 5: CoD2.	Austrian pine	Poor		Black walnut	Poor		American plum	Poor	
	Colorado blue spruce.	Poor		Boxelder	Poor		Amur honeysuckle	Poor	
	Eastern redcedar	Good	15	Bur oak	Good	15	Buffaloberry	Poor	
	Ponderosa pine	Fair	18	Eastern cottonwood	Poor		Common chokecherry	Fair	5
	Rocky Mountain juniper.	Good	15	Golden willow	Poor		Lilac	Fair	5
	Scotch pine	Poor		Green ash	Poor		Peking cotoneaster	Poor	
				Hackberry	Poor		Redosier dogwood	Poor	
				Honeylocust	Fair	18	Sandcherry	Poor	
				Russian mulberry	Poor		Skunkbush sumac	Good	5
				Russian-olive	Fair	16			
				Siberian elm	Fair	22			
				White willow	Poor				

WINDBREAK SUITABILITY GROUP 3

This group consists of deep, nearly level to gently sloping, well drained soils on uplands. The surface layer and underlying material are coarse textured, and the subsoil is moderately coarse textured or medium textured.

These soils are good tree planting sites. Survival and growth of adapted species are fair. Lack of moisture and soil blowing are the principal hazards. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Cultivation generally should be restricted to the tree rows.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep, nearly level to strongly sloping, well drained soils on uplands and gently sloping soils on foot slopes. The surface layer and underlying material are medium textured, and the subsoil is medium textured or moderately fine textured. Lime is leached below a depth of 10 inches.

These soils generally provide good tree planting sites and capability for good survival and fair growth of adapted species. Drought and competition from weeds and grasses for moisture are the principal hazards. Drought can be minimized by planting the species rated *good* or *fair*. Competition from weeds and grasses can be eliminated by using conventional cultivation equipment between tree rows and hand hoeing or by using recommended chemical herbicides in the tree rows. Trees should be planted on the contour in the sloping areas whenever possible. Tree growth may be somewhat slower on the steeper slopes because of rapid runoff.

WINDBREAK SUITABILITY GROUP 5

This group consists of deep, strongly sloping, eroded soils on uplands. The soils are well drained and medium textured. They have a thin surface layer. Lime is at or near the surface.

These soils provide poor tree planting sites and only fair to poor survival and growth of adapted species. Lack of adequate moisture is the principal hazard. The calcareous soil condition is the principal limitation. If trees are planted on the contour, the contour cultivation between the rows stores moisture and controls weeds. The effect of the calcareous soil condition can be minimized by using only those species rated *good* or *fair*.

WINDBREAK SUITABILITY GROUP 10

This group consists of soils and land types that have a wide range of soil characteristics. The soils range from coarse textured to medium textured. Those on uplands are deep and shallow, moderately steep to very steep, and somewhat excessively drained or excessively drained. Numerous rock outcrops occur in some of the very steep areas. The soils on bottom land are nearly level, poorly drained, or very poorly drained. Some are frequently flooded. Others have a water table at or near the surface.

Soils of this group are generally not suited to windbreak plantings of any kind because of their unfavorable qualities and characteristics. Some areas can be used for recreation, forestation, and wildlife plantings of tolerant tree and shrub species if they are hand planted or if special approved practices are used.

Wildlife and Recreation [5]

The wildlife population is determined largely by the quality and quantity of vegetation the soil is capable of producing. A proper combination of cover, food, and water determines wildlife abundance.

Topography and subsoil characteristics, such as fertility, are important factors. Fertile soils produce larger numbers and better quality wildlife, both game and nongame species.

The kind and numbers of wildlife can be used to evaluate the quality of the environment. It has been said that "a livable environment for wildlife is generally a quality environment for man."

In many cases, the soils rated highest for wildlife potential do not have the highest wildlife population. This is not caused by the inability of the soils to produce wildlife habitat, but rather by too many other factors, such as hunting pressure, clean tillage, and improved harvesting methods. The potential still remains and wildlife values can be enhanced with little cost and effort. Wildlife has a place in both rural and urban settings and should be considered in planning optimum use of these areas. Fish ponds that fill by runoff from fertile fields usually produce larger fish populations than average because of the increased food production.

Zooplankton are microscopic animals, and phytoplankton are microscopic plants produced in fertile ponds. They provide food for larger aquatic animals, such as frogs, which, in turn, are used by fish.

Steep slopes and rough, irregular topography are hazards to livestock and are poorly suited to crop production. In these areas, the natural undisturbed landscape can become escape cover for wildlife and provide a source of food. If vegetation is lacking, it can be developed by planting flowering and fruit-bearing trees and shrubs.

Wetness, permeability, and available water capacity are important soil characteristics to be considered in selecting pond sites for wildlife and recreation.

The principal soil associations, as shown on the general soil map, are evaluated for wildlife habitat potential in Frontier County. In table 4 the potential for each of the following habitat elements is rated. The elements are described as follows:

Grain and seed crops are domestic grain or other seed-producing annuals planted to produce food for wildlife. Examples are corn, sorghum, wheat, oats, barley, millet, soybeans, and sunflowers.

Domestic grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted to provide food and cover for wildlife. Examples are fescue, bluegrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established dryland herbaceous grasses and forbs (including weeds) that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod,

[5] Prepared by ROBERT O. KOERNER, biologist, Soil Conservation Service.

beggarweed, partridgepea, pokeweed, wheatgrass, fescue, and grama.

Hardwood trees and shrubs are nonconiferous trees and associated woody understory plants that provide cover for wildlife, or that produce nuts, buds, catkins, twigs, bark, or foliage used as food by wildlife. Shrubby plants are shrubs that produce buds, twigs, bark, or foliage used as food by wildlife, or that provide cover and shade for some wildlife species. Examples are snowberry, honeysuckle, and Russian-olive.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish cover or food for wildlife in the form of browse, seeds, or fruitlike cones. Commonly established through natural processes, they may be planted or transplanted. Examples are pine, spruce, fir, cedar, and juniper.

Wetland food and cover are annual and perennial wild herbaceous plants of moist to wet sites, exclusive of submerged or floating aquatics, that produce food or cover used extensively by wetland wildlife. Examples are smartweed, wild millet, rushes, sedges, reeds, cordgrass, and cattail.

Shallow water areas are areas of surface water that have an average depth of less than 5 feet and that are useful to wildlife. They may be natural wet areas or those created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, wildlife ponds, and beaver ponds.

Kinds of wildlife habitat

Soils are rated in table 4 according to their potential for producing various kinds of wildlife habitat.

Openland wildlife are birds and mammals of croplands, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Examples are bobwhite quail, pheasant, meadowlark, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland wildlife are birds and mammals of wooded areas containing either hardwood or coniferous trees and shrubs, or a mixture of both. Examples are wild turkey, ruffed grouse, thrush, vireos, woodpecker, squirrel, gray fox, raccoon, and white-tailed deer.

Wetland wildlife are birds and mammals of swampy, marshy, or open water areas. Examples are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland wildlife are birds and mammals of natural rangelands. Examples are antelope, white-tailed deer, mule deer, lark bunting, meadowlark, and prairie dog.

Soil associations are rated for both rangeland and woodland wildlife habitat potential. Many kinds of wildlife frequent both types of habitat in Frontier County.

Kinds of wildlife by soil associations

The Holdrege-Hall association provides habitat for openland wildlife. Most of the acreage is cultivated. Wheat and sorghum are fallowed. These crops, along with alfalfa, provide diversity for ring-necked pheasant and bobwhite quail. Irrigation systems are common and provide water for many fields of corn. Thus the wildlife is assured of water, cover, and food.

The Uly-Coly-Holdrege association is also an openland wildlife association. Scattered trees are on many side slopes. Slopes are generally long and smooth. A good drainage pattern that has herbaceous cover in the draws offers diversity and good permanent winter cover for wildlife. Farmstead windbreaks in this association provide winter cover for many kinds of wildlife, including bobwhite quail, pheasant, and cottontail.

The Coly-Uly-Rough broken land, loess association is an openland range association. Areas of this association have deeply entrenched intermittent drainageways that contain herbaceous and woody cover, mainly buckbrush, native rose, and plum. Some areas have a few oak, elm, and hackberry trees. Redcedar, buckbrush, and plum are in the bottoms of some drainageways. These areas provide both cover and food for wildlife. Most of this association is grassland. Some of the broader divides are cultivated, and these areas add diversity for wildlife. Many species of wildlife inhabit this association. Muledeer, coyote, fox, badger, and raccoon are common. There are also a few white-tailed deer (fig. 14). Some of the smoother slopes are mowed for hay. The steeper slopes are used almost entirely as range. This association offers a wide variety of topography, and the combination of food, cover, and water provide good habitat for many kinds of wildlife. Excellent hunting of both big game and small game is available. Fishing is good in both Red Willow and Harry Strunk Reservoirs. Many small streams and farm ponds offer excellent fishing and other recreational opportunities.

The Sarben-Vetal-Jayem association makes up a very small percent of the county. It has similar habitat and potential for wildlife expansion as the Holdrege-Hall association, with which it is closely associated. The soils in this association are mainly sandy and are generally cultivated. Fields provide food and cover for many species of wildlife.

Resources for recreation

Hunting pheasant, quail, and deer as well as fishing in the manmade reservoirs provide the main recreational activities of Frontier County. Two State recreation areas provide good fishing, boating, hunting, and camping opportunities. The Harry D. Strunk Reservoir covers 1,768 acres, and the Hugh Butler Lake, or Red Willow Reservoir, covers 1,628 acres. These two lakes fulfill recreational demand from surrounding counties and States, as well as from local residents.

