SOIL SURVEY OF

Pierce 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.

Major fieldwork for this soil survey was completed in the period 1959-69. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. 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 Lower Elkhorn Natural Resources District.

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 Pierce 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 windbreak suitability group and range site in which the soil has been placed.

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

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

Foresters and others can refer to the section "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 soils and wildlife in the section "Wildlife."

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

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

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

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

Contents

Cover: Field windbreaks help to control soil blowing on Thurman, Boelus, and Loretto soils. (Photo courtesy Richard Hufnagle.)

Issued September 1976

SOIL SURVEY OF PIERCE COUNTY, NEBRASKA

BY RONALD B. SCHULTE, CHARLES L. HAMMOND, AND CHARLES F. MAHNKE, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

PIERCE COUNTY is located in northeastern Nebraska (fig. 1). The total area is 573 square miles, or 366,720 acres. The northern part of the county is crossed by U.S. Highway 20, and the eastern part by U.S. Highway 81.

The county has cold winters and rather warm summers. Spring is usually cool and has a considerable amount of rain, and fall is mild and has a moderate amount of rain. The average annual precipitation is 25 inches, average snowfall is 29 inches, and the length of the growing season is 145 days.

Pierce County consists of silty and sandy bottom lands and stream terraces, silty loessal uplands, mixed sandy and loamy uplands, and a small area of sandhills. Some areas of bottom lands and stream terraces are poorly drained because of a high water table, but other areas are well drained. The silty uplands are well drained, the sandy and loamy uplands are well drained to somewhat excessively drained, and the sandhills are excessively drained. Relief is mainly nearly level to moderately sloping. The sandy areas are very gently undulating to rolling. Most of the county drains to the southeast. Natural vegetation is mid and tall grasses.

Pierce County was surveyed in 1858 and created by territorial legislation in 1859. The county and the county seat, Pierce, were named after Franklin Pierce, the 14th President of the United States. The first homestead was filed in November 1867, and the last in January 1906.

According to the U.S. Bureau of the Census, 8,493 persons lived in the county in 1970. Most employment is in farming or related businesses. Some residents drive to Norfolk in neighboring Madison County, where work is available in several industries.

Pierce, Plainview, and Osmond are the three largest towns. Each community has most of the businesses and services required in a farming area. The school district of each town includes part of the surrounding rural areas, and bus service is provided. There are few country schools. The villages of Hadar, Foster, and McLean have grade schools.

Farming is the main enterprise. Combination cash-grain and livestock farms are the most common kind of operation. Dairying supplements many farm incomes throughout the county. Most of the land is dryfarmed, although more irrigation systems are installed each year. Corn, oats, and alfalfa are the main crops. A considerable acreage of meadow lies along the upper end of the streams that drain the county and is mowed for hay or grazed. Range is a major land use in the sandhills in the southwestern part of the county.

In 1969, 1,061 farms were in the county. The average size was 324 acres. On these farms were 71,810 cattle, of which 6,425 were milk cows; 78,260 hogs; 2,600 sheep; and 97,370 chickens. About 266,645 acres was in crops, 74,275 acres was in range, and 2,593 acres was wooded. Corn was grown on 125,500 acres, of which 15,600 acres was irrigated. Water for irrigation was from 170 wells plus some pumping from the North Fork Elkhorn River. Alfalfa was grown on 28,600 acres, oats on 21,800 acres, soybeans on 14,600 acres, rye on 5,000 acres, grain sorghum on 4,000 acres, and wheat on 700 acres. Of the range, 11,200 acres was mowed for hay.

A soil survey of Pierce County was made by the United States Department of Agriculture in 1928 (*4*).[1] The new survey was made to provide up-to-date information about the soils and because of advances that have been made in soil interpretations, engineering, and soil classification.

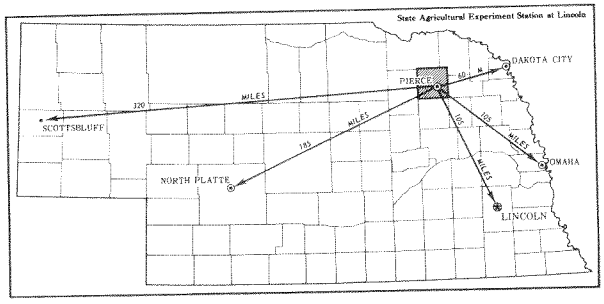

***Figure 1.*—Location of Pierce County in Nebraska.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Pierce County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to

[1] Italic numbers in parentheses refer to Literature Cited, p. 103.