Farm ponds provide additional potential for good fishing. Largemouth bass, bluegill, and catfish are the primary species.

The flowing streams of Frontier County are only fair for fishing. Habitat is limited for most species of game fish. High populations of rough fish and high turbidity are accompanied by low natural stream flow which limits good stream habitat and natural production. Additional good watershed management would benefit stream environment for fish.

Developing good habitat for wildlife requires the proper location and distribution of vegetation. Technical assistance in planning wildlife developments and determining species of vegetation can be obtained at the local office of the Soil Conservation Service.

Additional information and assistance can be ob-

TABLE 4.—*Wildlife habitat*

Soil association	Potential for elements of wildlife habitat—							Potential habitat for—			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs	Coniferous trees	Wetland food and cover	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Range wildlife
Holdrege-Hall:											
Holdrege	Good to fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor	Good.
Hall	Good to fair	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor	Good.
Uly-Coly-Holdrege:											
Uly	Fair	Good	Good	Poor	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Coly, 5 to 11 percent slope.	Fair	Good	Good	Poor	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Coly, 11 to 30 percent slope.	Poor	Fair	Fair	Poor	Fair	Very poor	Very poor	Fair	Poor	Very poor	Fair.
Holdrege	Good to fair	Good	Good	Fair	Fair	Very poor	Very poor	Good	Fair	Very poor	Good.
Coly-Uly-Rough broken land, loess:											
Coly, 5 to 11 percent slope.	Fair	Good	Fair	Poor	Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Coly, 11 to 30 percent slope.	Poor	Fair	Fair	Poor	Fair	Very poor	Very poor	Fair	Poor	Very poor	Fair.
Uly	Fair to poor	Good	Good	Good	Fair	Very poor	Very poor	Fair	Poor	Very poor	Good.
Rough broken land, loess.	Very poor	Fair	Fair	Fair	Fair	Very poor	Very poor	Poor	Fair	Very poor	Fair.
McCook-Hord-Hobbs:											
McCook	Good	Good	Good	Fair	Fair	Very poor	Very poor	Good	Fair	Very poor	Good.
Hord	Good	Good	Good	Good	Good	Very poor	Very poor	Good	Good	Very poor	Good.
Hobbs	Good	Good	Fair	Fair	Good	Poor	Poor	Good	Fair	Poor	Fair.
Sarben-Vetal-Jayem:											
Sarben	Fair	Good	Good	Poor	Fair	Very poor	Very poor	Fair	Poor	Very poor	Good.
Vetal	Fair	Good	Good	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor	Good.
Jayem	Fair	Good	Good	Fair	Good	Very poor	Very poor	Fair	Good	Very poor	Good.

Figure 14.—**Areas in the Coly-Uly-Rough broken land, loess association make excellent habitat for deer and other kinds of openland wildlife.**

tained from Nebraska Game and Parks Commission, the Fish and Wildlife Service, and the Federal Extension Service.

The Soil Conservation Service also provides technical assistance in planning conservation practices for developing outdoor recreation facilities.

Engineering[6]

This section is useful to those who need information about soils used as structural material or as foundations 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 properties of soils highly important in engineering are permeability, strength, compaction characteristics, drainage, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

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

1. Select potential residential, industrial, commercial, and recreational 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 5, 6, and 7, which show, respectively, several estimated soil properties significant in engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in tables 5 and 6. It can also be used to make other useful maps.

This information, however, is not intended for use

[6] WAYNE W. LIESEMEYER, engineer, Soil Conservation Service, helped prepare this section.

TABLE 5.—*Estimates of soil*

[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. carefully the instructions for referring to other series in the first column

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Feet	*Inches*			
Broken alluvial land: Ba Most properties too variable to be rated.	>10				
*Coly: CoD2, CoF2, CuF For Uly part of CuF, see Uly series.	>10	0–4 4–60	Silt loam Silt loam	ML ML or CL	A–4 A–4
Fillmore: Fm	>10	0–16 16–32 32–60	Silt loam and silty clay loam. Silty clay Silty loam and silty clay loam.	ML or CL CH ML or CL	A–4 or A–6 A–7 A–4 or A–6
Hall: Ha, HaB, HaC	>10	0–16 16–30 30–60	Silt loam Silty clay loam Silt loam	ML or CL CL or ML CL or CL-ML	A–4 A–6 or A–4 A–4 or A–6
Hobbs: Hb	>10	0–6 6–60	Silt loam Silt loam	ML ML or CL	A–4 A–4 or A–6
Holdrege: Ho, HoB, HoB2, HoC, HoC2	>10	0–11 11–18 18–60	Silt loam Heavy silt loam and light silty clay loam. Silt loam	ML or CL CL ML	A–4 or A–6 A–6 A–4
Hord: HpC, Hr, HrB	>10	0–13 13–27 27–60	Silt loam Silt loam Silt loam	ML or CL ML or CL ML or CL	A–4 A–4 A–4
Jayem: JmB	>10	0–6 6–18 18–60	Loamy very fine sand Very fine sandy loam Loamy very fine sand	SM or ML ML SM or ML	A–4 A–4 A–4
McCook: Mc, McB, Md	>10	0–11 11–60	Silt loam Very fine sandy loam and silt loam.	ML or CL ML	A–4 A–4
Me	2–3	0–10 10–31 31–60	Silt loam Silt loam Very fine sandy loam	ML or CL ML or CL ML or CL	A–4 A–4 A–4
Rough broken land, caliche: RaG Too variable to be rated.	>10				
Rough broken land, loess: RbG	>10	0–60	Silt loam	ML	A–4
Rough broken land, sandy: RcG Most properties too variable to be rated.	>10				
Sarben: SaD	>10	0–6 6–23 23–60	Loamy very fine sand Loamy very fine sand Very fine sand	SM or ML SM or ML SM	A–4 A–4 A–4 or A–2
*Uly: UaC2, UaD, UcD2, UcF For Coly part of UcD2 and UcF, see Coly series.	>10	0–10 10–16 16–60	Silt loam Silt loam Silt loam	CL or ML CL CL or CL-ML	A–4 or A–6 A–6 or A–4 A–4 or A–6
Vetal: VeB	>10	0–6 6–36 36–60	Loamy very fine sand Very fine sandy loam Loamy very fine sand	SM or ML ML SM or ML	A–4 A–4 A–4
Wet alluvial land: Wx Most properties too variable to be rated.	0–1				

[1] NP = Nonplastic.

properties significant in engineering

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

Percentage less than 3 inches passing sieve				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	----------	100	90–100	25–40	2–10	0.6–2.0	0.22–0.24	6.6–7.3	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.20–0.22	7.4–7.8	Low.
----------	----------	100	90–100	20–40	2–15	0.2–2.0	0.21–0.24	5.6–6.0	Low to moderate.
----------	----------	100	90–100	50–75	30–45	0.06	0.11–0.14	6.1–6.5	High.
----------	----------	100	90–100	25–40	2–15	0.2–2.0	0.18–0.22	6.1–6.5	Low to moderate.
----------	----------	100	90–100	25–35	5–10	0.6–2.0	0.22–0.24	6.1–6.5	Low.
----------	----------	100	90–100	30–40	8–18	0.6–2.0	0.22–0.24	6.6–7.3	Moderate.
----------	----------	100	90–100	25–35	5–18	0.6–2.0	0.20–0.22	7.4–7.8	Low to moderate.
----------	----------	100	95–100	25–40	2–10	0.6–2.0	0.22–0.24	6.6–7.3	Low.
----------	----------	100	95–100	25–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Moderate.
----------	----------	100	90–100	25–40	5–15	0.6–2.0	0.22–0.24	6.1–6.5	Moderate.
----------	----------	100	90–100	30–40	11–20	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
----------	----------	100	90–100	25–40	2–10	0.6–2.0	0.20–0.22	6.6–7.8	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.22–0.24	6.1–6.5	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.22–0.24	6.6–7.3	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.20–0.22	6.6–7.8	Low.
----------	100	97–100	40–60	----------	[1] NP	2.0–6.0	0.15–0.17	6.1–6.5	Low.
----------	100	97–100	50–65	----------	NP	2.0–6.0	0.17–0.19	6.1–6.5	Low.
----------	100	97–100	40–60	----------	NP	2.0–6.0	0.12–0.14	6.6–7.3	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.22–0.24	6.6–7.3	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.17–0.22	6.6–7.8	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.22–0.24	7.4–7.8	Low.
----------	----------	100	90–100	25–35	2–10	0.6–2.0	0.20–0.22	7.4–7.8	Low.
----------	----------	100	70–97	20–30	2–10	0.6–2.0	0.17–0.19	7.4–7.8	Low.
----------	----------	100	90–100	25–32	2–10	0.6–2.0	0.20–0.22	7.4–7.8	Low.
----------	100	97–100	40–60	----------	NP	2.0–6.0	0.15–0.17	6.1–6.5	Low.
----------	100	97–100	40–60	----------	NP	2.0–6.0	0.13–0.15	6.1–6.5	Low.
----------	100	97–100	30–50	----------	NP	6.0–20.0	0.05–0.07	6.1–6.5	Low.
----------	----------	100	90–100	25–35	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low or moderate.
----------	----------	100	95–100	30–40	10–20	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
----------	----------	100	95–100	25–35	7–15	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
----------	100	97–100	40–60	----------	NP	2.0–6.0	0.15–0.17	6.1–6.5	Low.
----------	100	97–100	50–65	----------	NP	2.0–6.0	0.17–0.19	6.1–6.5	Low.
----------	100	97–100	40–60	----------	NP	2.0–6.0	0.12–0.14	6.1–6.5	Low.

TABLE 6.—*Engineering interpretations: Part I*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Sanitary landfill [1]	Local roads and streets
Broken alluvial land: Ba. Too variable to be rated; severe limitations for most uses; frequently flooded.						
Coly: CoD2, CoF2, CuF — For Uly part of CuF, see Uly series.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Moderate if slope is less than 7 percent, severe if more than 7 percent; moderately permeable.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Moderate if slope is less than 15 percent, severe if more than 15 percent; fair to poor bearing capacity.	Area type: Slight if slope is 5 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent. Trench type: Slight if slope is 5 to 15 percent, moderate if 15 to 25 percent, severe if more than 25 percent. Cover material: Slight if slope is 5 to 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent.	Severe: susceptible to frost action; highly erodible; slope is more than 15 percent.
Fillmore: Fm	Severe: very slowly permeable; occasionally ponded.	Slight if excavation is less than 3 feet; high seepage potential below 3 feet.	Severe: poorly drained.	Severe: occasionally ponded; high shrink-swell potential.	Area and trench: Severe: poorly drained; occasionally ponded. Cover material: Poor: clayey subsoil; poorly drained.	Severe: susceptible to frost action; high shrink-swell potential; poorly drained.
Hall: Ha, HaB, HaC	Slight if filter field is below 36 inches; slower permeability above 36 inches.	Moderate: moderately permeable.	Slight	Moderate: possible frost action; moderate shrink-swell potential.	Area and trench: Slight. Cover material: Good.	Moderate: susceptible to frost action; moderate shrink-swell potential.
Hobbs: Hb	Severe: occasional flooding.	Severe: moderately permeable; occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.	Area and trench: Severe: occasional flooding. Cover material: Fair: occasional flooding.	Moderate: subject to frost action.
Holdrege: Ho, HoB, HoB2, HoC, HoC2.	Slight if filter field is below 30 inches; slower permeability above 30 inches.	Moderate: moderately permeable.	Slight	Moderate: potential settlement when wet; moderate shrink-swell potential.	Area and trench: Slight. Cover material: Good.	Moderate: subject to frost action; moderate shrink-swell potential.

Hord: HpC, Hr, HrB	Slight	Moderate: moderately permeable.	Slight	Slight	Area and trench: Slight. Cover material: Good.	Moderate: subject to frost action.
Jayem: JmB	Slight	Severe: moderately rapidly permeable.	Slight: vertical cuts subject to caving.	Slight: vertical cuts subject to caving.	Area and trench: Severe: moderately rapidly permeable. Cover material: Fair: sandy texture.	Moderate: subject to frost action; slopes erodible.
McCook:						
Mc, McB, Md	Moderate: Mc and McB rarely flooded. Severe for Md; occasionally flooded.	Severe: flooding	Moderate: Mc and McB rarely flooded. Severe for Md; occasionally flooded.	Severe: flooding; subject to frost action.	Area type: Severe for Md: occasionally flooded. Moderate for Mc and McB: rarely flooded. Trench type: Severe for Md: occasionally flooded. Moderate for Mc and McB: rarely flooded. Cover material: Good to fair: subject to flooding.	Moderate: subject to frost action; rarely flooded. Severe for unit Md: occasionally flooded.
Me	Severe: seasonal high water table at 2 to 3 feet in spring; possible contamination to ground water.	Severe: seasonal high water table at 2 to 3 feet in spring; possible contamination to ground water.	Severe: seasonal high water table at 2 to 3 feet in spring; possible danger of caving.	Severe: seasonal high water table at 2 to 3 feet in spring; basements not feasible.	Area and trench: Severe: seasonal high water table at 2 to 3 feet. Cover material: Poor: high water table.	Moderate: subject to frost action; seasonal high water table at 2 or 3 feet in spring.
Rough broken land:						
RaG. Severe limitations for most uses; shallow soil material over bedrock; very steep.						
RbG	Severe: very steep.	Severe: very steep.	Severe: very steep.	Severe: very steep.	Area and trench: Severe: very steep. Cover material: Poor: very steep.	Severe: very steep; susceptible to frost action.
RcG	Severe: very steep.	Severe: very steep; rapid permeability.	Severe: very steep; vertical cuts subject to caving.	Severe: very steep.	Area and trench: Severe: moderately rapidly to rapidly permeable; very steep. Cover material: Good.	Severe: very steep; highly erodible.

TABLE 6.—*Engineering interpretations: Part I*—Continued

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with or without basements	Sanitary landfill [1]	Local roads and streets
Sarben: SaD	Slight	Severe where slope exceeds 7 percent; moderately rapidly permeable.	Slight: vertical cuts subject to caving.	Slight: vertical cuts subject to caving.	Area and trench: Severe: moderately rapidly permeable. Cover material: Fair: sandy.	Moderate: subject to frost action; erodible; low strength.
Uly: UaC2, UaD, UcD2, UcF. For Coly part of UcD2 and UcF, see Coly series.	Slight if slope is less than 8 percent, moderate if 8 to 15 percent.	Moderate: UaC2 moderately permeable and gently sloping. Severe: UaD, UcD2, and UcF strongly sloping to steep.	Slight	Moderate if slope is 3 to 15 percent; moderate shrink-swell potential; low strength. Severe if slope is more than 15 percent.	Trench type: Slight if slope is less than 15 percent, moderate if more than 15 percent. Area type: Slight if slope is less than 8 percent, moderate if 8 to 15 percent, severe if more than 15 percent. Cover material: Good if slope is less than 8 percent, fair if more than 8 percent.	Moderate: subject to frost action; erodible.
Vetal: VeB	Slight	Severe: moderately rapidly permeable.	Slight: vertical cuts subject to caving.	Slight: vertical cuts subject to caving.	Area and trench: Severe: seepage; moderately rapidly permeable. Cover material: Fair: sandy.	Moderate: subject to frost action.
Wet alluvial land: Wx. Severe limitations for most uses; high water table.						

[1] Onsite study is needed of the deep underlying strata, the water table, and the hazards of aquifer pollution and drainage in landfill deeper than 5 or 6 feet.

in design, and does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to a depth greater than those shown in the tables, generally a depth greater than 6 feet. Also, inspection of sites, especially the 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.

Some of the terms used in this soil survey have special meaning in soil science that may not be familiar to engineers. Many terms commonly used in soil science are defined in the "Glossary."

Engineering classification

The two systems most commonly used in classifying soil samples for engineering are the Unified system (*2*) used by the SCS engineers, Department of Defense, and others, and the AASHTO system (*1*) adopted by the American Association of State Highway and Transportation Officials.

The Unified system is used to classify soils according to engineering uses for building material. Soils are classified according to particle size, distribution, liquid limit, plastic index, and organic-matter content. Soils are divided into coarse-grained or fine-grained groups. The coarse-grained group is further divided into sands or gravels according to grain size distribution. Sands are divided on the basis of gradation or classification of the fines they contain into four principal classes, identified by the symbols SW, SP, SM, and SC. Gravels are also divided by gradation or classification of the fines they contain into four principal classes, identified by the symbols GW, GP, GM, and GC. Coarse grained soil that is 5 to 12 percent fines is considered borderline and has dual symbols, such as GW–GM or SW–SC. The fine grained group is divided into six principal classes on the basis of liquid limit, plastic index, and organic-matter content. Nonplastic classes are ML, MH, OL, and OH. Plastic classes are CL and CH. One transition class is identified by the dual symbol CL–ML. The one class of highly organic soils is identified by the symbol Pt.

The AASHTO system is used to classify soils according to those properties that affect their use in highway construction and maintenance. In this system, a soil is classified 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, which have high bearing strength and are the best soils for subgrade, or foundations. At the other extreme, in group A–7, are clay soils that have low strength when wet and are the poorest soils for subgrade. If laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are further subdivided as A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the 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 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 7. The estimated classification, without group index numbers for all soils mapped in the survey area is given in table 5.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made by layers of representative soil profiles having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 5.

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

Soil texture is described in table 5 in the standard terms used by the Department of Agriculture. These terms are based on the percentages of sand, silt, and clay in the less than 2 millimeter fraction of the soil. "Loam," for example, is soil material that is 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 USDA textural classification are defined in the "Glossary" of this survey.

Liquid limit and plasticity index are water contents obtained by specified operations. As the water content of a clayey soil, from which the particles coarser than 0.42 millimeter have been removed, is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic, and the liquid limit, from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5. In table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability, as used here, estimates the rate at which saturated soil transmits water in a vertical direction. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or transient soil features, such as plowpans and surface crusts, are not considered.

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

Reaction is the acidity or alkalinity of a soil, expressed in pH values, for a stated soil solution mixture. The pH value and terms used to describe soil reaction are defined in the "Glossary."