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

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects 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, Hobbs silt loam, occasionally flooded, is one of several phases within the Hobbs 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. Two such kinds of mapping units are shown on the soil map of Pierce County: soil complexes and undifferentiated soil groups.

A soil complex consists of areas of two or more soils, so intricately mixed that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Crofton-Nora silt loams, 7 to 11 percent slopes, eroded, is an example.

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 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 two or more dominant series are represented in the group, the name of the group ordinarily consists of the names of the dominant soils joined by "and." Valentine and Thurman soils, rolling, is an undifferentiated soil group in Pierce 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 by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Silty alluvial land is a land type in this county.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of 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 Pierce County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map that shows soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a

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

The soil associations in this survey have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of the broad groups and their included soil associations are described in the following pages. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of Thurman-Ortello-Boelus association, the words "sandy and loamy" refer to the texture of the surface layer.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil map in adjacent counties published at a different date. Differences on the maps are the result of improvements in the classification or refinements in soil series concepts. In addition, more precise maps are needed because the uses of the general soil map have expanded in recent years. The more modern maps meet this need.

The nine soil associations in Pierce County are described in the pages that follow.

Excessively Drained and Somewhat Excessively Drained Soils on Uplands

Only one association is in this group. It consists of rolling to gently undulating sandy soils.

1. Valentine-Thurman association

Deep, gently undulating to rolling, sandy soils formed in eolian sand

This association consists of undulating to rolling, smooth, round-topped sandhills. There are few established drainage channels. Most of the precipitation soaks into the porous sand.

This association occupies about 32,000 acres, or about 9 percent of the county. Valentine soils make up about 60 percent of this association and Thurman soils about 35 percent. The remaining 5 percent is minor soils and land types.

Valentine soils are on convex ridgetops and on the upper part of hummocks and low sandhills. These soils are mainly gently rolling to rolling and excessively drained. They have a thin surface layer of grayish-brown fine sand. The underlying material, at a depth of 5 inches, is very pale brown fine sand.

Thurman soils are on the lower part of hummocks and in concave areas. These soils are gently undulating to rolling and somewhat excessively drained. They have a surface layer of grayish-brown and dark grayish-brown loamy fine sand. Beneath this layer is a thin transitional layer of grayish-brown loamy fine sand. The underlying material, at a depth of 19 inches, is very pale brown fine sand.

Minor soils in this association are mainly of the Elsmere and Loup series. Also of minor extent are areas of Blown-out land and small intermittent lakes. Elsmere and Loup soils and the intermittent lakes are in basins and depressions. Blown-out land is commonly on the upper part of convex side slopes within areas of Valentine soils.

Most of this association is in range used for grazing cattle. Less than 20 percent of the acreage in grasses is mowed for hay. This association is better suited to range than to most other uses, but a few small areas are cultivated.

The main concern in managing range is to establish a planned grazing system and proper grazing use. If the soils are overgrazed, soil blowing is a hazard. Under dryland cultivation, the soils are droughty because they have low available water capacity.

Very few farmsteads are in this association, and they average between 600 and 1,200 acres. They are commonly managed from headquarters that are located in adjoining soil associations. Wells of good yield can be readily drilled in this area. They provide water of good quality for livestock and irrigation. Where irrigation is feasible, some gently undulating soils have potential for crops. There are a few gravelled roads, but roads are poor along many section lines.

Somewhat Excessively Drained and Well Drained Soils on Uplands

In this group of associations are nearly level to gently rolling sandy and loamy soils. Two associations are in this group.

2. Thurman-Ortello-Boelus association

Deep, nearly level to gently rolling, sandy and loamy soils formed in eolian sand and loess

This association consists mainly of gently undulating slopes and low convex ridges of the uplands. Slopes range from nearly level to gently rolling (fig. 2).

This association occupies about 112,720 acres, or about 30 percent of the county. Thurman soils make up about 42 percent of this association, Ortello soils 16 percent, and Boelus soils 11 percent. The remaining 31 percent is minor soils and land types.