Shrink-swell potential refers to the relative change in volume to be expected of soil material as moisture content changes, that is, the extent to which the soil shrinks when dry or swells when wet. The extent of shrinking and swelling is determined by the amount

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—		
	Road fill	Sand	Topsoil
Broken alluvial land: Ba	Poor: frequently flooded; material silty in most places; not readily accessible.	Unsuited: generally not available; frequently flooded.	Poor: frequently flooded; not readily accessible.
Coly: CoD2, CoF2, CuF For Uly part of CuF, see Uly series.	Fair: susceptible to frost action; compaction control needed; steep; erodible by water on unprotected slopes.	Unsuited: no sand	Poor: thin surface layer; steep slopes highly erodible.
Fillmore: Fm	Fair: susceptible to frost action; high shrink-swell potential.	Unsuited: no sand	Poor: poorly drained; limited depth; clayey below 7 inches.
Hall: Ha, HaB, HaC	Fair: moderate shrink-swell potential; susceptible to frost action.	Unsuited: no sand	Good: very friable; moderately thick surface layer.
Hobbs: Hb	Fair: subject to frost action; fair compaction characteristics.	Unsuited: no sand	Good: very friable; thick surface layer.
Holdrege: Ho, HoB, HoB2, HoC, HoC2	Fair: moderate shrink-swell; good compaction characteristics; subject to frost action.	Unsuited: no sand	Fair: moderately thick surface layer; very friable.
Hord: HpC, Hr, HrB	Fair: subject to frost action.	Unsuited: no sand	Good: very friable; thick surface layer.
Jayem: JmB	Fair: subject to frost action; confinement needed.	Poor: poor graduation; too many fines.	Fair: loamy very fine sand surface layer; subject to blowing.
McCook: Mc, McB, Md	Fair: subject to frost action and flooding; low strength.	Unsuited: no sand	Good: very friable; moderately thick surface layer.
Me	Fair: subject to frost action; water table limits depth of cuts.	Unsuited: no sand	Fair: moderately thick surface layer; seasonal high water table at 2 or 3 feet in spring.
Rough broken land: RaG	Poor: shallow; limited amount of soil.	Poor: pockets of sand in places.	Poor: shallow; thin surface layer.
RbG	Poor: very steep; subject to frost action.	Unsuited: no sand available.	Poor: thin surface layer; very steep slopes erodible.

interpretations: Part II

Soil features affecting—				
Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Frequently flooded; areas long and narrow.	Areas not readily accessible for borrow material; frequently flooded.	Frequently flooded; channel sides very steep.	(1)	(1,2)
Moderate permeability; difficult to seal because of low clay content.	Collapse potential when wet and under load.	Well drained to somewhat excessively drained.[1]	Suited only if slope is less than 9 percent; moderate permeability; erodible by wind and water.	Steep and irregular slopes; diversion outlets high; erodible; siltation increases maintenance cost.
Low seepage unless excavation is below 3 feet; slopes unfavorable for large storage potential.	Medium to low shear strength; medium to high compressibility; subject to settlement.	Poorly drained; subject to occasional ponding; poor internal drainage in places; no adequate outlet available.	Very slow permeability; moderate available water capacity; occasionally ponded unless drained.	(1,2)
Moderate seepage; low natural storage potential because of nearly level to gentle slopes.	Low permeability when compacted.	Well drained[1] ----------	High available water capacity; moderate intake rate; moderate permeability.	Moderate permeability; not needed on unit Ha.
Moderate permeability; dugouts may require sealing.	Medium to low permeability for compacted soil; fair compaction characteristics.	Well drained; occasionally flooded; moderate permeability.	High available water capacity; moderate intake rate; moderate permeability; occasional flooding.	(1,2)
Moderately permeable; limited storage potential in Ho.	Good compaction characteristics; low permeability when compacted.	Well drained[1] ----------	High available water capacity; moderate intake rate; erodible slopes.	Features generally favorable. No terraces needed on Ho; moderately permeable.
Moderately permeable; limited storage potential in Hr.	Good compaction characteristics; low permeability when compacted.	Well drained[1] ----------	High available water capacity; moderate intake rate; erodible slopes.	Features generally favorable; moderately permeable; no terraces needed on Hr.
Moderately rapidly permeable.	Low permeability for compacted soil; subject to blowing; easily eroded.	Well drained[1] ----------	Moderate available water capacity; irregular surface topography.	Embankment slopes erodible; gently undulating; moderately rapidly permeable.
Moderately permeable	Low permeability for compacted soil.	Well drained. Md occasionally flooded; slow runoff; moderately permeable.	High available water capacity; moderate intake rate. Md occasionally flooded.	Features generally favorable on McB. No terraces needed on Mc and Md.
Moderately high water table.	Limited borrow -------	Somewhat poorly drained; seasonal high water table at 2 to 3 feet in spring; outlet available in most places; moderately permeable.	Seasonal high water table at 2 to 3 feet.	(1,2)
Shallow over rock; difficult to excavate; possible seepage; steep.	Shallow over rock; difficult to excavate.	Excessively drained[1] --	(1)	(1)
Moderately permeable; very steep.	Good fill with compaction control; borrow areas difficult to revegetate.	Excessively drained[1] --	(1)	(1)

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—		
	Road fill	Sand	Topsoil
RcG	Poor: very steep; subject to soil blowing unless vegetated; confinement needed.	Poor: poor gradation	Poor: loamy very fine sand surface layer highly erodible; very steep slopes.
Sarben: SaD	Fair: subject to frost action; highly erodible by wind; low strength; confinement needed.	Poor: poor gradation	Poor: thin surface layer; loamy very fine sand highly erodible by wind and water.
Uly: UaC2, UaD, UcD2, UcF For Coly part of UcD2 and UcF, see Coly series.	Fair: susceptible to frost action; low strength; slopes; compaction control needed.	Unsuited: no sand	Fair: thin surface layer; subsoil highly erodible; gently sloping to moderately steep.
Vetal: VeB	Fair: subject to frost action; confinement needed.	Poor: poor gradation	Fair: subject to wind and water erosion on slopes; sandy texture.
Wet alluvial land: Wx Severe limitations for most uses. High water table.	Poor: high water table	Unsuited: no sand available.	Poor: high water table

[1] Not needed or not suited because of slope, soil characteristics, or physiographic position.

and kind of clay in the soil. Shrinking and swelling of the soils may damage building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are the most hazardous.

Shrink-swell is not indicated for organic soils or for certain soils that shrink markedly when they dry out but do not swell quickly when rewetted.

Engineering interpretations

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Frontier County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 6 lists those soils features that need to be considered in planning, installation, and maintenance.

Soil limitations are expressed as slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and are easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* indicates soil properties so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Soil suitability is expressed as good, fair, and poor, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the soil material. 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 the water table or bedrock, and susceptibility to flooding. Slope affects difficulty of layout and construction and the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons (aerobic type) are shallow ponds constructed to hold sewage within a depth of 2 to 6 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. It is assumed that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Properties that affect the pond floor are permeability, organic matter, and slope. If the pond floor needs levelling, depth to bedrock is an important property. Properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the number, or content, of stones, if any, that influence

interpretations: Part II—Continued

Soil features affecting—				
Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Moderately rapidly to rapidly permeable; subject to seepage; very steep.	Easily compacted; subject to soil blowing and water erosion.	Excessively drained [1]	(1)	(1)
Moderately rapidly permeable; subject to seepage.	Medium to low permeability for compacted soil; good compaction characteristics; subject to soil blowing and water erosion.	Well drained [1]	Low available water capacity.	Subject to blowing; irregular slopes.
Moderate seepage	Subject to potential settlement and cracking.	Well drained [1]	Erodible by water; high available water capacity. UcF not suitable; too steep.	Highly erodible; siltation increases maintenance cost.
Moderately rapidly permeable.	Fair compaction characteristics; subject to erosion by wind and water.	Well drained [1]	Moderate available water capacity; moderately rapid intake rate.	Subject to wind and water erosion.
Possible dugouts; high water table.	Wetness; high water table.	Very poorly drained; no suitable outlet.	(1)	(1)

[2] Diversions constructed on adjacent, higher soils are beneficial in some areas.

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. Examples are excavations for pipelines, sewer lines, telephone and power transmission lines, basements, and open ditches. Desirable soil properties are good workability, absence of rock outcrops or large stones, and no flooding or high water table.

Dwellings, as rated in table 6, are no more than three stories high and are supported by footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. 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.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted in layers, and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal high water table, are free of large stones and boulders, and are not subject to flooding. If the seasonal water table is high, water seeps into the trenches and limits excavating and filling. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are generally sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 6 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

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

Soil properties that affect design and construction of roads and streets are the load supporting capacity, the stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil mate-

TABLE 7.—*Engineering*

[Tests performed by the Nebraska Department of Roads in accordance with standard procedures

Soil name and location	Parent material	Report No. S70	Depth	Specific gravity	Mechanical analysis [1]	
					Percentage passing sieve—	
					No. 60 (0.25 mm)	No. 200 (0.074 mm)
			Inches			
Coly silt loam: 0.05 mi. S. and 0.05 mi. W. of NE. corner of sec. 34, T. 7 N., R. 26 W. (Modal)	Peoria loess.	1771 1772	0–4 10–60	2.60 2.67	100 100	96 97
Hall silt loam: 200 feet W. and 30 feet S. of NE corner of sec. 11, T. 8 N., R. 27 W. (Modal)	Peoria loess.	1773 1774 1775	0–8 8–16 44–54	2.65 2.66 2.67	100 100 100	94 96 93
Hobbs silt loam: 0.25 mi. W. and 100 feet S. of NE. corner of sec. 2, T. 8 N., R. 26 W. (Modal)	Silty alluvium.	1776 1777	0–6 10–16	2.63 2.65	100 100	98 98
Holdrege silt loam: 0.35 mi. S. and 150 feet E. of NW. corner of sec. 19, T. 7 N., R. 25 W. (Modal)	Peoria loess.	1778 1779 1780	0–11 14–18 28–48	2.60 2.65 2.69	100 100 100	95 94 92
Hord silt loam: 0.4 mi. W. and 0.1 mi. S. of NE. corner of sec. 31, T. 6 N., R. 25 W. (Modal)	Old alluvium.	1781 1782 1783	6–13 21–27 31–60	2.64 2.68 2.67	100 100 100	93 94 92
McCook silt loam: 0.3 mi N. and 0.2 mi. W. of SE. corner of sec. 31, T. 5 N., R. 29 W. (Modal)	Silty alluvium-colluvium.	1768 1769 1770	0–6 10–16 16–60	2.52 2.66 2.67	100 100 100	93 94 94
Uly silt loam: 50 feet S. and 50 feet E. of the NW. corner, sec. 27, T. 6 N., R. 26 W. (Modal)	Peoria loess.	1784 1785 1786	0–7 10–16 26–60	2.64 2.70 2.73	100 100 100	89 92 92

[1] Mechanical analysis according to the American Association of State Highway and Transportation Officials Designation T survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser are not suitable for use in naming textural classes for soil.

[2] Based on AASHTO Designation 145–49.

[3] Based on ASTM Stand. D 2487–69 (*2*).

rial and the shrink-swell potential indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill needed to reach an even grade.

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

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide information 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 the water table, or other factors that affect mining of the materials, nor do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; the 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 results at the site where topsoil is taken.

Pond reservoirs hold water behind a dam or embankment. Soils suitable as pond reservoir areas have

test data

of the American Association of State Highway and Transportation Officials (AASHTO)]

Mechanical analysis [1]—Continued				Liquid limit	Plasticity index	Classification	
Percentage smaller than—							
0.05 mm	0.02 mm	0.005 mm	0.002 mm.			AASHTO [2]	Unified [3]
				Percent			
86	33	18	15	36	9	A-4(8)	ML
91	36	18	11	32	6	A-4(8)	ML
46	34	19	17	29	5	A-4(8)	ML
90	46	28	16	28	5	A-4(8)	ML
68	42	19	15	26	4	A-4(8)	ML
93	44	25	19	34	9	A-4(8)	ML
84	56	32	23	39	15	A-6(8)	CL
82	40	22	16	36	11	A-6(8)	ML
84	43	27	22	36	16	A-6(10)	CL
80	34	18	16	29	2	A-4(8)	ML
86	32	19	16	29	5	A-4(8)	ML
84	28	16	14	29	4	A-4(8)	ML
80	24	15	13	26	3	A-4(8)	ML
84	33	20	17	28	5	A-4(8)	ML
86	34	20	16	28	5	A-4(8)	ML
87	30	17	15	26	4	A-4(8)	ML
76	35	25	20	32	9	A-4(8)	CL
82	46	31	26	40	19	A-6(12)	CL
81	42	27	24	32	12	A-6(9)	CL

88–47 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil hydrometer method and the various grain-size fractions are calculated on the basis of all the material including that coarser than 2 than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table

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 that is resistant to seepage and piping and with favorable stability, shrink-swell potential, shear strength, and compactibility. Stones and organic material are unfavorable characteristics.

Drainage of crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence the rate of water movement; depth to the water table; slope and stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope; susceptibility to stream overflow, water erosion or soil blowing; soil texture; content of stones; accumulation of salts and alkali; depth of the root zone; intake rate at the surface; permeability below the surface layer or other layers that restrict movement of water; available water capacity; and need for drainage or depth to the water table or bedrock.[7]

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; stones; permeability; and resistance to water erosion, soil slipping,

[7] Further information on soil use for irrigation is contained in "Irrigation Guide for Nebraska," Soil Conservation Service, 1971.

and soil blowing. A soil suited to these structures provides outlets for runoff and is not difficult to vegetate.

Soil test data

Table 7 contains engineering test data for some of the major soil series in Frontier County. These tests were made to 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.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as explained for table 5.

Specific gravity is the ratio of the unit weight of the soil solids to the unit weight of water. It is a measure of, and a means of expressing, the heaviness of the soil. The specific gravity of the solid particles of a soil, exclusive of the void spaces, is also called the "true" or "real" specific gravity. This property has an important influence on the density of the soil.

Formation and Classification of Soils

This part of the survey describes the factors of soil formation and explains how they have affected the soils of Frontier County. It also explains the current system of soil classification and classifies each soil series according to 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 time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, mainly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that 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. It may be much or little time, but some time is always required 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

The soils in Frontier County formed in several kinds of parent material, such as loess, eolian sand, colluvium, and alluvium. There are also outcrops of rocks from the Ogallala Formation, but no soils formed in material weathered from bedrock were recognized in this survey.

Loess, or wind deposited silt, is the parent material of soils throughout all but a small area along the western edge of the county and the stream valleys. Most of this material, Peoria Loess, is a friable, massive, light gray silt loam. It is calcareous and contains a few lime concretions. In Frontier County it ranges from a few feet to more than a hundred feet in thickness. Holdrege, Uly, Coly, Fillmore, and the lower part of Hall soils formed in this material.

In the northern part of the county the upper part of Hall soils formed in Bignell Loess, which is more recently deposited than Peoria Loess. Bignell Loess is also light gray silt loam, but it contains more very fine sand than Peoria Loess. The loess of the Bignell Formation is only 2 or 3 feet thick over Peoria Loess (fig. 15). Material of the Loveland Formation, a reddish silty to clayey material assumed to be of loess origin, underlies the Peoria Loess. It occurs only as small outcrops on road cuts or along the base of canyon walls in the mapping unit of Coly and Uly silt loams, 9 to 30 percent slopes.

Eolian sand is wind deposited sandy material. It mantles only a small area along the western edge of Frontier County. This material is loose, very pale brown very fine sand. It ranges from only a few feet to several feet in thickness and is underlain by loess. Eolian sand occurs as hummocks or has an undulating topography. Soils formed in this material are moderately low or low in organic-matter content and natural fertility. Jayem, Sarben, and Vetal soils formed in eolian sand.

Colluvium is soil material that accumulates as a result of the combined forces of gravity and water. This material is on foot slopes at the base of loess hills that border the larger drainageways. It is light gray or light brownish gray silt loam. The gently sloping Hord soils and the very gently sloping McCook soils formed in colluvium.

Alluvium is a heterogeneous mixture of silt, sand, and clay deposited by water. It is on flood plains and at the bottoms of canyons. McCook and Hobbs soils formed in alluvium. Hord soils on stream terraces formed in alluvial sediments that had their origin in loess.

Climate

Climate influences formation of soils both directly and indirectly. It affects the weathering and reworking of parent material through rainfall, temperature, and wind. It affects the soils indirectly through the amount and kind of vegetation and animal life sustained.

In Frontier County, the average annual precipitation is about 21 inches. There has been sufficient moisture movement through the soil to leach free lime from the surface layer to the subsoil and in some soils to the upper part of the underlying material. In a few soils, moisture has moved clay particles from the surface

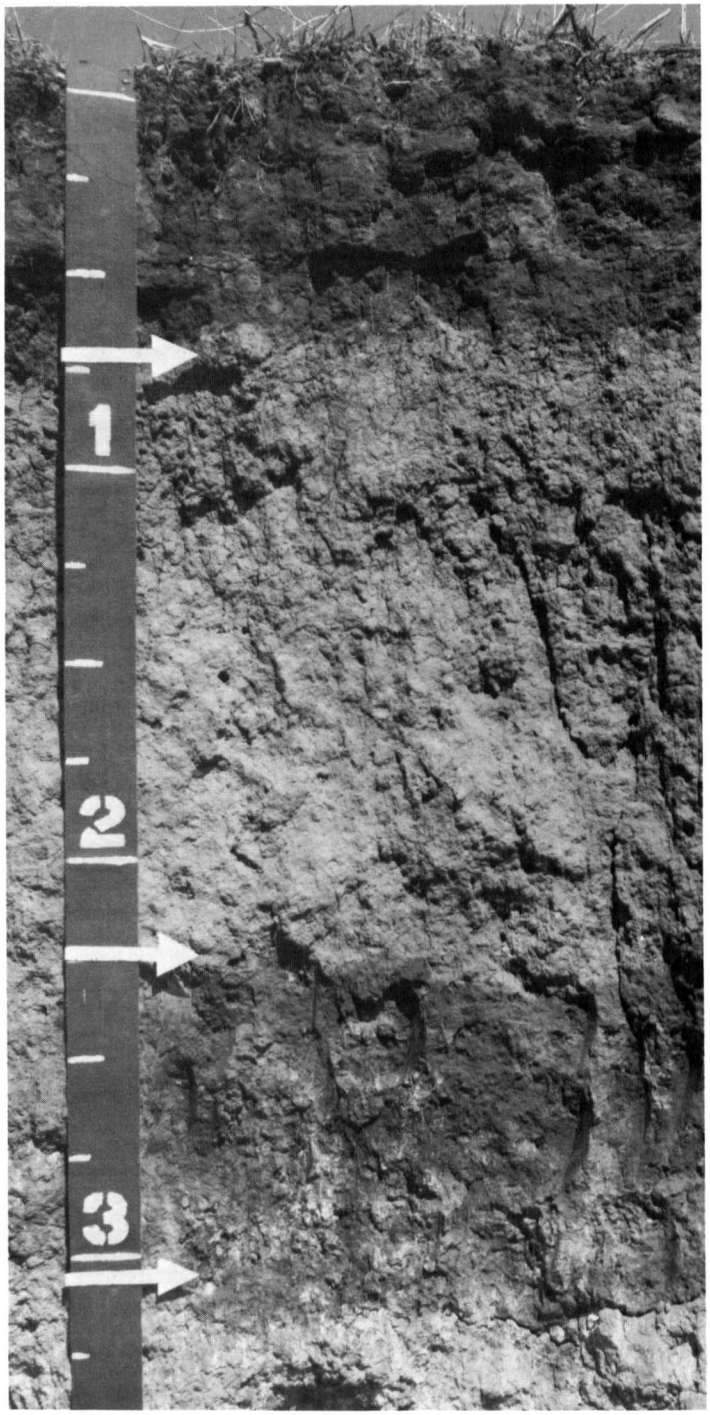

Figure 15.—**Buried soil formed in Peoria Loess is capped by about 27 inches of Bignell Loess. These buried soils are common in the northern part of Frontier County.**

layer downward into the subsoil. This is especially evident in depressions where ponding has increased the water movement into and through the soil, and soil development has formed a claypan type of subsoil. Where slopes are steep, erosion has influenced the thickness of the surface layer. On low-lying bottom land, excessive runoff of rainfall or snowmelt results in flooding and deposition of sediment, which influences the soil characteristics.