Thurman soils are mainly on gently undulating uplands. These soils are nearly level to gently rolling and somewhat excessively drained. They have a surface layer of grayish-brown and dark grayish-brown loamy fine sand. Beneath this is a thin transitional layer of grayish-brown loamy fine sand. The underlying material, at a depth of 19 inches, is very pale brown fine sand.

Ortello soils are mainly on uplands, but they are also on some stream terraces. These soils are nearly level to gently undulating and well drained. They have a surface layer of dark grayish-brown fine sandy loam. Beneath this is a transitional layer of grayish-brown fine sandy loam. The underlying material, at a depth of 26 inches, is pale-brown loamy fine sand.

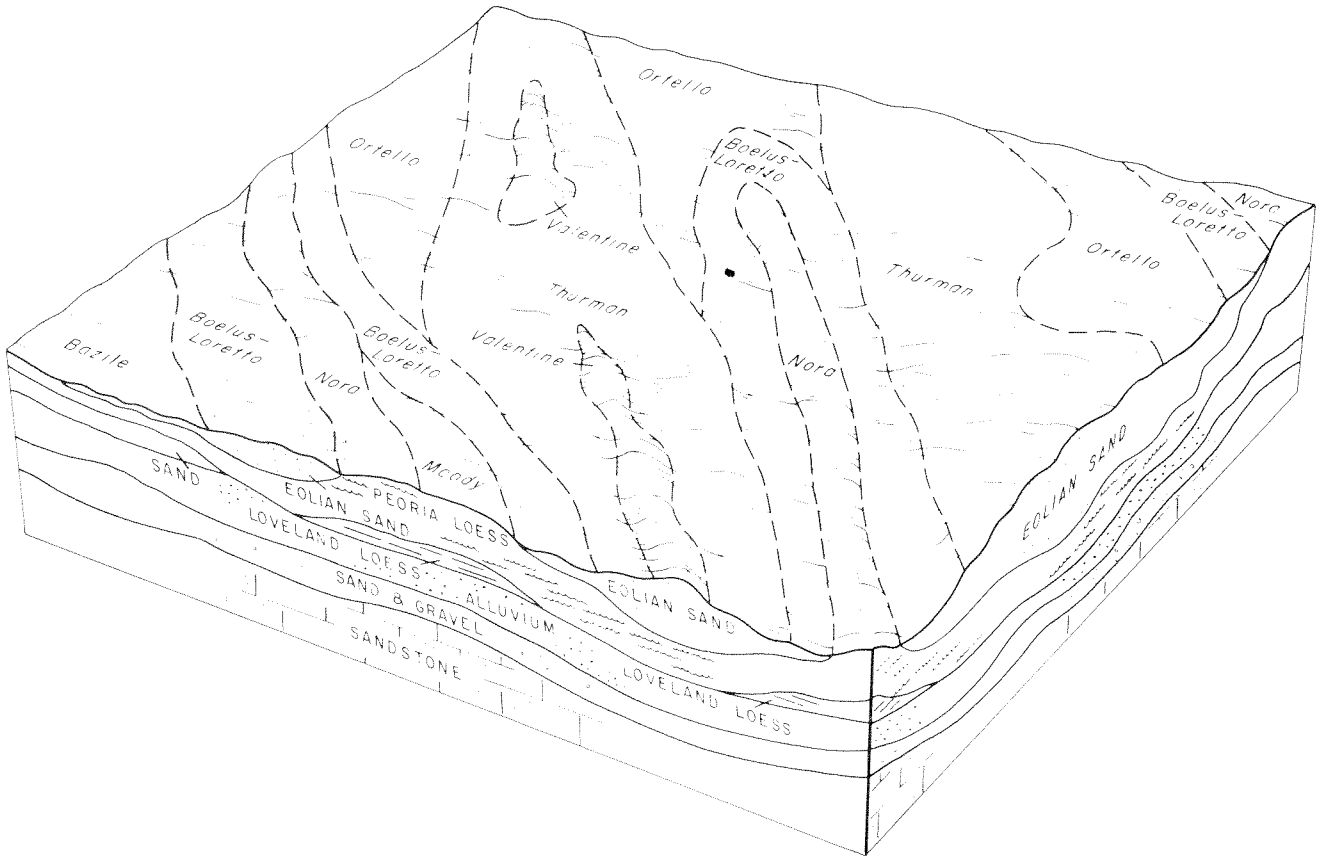

***Figure 2.*—Pattern of soils and parent material in Thurman-Ortello-Boelus association.**

Boelus soils are on uplands. These soils are nearly level to gently undulating and well drained. They have a surface layer of dark grayish-brown and grayish-brown loamy fine sand about 23 inches thick and a subsoil of pale-brown silt loam. The underlying material, at a depth of 47 inches, is calcareous, very pale brown silt loam.