Temperature changes influence soil formation. Hot weather in summer and abundant soil moisture speeds chemical weathering. Alternate freezing and thawing and wetting and drying aid in the development of granular structure in the surface layer.

Northwest winds have influenced the distribution of both eolian sand and loess. In winter, snow accumulates on the southeast facing slopes, resulting in additional moisture. This in turn causes deeper leaching and an added amount of organic matter from the increase in vegetative growth. Wind also causes soil blowing, resulting in thinned surface layers. Movement of soil material by wind is most active on the sandier soils.

Plant and animal life

Plants and animals on and in the soil are active in the soil forming processes in Frontier County.

Prairie grasses provide the organic matter that has accumulated in the soils of Frontier County. This organic matter has darkened the color of the surface layer and parts of the subsoil. The largest amount of organic matter is generally near the surface, and generally declines gradually as depth increases. Holdrege soils, for example, have a fairly large amount of organic matter in the surface layer. They are dark grayish brown to a depth of 14 inches. Below this, the color grades from grayish brown to light gray as the amount of organic matter decreases.

In contrast with Holdrege soils, Fillmore soils formed in depressions. The additional moisture produces more tall grasses and consequently, more organic matter. As a result, soils in moist sites have organic enriched layers that are thicker and darker colored than those on uplands where moisture moves off the soil more rapidly.

Animals mix the darkened organic rich layers with the mineral rich material from below. Rodent burrows filled with soil material of a contrasting color are evidence of animal activity in the soil. Worms and burrowing insects also mix the soil material, improve granulation, and increase the availability of plant nutrients.

Micro-organisms are an important factor in soil development. They aid in the decomposition of organic matter into nutrients that can be used by plants. Some bacteria perform specific processes such as using nitrogen gas from the atmosphere or transforming ammonium nitrogen into nitrate nitrogen.

Man's activities are a major influence in soil formation. Through his management of soils for increased production and the introduction of drainage, irrigation, summer fallow, and soil conserving practices, the soil-water-erosion relationship that existed for several thousand years has changed. Removing the grass cover exposes the fertile surface layers to erosion. Drainage increases chemical activity and weathering in poorly drained soils. Irrigation and summer fallow increase the moisture supply in the soil, which results in increased chemical weathering and greater water movement through the soil. Soil conserving practices attempt to reestablish equilibrium under man's management practices. Man's activities have an immediate

effect upon both rate and direction of soil forming processes.

Relief

Relief, or lay of the land, is an important factor in the formation of the soils in Frontier County.

Steepness, shape, length, and direction of slope affect runoff, erosion, and the amount of moisture available for soil development. For example, moderately steep and steep Coly soils have a thin surface layer, which is the result of the combined effects of excessive runoff, erosion, insufficient moisture to produce a large amount of vegetation needed for the buildup of organic matter, and insufficient moisture for soil development processes to develop the subsoil.

In nearly level to gently sloping areas, however, where Holdrege and Hall soils formed, water infiltrates into the soil instead of running off. These soils have a moderately thick to thick surface layer. The increased soil moisture stimulated soil development in the subsoil by leaching carbonates and clay particles out of the surface layer and into a lower horizon.

The shape of the slope is often important in soil development. The upper part of the steep slopes in Coly and Uly silt loams, 9 to 30 percent slopes, is commonly convex. Water is shed rapidly, and only a limited amount enters the soil. Soils that have a thin surface layer and lack subsoil development, as in the Coly series, formed in these areas. Where the landscapes are plane or convex, a thicker surface layer and subsoil formed.

Shape of slope is also evident in nearly level areas in Frontier County. Upland depressions receive additional moisture that runs in from higher lying surrounding areas. This additional moisture contributed to the development of an A2 horizon, or a leached layer, directly above a claypan soil. Fillmore soils, for example, formed in depressions.

On bottom land the water table is closest to the surface where the relative elevation is lowest. When the soil is saturated, many physical and chemical reactions are altered. Downward movement of water is restricted. Anaerobic reactions become dominant because there is a lack of oxygen for bacteria to grow, and these soils tend to be colder than soils with aerobic conditions. In Wet alluvial land the ground water is at or near the surface.

Bottom land, because of its relatively low-lying position, commonly receives additional sediment from flooding. This usually prevents normal soil development as each period of flooding and deposition provides new soil parent material and starts another cycle of soil development. An example of this is in the stratified Hobbs, occasionally flooded, soil.

Time

Time, in soil development, begins once a land surface is reasonably stabilized. Several thousand years is required for the development of a mature soil, but less well developed soils develop in a few tens or hundreds of years. Mature soils commonly have a darkened surface layer, a clay enriched subsoil, and a horizon where calcium carbonate has accumulated. Such soils as Holdrege, Hall, and Fillmore are mature soils in Frontier County. They are approaching an equilibrium with their environment. An example of a less mature soil is Hord soil. It is on high stream terraces that have been stabilized for a shorter period of time than upland sites.

Some soils in Frontier County are kept perpetually young by deposition of soil material, erosion, or lack of sufficient moisture for soil development to progress very rapidly. Soils on bottom land that are frequently subject to flooding and deposition of soil material have little time for uninterrupted soil development. They are considered young soils. Some Coly soils have steep slopes where runoff is rapid. This limits the amount of moisture necessary for soil development to take place and erodes the surface nearly as fast as soil development progresses. Coly soils, however, formed in material that is the same age as the material in which Holdrege soils formed.

Classification of Soils

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

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

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*3, 6*).

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 can be observed and measured. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The same property or subdivisions of this property may be used in several different categories. In table 8, the soil series of Frontier County are placed in three categories of the current system. The table is current as of October, 1976. Classes of the current system are briefly defined in the following paragraphs.

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

SUBORDER. Each order is divided into suborders according to those soil characteristics that produce classes that have the greatest genetic similarity. The

TABLE 8.—*Soils classified according to the current system of classification*

Series	Family	Subgroup	Order
Coly	Fine-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Fillmore	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Hall	Fine-silty, mixed, mesic	Pachic Argiustolls	Mollisols.
Hobbs	Fine-silty, mixed, nonacid, mesic	Mollic Ustifluvents	Entisols.
Holdrege	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Hord	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Jayem	Coarse-loamy, mixed, mesic	Aridic Haplustolls	Mollisols.
McCook	Coarse-silty, mixed, mesic	Fluventic Haplustolls	Mollisols.
Sarben	Coarse-loamy, mixed, nonacid, mesic	Ustic Torriorthents	Entisols.
Uly	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Vetal	Coarse-loamy, mixed, mesic	Pachic Haplustolls	Mollisols.

suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table near the surface; soil climate; the accumulation of clay, iron, or organic carbon in the upper part of the solum; cracking of soils caused by a decrease in soil moisture; and fine stratification. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is *Ustoll* (*Ust*, meaning burnt, or dry, and *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed and those that have pans that interfere with the growth of roots, the movement of water, or both. The features used are soil acidity, soil climate, soil composition, and soil color. Each great group is identified by a word of three or four syllables; a prefix is added to the name of the suborder. An example is Haplustoll (*Hapl*, meaning simple horizons, *Ust*, for dry climate, and *oll*, from Mollisols).

SUBGROUP. Each great group is divided into subgroups, one representing the central, or typic, segment of the group, and others called intergrades, which have properties of the group as well as one or more properties of another great group, suborder, or order. Other subgroups have soil properties unlike those of any other group, suborder, or order. Each subgroup is identified by the name of the great group preceded by one or more adjectives. An example is Typic Haplustoll (a typical Haplustoll).

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when they are used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name is the subgroup name preceded by a series of adjectives, class names for texture, and mineralogy, for example, that are used as family differentiae (see table 8). An example is the fine-silty, mixed, mesic family of Typic Haplustolls.

Physical and Chemical Analyses

Much data on physical and chemical properties of soils can be obtained by analysis of the soils in a laboratory. This information is useful to soil scientists in classifying soils and in developing concepts of soil genesis. It is also helpful in estimating available water capacity, soil blowing, fertility, tilth, and other practical aspects of soil management.

Useful data on the soil series in Frontier County, but which has been sampled in locations outside of the county, are recorded in Soil Survey Investigations Report Number 5 (*7*). In this group are the Hall, Holdrege, and Hord soils.

Environmental Factors Affecting Soil Use

This section is mainly for those not familiar with Frontier County. It defines the natural and cultural factors of the environment as they affect soil use.

Natural factors, such as geology, physiography and drainage, natural resources, climate, and water supply directly relate to many uses of soils. Cultural features, for example, are transportation facilities, general facilities, and trends in soil use.

Geology

The oldest exposed geologic materials in Frontier County are of the Niobrara Formation of late Cretaceous age. Where exposed, the Niobrara consists mainly of orange and white chalk rock interbedded with thin layers of altered volcanic ash, which has been weathered to clay. Exposures are limited to the banks of Harry Strunk Lake and banks along Medicine Creek downstream from the lake.

Overlying the Niobrara Formation are materials of the Ogallala Formation of Tertiary (Pliocene) age. Outcrops are mainly restricted to valley sides and channels of Medicine and Red Willow Creeks. Exposed sections consist of clay, silt, volcanic ash, sand, and gravel poorly sorted into beds that are weakly cemented to strongly cemented with carbonates.

Pleistocene and Recent deposits cover the Ogallala material. They are the parent material for the modern soils. Loess of Peorian age mantles most of the county. Eolian sand mantles an area along the west side of the county about 5 to 12 miles south of the northwestern corner. Colluvial and alluvial materials are on

stream flood plains. Silty material and sandy material is dominant at some locations. Silt, sand, and clayey materials of the early Pleistocene sequence, Illinoian, Kansan, and Nebraskan, lie between the Peoria loess and the bedrock, Ogallala and Niobrara. They outcrop on valley sides of the larger streams and on canyon sides.

Physiography and Drainage

Frontier County is in the dissected plains area of Nebraska. It is a part of what was once a smooth, gently sloping, loess-mantled plain. Erosion by Medicine, Red Willow, Deer, Coon, Plum, East Muddy and West Muddy Creeks and their numerous tributaries has greatly modified the old plainlike surface. These drainage systems have resulted in an intricate system of deep, steep sided drainageways separated by narrow flat-topped remnants of the old constructional plain. A few shallow undrained basins remain in the more level upland areas.

About 2 square miles of sandhills fringe the western edge of the county, near the central part. They are undulating to rolling. The boundary between the sandhills and the loess-mantled plain to the east is sharply defined.

The major streams and their principal tributaries are entrenched 100 to 200 feet below the general level of the upland. The valleys of the smaller tributaries are cut from 20 to 75 feet below the upland. Most of the drainages are V-shaped, are narrow at the head, and become deeper and wider downstream with sloping valley sides. "Catsteps" have formed on the steep slopes.

A small percentage of the land in Frontier County consists of alluvial deposits. These sediments are on the stream terraces and flood plain of Medicine Creek, where they are about 1 mile wide in several places. The stream terraces, which are 10 to 50 feet above the normal level of the streams, are mantled with loess.

Nearly all of the county is well drained, and over a large part, runoff is rapid. Drainage from about 25,000 acres in the northeast corner of the county flows to the Platte River. The rest is drained by the Republican River drainage system.

Climate [8]

Frontier County, in southwestern Nebraska, is near enough to the Rocky Mountains that their high unbroken arrangement to the west has a marked influence on its climate. The climate is influenced also by the relatively high elevation of the county and the great distance from any large body of water. The effects of Harry Strunk and Hugh Butler Lakes on temperature and humidity are limited to immediate areas around the lakes and to times when conditions in the lower layers of the atmosphere are calm and still.

The climate of the county is typical for the center of a large continent at this latitude. Summers are warm, and winters relatively cold. Precipitation is moderate. The Rocky Mountains to the west block most of the moisture from the Pacific Ocean, while the chinook winds on the east side of the mountains supply warm air for occasional sudden rises in temperature during the colder seasons.

Most of the precipitation originates in the Gulf of Mexico and in the Caribbean areas. Frontier County is near the western edge of the moisture-laden southerly winds. An eastward shift of this wind belt can result in a large decrease in rainfall, while a slight westward movement can result in a large increase. There is a significant variation in annual precipitation. In 73 years of record at Curtis, precipitation in the driest year (1894) was 8.63 inches, and in the wettest year (1915) it was 38.25 inches.

The distribution of the precipitation takes on added importance because of its limited amount. More than three-fourths of the annual precipitation normally falls during the growing season, April through September (see table 9), but the distribution is not uniform during the season. If precipitation is poorly distributed or poorly timed, drought develops.

Winter precipitation is light, generally falling as snow; however, most winters have at least one period of freezing rain. Winter snows are light and dry and frequently are accompanied by strong northerly winds. The wind piles the snow into drifts, often leaving only part of the ground covered. Snowstorms are usually interspersed with warm periods that cause the snow to melt within a few days after it falls. Some of the March snows are wet, and less drifting is likely. Average annual snowfall is about 28 inches, but the annual amount varies.

As the spring season progresses, the snow is replaced by slow, steady drizzle or rain. During May there is a change to heavy showers and thunderstorms. The thunderstorms in June and July are frequently severe and are often accompanied by hail and damaging winds. They are infrequently accompanied by a tornado. As summer advances, precipitation decreases, its distribution becomes more erratic, and drought may occur. Precipitation is slight in fall, which is characterized by bright warm days and cool nights.

The elevation of Frontier County and the frequent low humidity cause large changes in daytime to nighttime temperatures. Maximum temperatures of 100° F. or higher are frequent in summer, while sub-zero temperatures are common in winter. Temperature records which began at Curtis in 1895 show that the highest reading ever recorded was 114° on July 11, 1954, and that the lowest ever recorded was 36° below zero on February 12, 1899.

At Curtis, the average date of the last 32° air temperature in spring is May 10. The average date of the first 32° air temperature in fall is September 28. Other temperature thresholds are listed in table 10. Local topography has little effect upon average temperatures over a period of time. Long term average temperatures recorded over flat land, for example, do not differ greatly from those recorded over small rolling hills or in valleys in the immediate area. Dates when specific temperatures are reached may, however, differ markedly over short distances. If freeze data are used, dates should be adjusted to fit the particular exposure. Less exposed areas will have the last spring freeze at an earlier date and the first fall freeze at a later date.

Annual evaporation from the free surface of the wa-

[8] Furnished by climatology office, Conservation and Survey Division, University of Nebraska.

TABLE 9.—*Temperature and precipiation*

[All data from Curtis, Nebraska]

Month	Temperature				Precipitation				
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have at least 4 days with [2]—		Average total [1]	One year in 10 will have [3]—		Days with 1 inch or more snow cover [1]	Average depth of snow on days with snow cover [1]
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Equal to or less than—	Equal to or more than—		
	°F	°F	°F	°F	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	40	10	62	−12	0.4	(4)	0.9	10	4
February	46	16	66	−3	.6	.1	1.4	8	3
March	53	23	74	5	1.0	.1	2.6	4	4
April	66	34	84	20	1.8	.4	4.7	1	4
May	76	45	90	33	3.5	.9	5.8		
June	85	55	103	44	4.0	1.5	6.8		
July	91	60	102	51	3.3	.7	5.9		
August	90	59	103	48	2.2	.8	4.9		
September	81	48	98	33	1.9	.3	4.4		
October	71	35	88	23	1.2	.1	3.0	(5)	2
November	53	22	73	3	.6	(4)	1.7	2	3
December	42	14	62	−3	.5	.1	1.1	7	4
Year	66	35	[6] 104	[7] −19	21.0	13.9	30.5	32	3

[1] Based on period 1944–73.
[2] Based on computer study 1948–63.
[3] Based on period 1894–1973.
[4] Trace.
[5] Less than 0.5 day.
[6] Average annual maximum.
[7] Average annual minimum.

ter in small lakes and farm ponds averages 52 inches, about 75 percent of which occurs from May through October.

Water Supply

Ground water is available and is of suitable quality for livestock and domestic use throughout Frontier County. The wells are 50 to 500 feet deep. Sufficient ground water for irrigation is not available in all areas. Irrigation wells are 350 to 600 feet deep in the uplands and yield as much as 2,300 gallons of water per minute. On the flood plains, wells are 75 to 125 feet deep and yield less than 1,000 gallons of water per minute. As of December 31, 1973, there were 379 irrigation wells in the county registered with the Nebraska Department of Water Resources. In 1974, about 46,000 acres was under irrigation, 1,500 of which was irrigated from flowing streams.

Natural Resources

Soil and ground water are important natural resources in Frontier County. Surface water stored in the county is used in other areas. A few outcrops of Ogallala sand and gravel is generally poor, and the quantity is limited. Silica, or volcanic ash, formerly mined in the northeast corner of the county, is used as an abrasive in cleaning products. The most accessible of these deposits has been depleted and, at this time, none is being mined. There are several oil wells at the southwest corner of the county.

Transportation Facilities

A spur line of a railroad in the northern part of the county, provides transportation for Maywood, Curtis, Moorefield, and Eustis. It connects to the main line at Holdrege, Nebraska. Federal Highway 83 crosses the western part of the county from north to south. State Highways No. 23 and 235 connect all towns in the county. These highways provide good roads for farm, industrial, and service vehicles. All rural mail routes are graveled. There is no scheduled service of aircraft to Frontier County.

General Facilities

Elementary schools are in all towns in the county, and in one rural location. High schools are in Curtis, Eustis, and Maywood. A 2-year curriculum in agricultural related subjects is available in Curtis. Libraries are provided in most of the towns. A weekly newspaper is published in Curtis.

Rural electricity is supplied throughout Frontier County. Natural gas is available in many areas within the county for both domestic use and as fuel for motors on irrigation wells.

Outdoor recreation is available at Hugh Butler and Harry D. Strunk Lakes. The lakes provide excellent

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

(All data from Curtis, Nebraska)

[All freeze data are based on temperatures measured in a standard National Weather Service thermometer shelter. The thermometers are placed approximately five feet above the ground, and the exposure is representative of the surrounding area. Lower temperatures exist at times nearer the ground and in local areas subject to extreme air drainage on calm nights]

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 14	April 21	May 2	May 14	May 26
2 years in 10 later than	April 9	April 16	April 27	May 9	May 21
5 years in 10 later than	March 30	April 5	April 16	April 28	May 10
Fall:					
1 year in 10 earlier than	October 20	October 15	October 5	September 22	September 14
2 years in 10 earlier than	October 26	October 20	October 10	September 27	September 19
5 years in 10 earlier than	November 6	October 30	October 20	October 8	September 28

fishing, hunting, boating, and water skiing. They also provide areas for picnicking, camping, and trail riding. A golf course is available at Curtis.

Trends in Agriculture

According to the U.S. Census of Agriculture, farms in Frontier County are decreasing in number but are increasing in size. In 1964 there were 622 farms with an average size of 945 acres. In 1969 there were 545 farms with an average size of 1,020 acres. The percentage of tenant operated farms decreased from 28 percent in 1964 to 22 percent in 1969.

Total cropland decreased from 244,293 acres in 1964 to 238,519 acres in 1969. The acreage of land under irrigation is increasing rapidly. In 1964, about 11,635 acres was irrigated. By 1969 this acreage had increased to 19,879. The Agriculture Stabilization Conservation Service reports 46,000 acres irrigated in 1974. The rapid increase in irrigated land is the result mainly of low rainfall and the higher prices paid for crops.

The acreage of field corn for all purposes increased from 16,424 acres in 1964 to 22,672 acres in 1969. Sorghum for all purposes decreased from 53,453 acres in 1964 to 37,028 acres in 1969. Wheat, an important, stable crop, decreased slightly from 47,960 acres in 1964 to 46,095 acres in 1969. Hay crops, mainly alfalfa, decreased from 20,361 acres in 1964 to 15,894 acres in 1969. The acreage of soybeans increased from 27 acres in 1964 to 709 acres in 1969.

The total number of cattle and calves in 1964 was 53,387 and decreased slightly to 52,350 in 1969. Swine increased from 14,705 in 1964 to 16,502 in 1969. Sheep, a minor livestock in the county, numbered only 921 head in 1969. There were 587 horses and ponies in the county in 1969.

Much of the moderately steep and steep land that was previously cultivated has been reseeded to grass. Federally sponsored conservation programs are a help in reseeding areas to native grass.

Most cultivated fields having a slope of 2 percent or more are terraced. Irrigation reuse pits at the end of irrigated fields, a common practice, have conserved water and helped to control erosion from excess tail-water runoff.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.
Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.
Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.
Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water

per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer, is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

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

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

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

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

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.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse textured (light textured) soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that creates the best environment possible for a growing crop, with a limited amount of soil disturbance and maximum retention of crop residue on the soil surface.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Depth (soil). Depth to a layer that restricts movement of water and roots. Depth classes recognized in this survey are—

	Inches
Very shallow	Less than 10
Shallow	10 to 20
Moderately deep	20 to 40
Deep	More than 40

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

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Intake rate. The average rate of water that enters the soil, under irrigation. Most soils have a faster initial rate, which decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending upon the net irrigation application.

Leaching. The removal of soluble material from soil or other material by percolating water.

Level terrace. A terrace that follows the absolute contour, as contrasted with a graded terrace. Used only on permeable soils where conservation of moisture for crops is particularly important or where outlet channels are not practical.

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

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded 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 of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition. In this survey, the content and percentage of organic matter are expressed as—

	Percent
Very low	Less than 0.5
Low	0.5 to 1.0
Moderately low	1.0 to 2.0
Moderate	2.0 to 4.0
High	4.0 to 8.0

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plow layer. The soil ordinarily moved in tillage; equivalent to surface soil.

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

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	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

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

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

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

Slipping, soil. The downward movement of masses of soil and soil material, primarily through the action of gravity. The movement is generally slow and irregular. It occurs most commonly when the lower part of the soil is nearly saturated with water, and it may be facilitated by alternate freezing and thawing.

Slope, (soil). The degree of deviation of a surface from the horizontal, usually expressed in percent or degrees. In this survey, the following slope classes are recognized:

Simple slope	*Complex slope*	*Percent*
Nearly level	Nearly level	0–1
Very gently sloping	Gently undulating	1–3
Gently sloping	Undulating	3–6
Strongly sloping	Rolling	6–9
Moderately steep	Hilly	9–15
Steep	Steep	15–30
Very steep	Very steep	>30

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

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

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the

processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stream terrace. An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Frequently called second bottoms.

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

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

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

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 can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

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, silt loam, 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," or "fine," or "very fine."

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

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, aparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

Map symbol	Mapping unit	Described on page	Capability units Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Range site Name	Range site Page	Windbreak suitability group Number
Ba	Broken alluvial land----------	8	VIw-7	26	------	--	----------	--	10
	Lower part----------	--	------	--	------	--	Silty Overflow	33	--
	Higher part----------	--	------	--	------	--	Silty Lowland	34	--
CoD2	Coly silt loam, 5 to 9 percent slopes, eroded----------	9	IVe-9	25	IVe-6	30	Limy Upland	34	5
CoF2	Coly silt loam, 9 to 20 percent slopes, eroded----------	9	VIe-9	26	------	--	Limy Upland	34	10
CuF	Coly and Uly silt loams, 9 to 30 percent slopes----------	9	VIe-9	26	------	--	----------	--	10
	Coly soil----------	--	------	--	------	--	Limy Upland	34	--
	Uly soil----------	--	------	--	------	--	Silty	34	--
Fm	Fillmore silt loam, 0 to 1 percent slopes----------	10	IIIw-2	24	IIIw-2	30	Clayey Overflow	34	2
Ha	Hall silt loam, 0 to 1 percent slopes----------	11	IIc-1	23	I-4	28	Silty	34	4
HaB	Hall silt loam, 1 to 3 percent slopes----------	11	IIe-1	23	IIe-4	29	Silty	34	4
HaC	Hall silt loam, 3 to 6 percent slopes----------	11	IIIe-1	24	IIIe-4	29	Silty	34	4
Hb	Hobbs silt loam, occasionally flooded, 0 to 2 percent slopes----------	12	IIw-3	23	IIw-6	29	Silty Overflow	33	1
Ho	Holdrege silt loam, 0 to 1 percent slopes----------	13	IIc-1	23	I-4	28	Silty	34	4
HoB	Holdrege silt loam, 1 to 3 percent slopes----------	13	IIe-1	23	IIe-4	29	Silty	34	4
HoB2	Holdrege silt loam, 1 to 3 percent slopes, eroded-------	13	IIe-1	23	IIe-4	29	Silty	34	4
HoC	Holdrege silt loam, 3 to 6 percent slopes----------	13	IIIe-1	24	IIIe-4	29	Silty	34	4
HoC2	Holdrege silt loam, 3 to 6 percent slopes, eroded-------	13	IIIe-1	24	IIIe-4	29	Silty	34	4
HpC	Hord silt loam, 3 to 6 percent slopes----------	15	IIIe-1	24	IIIe-6	30	Silty	34	4
Hr	Hord silt loam, terrace, 0 to 1 percent slopes----------	15	IIc-1	23	I-6	28	Silty Lowland	34	1
HrB	Hord silt loam, terrace, 1 to 3 percent slopes----------	15	IIe-1	23	IIe-6	29	Silty Lowland	34	1
JmB	Jayem loamy very fine sand, 1 to 3 percent slopes----------	15	IIIe-5	24	IIIe-8	30	Sandy	34	3
Mc	McCook silt loam, 0 to 1 percent slopes----------	16	I-1	23	I-6	28	Silty Lowland	34	1
McB	McCook silt loam, 1 to 3 percent slopes----------	16	IIe-1	23	IIe-6	29	Silty Lowland	34	1
Md	McCook silt loam, occasionally flooded, 0 to 2 percent slopes----------	16	IIw-3	23	IIw-6	29	Silty Overflow	33	1
Me	McCook silt loam, wet, 0 to 1 percent slopes----------	17	IIw-4	24	IIw-6	29	Subirrigated	33	2
RaG	Rough broken land, caliche, 30 to 60 percent slopes---------	17	VIIs-3	27	------	--	Shallow Limy	35	10
RbG	Rough broken land, loess, 30 to 60 percent slopes----------	18	VIIe-7	27	------	--	Thin Loess	35	10
RcG	Rough broken land, sandy, 30 to 60 percent slopes----------	18	VIIe-5	27	------	--	----------	--	10
	Smooth part----------	--	------	--	------	--	Sandy	34	--
	Rough part----------	--	------	--	------	--	Sands	34	--
SaD	Sarben loamy very fine sand, 3 to 9 percent slopes----------	18	IVe-5	25	IVe-8	31	Sandy	34	3

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability units Dryland Symbol	Dryland Page	Capability units Irrigated Symbol	Irrigated Page	Range site Name	Range site Page	Windbreak suitability group Number
UaC2	Uly silt loam, 3 to 6 percent slopes, eroded	19	IIIe-1	24	IIIe-6	30	Silty	34	4
UaD	Uly silt loam, 6 to 9 percent slopes	19	IVe-1	25	IVe-6	30	Silty	34	4
UcD2	Uly and Coly silt loams, 6 to 9 percent slopes, eroded	20	IVe-1	25	IVe-6	30	----------	--	4
	Uly soil	--	------	--	------	--	Silty	34	--
	Coly soil	--	------	--	------	--	Limy Upland	34	--
UcF	Uly and Coly silt loams, 9 to 20 percent slopes	20	VIe-1	25	------	--	----------	--	10
	Uly soil	--	------	--	------	--	Silty	34	--
	Coly soil	--	------	--	------	--	Limy Upland	34	--
VeB	Vetal loamy very fine sand, 0 to 3 percent slopes	20	IIIe-5	24	IIIe-8	30	Sandy	34	3
Wx	Wet alluvial land	21	Vw-7	25	------	--	Wet Land	33	10

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978— 224-894/61

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