Minor soils in this association are mainly of the Bazile, Loretto, Moody, Nora, Paka, and Valentine series. Bazile soils are on low ridges of the uplands and on stream terraces mainly north of Dry Creek. Loretto soils are below areas of Thurman soils on uplands or stream terraces. Moody soils are on low ridges, and Nora soils are mainly on low ridges that have northwest-facing slopes. Paka soils are on the higher ridges of the association, mainly near the northwestern corner of the county and near Breslau. Valentine soils are on the highest parts of the landscape.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, rye and vetch, and alfalfa are the main crops. A minor acreage of oats and soybeans is also grown. Corn is the main irrigated crop. The soils are mainly under dryland cultivation. A significant acreage is irrigated by sprinklers, commonly the self-propelled, center-pivot system. West of the North Fork Elkhorn River the potential for additional irrigation is high. Well yields are commonly high. Many farms have small native or bromegrass pastures. Livestock is fattened on most farms, and some farms have dairy herds.

Soil blowing is the main hazard in cultivated areas. It is controlled to some extent by field windbreaks, which are common throughout this association. Water erosion is a hazard in some areas on long smooth slopes. Improving the organic-matter content and maintaining soil fertility are important concerns in management. Lime is commonly needed for alfalfa.

Farms in this association average about 400 acres. Most farmsteads have access to gravel roads, but roads are poor along many other section lines. U.S. Highway No. 20 crosses this association east of Plainview. Farm produce is marketed mainly within the county or in adjacent counties.

3. *Thurman-Hadar-Ortello association*

Deep, nearly level to gently rolling, sandy and loamy soils formed in eolian sand and glacial till

This association consists of gently undulating convex ridges and gently rolling hillsides.

This association occupies about 20,000 acres, or about 6 percent of the county. Thurman soils make up about 50 percent of this association, Hadar soils 19 percent, and Ortello soils 15 percent. The remaining 16 percent is minor soils.

Thurman soils are mostly gently undulating on uplands, but a minor acreage is on stream terraces. These soils are nearly level to gently rolling and somewhat excessively drained. They have a surface

layer of grayish-brown and dark grayish-brown loamy fine sand. Beneath this is grayish-brown loamy fine sand. The underlying material, at a depth of 19 inches, is very pale brown fine sand.

Hadar soils are gently undulating to gently rolling, well-drained soils on uplands. These soils have a surface layer of grayish-brown loamy fine sand about 14 inches thick and a subsoil that is pale-brown loamy sand in the upper part, light yellowish-brown clay loam in the middle part, and light-gray clay loam in the lower part. The underlying material, at a depth of 46 inches, is light-gray clay loam. Stones and pebbles are scattered throughout the subsoil and underlying material.

Ortello soils are mainly on uplands, but a minor acreage is on stream terraces. These soils are nearly level to gently undulating and well drained. They have a surface layer of dark grayish-brown fine sandy loam. Beneath this is grayish-brown fine sandy loam. The underlying material, at a depth of 26 inches, is pale-brown loamy fine sand.

Minor soils in this association are mainly of the Betts, Clarno, Loretto, Simeon, and Valentine series. Betts and Clarno soils are gently sloping or moderately sloping and occupy northwest-facing slopes on uplands. Loretto soils are nearly level to gently undulating and are on uplands and stream terraces. Simeon soils are on ridges above areas of Betts and Clarno soils. Gently undulating to gently rolling Valentine soils are on the highest parts of the landscape.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, alfalfa, and rye and vetch are the main crops. A minor acreage of oats and soybeans is also grown. About half the acreage of these soils is under dryland cultivation, and a minor acreage is irrigated by sprinklers. Range and bromegrass pasture make up the rest of the acreage, and they are used for grazing cattle. The potential for additional irrigation is low. Well yields are commonly low to moderate. Livestock is fattened on most farms, and some farms have dairy herds. Several gravel pits are in the western part of this association.

Soil blowing is the main hazard in cultivated areas. It can be controlled to some extent by field windbreaks, which are common throughout this association. Water erosion is a hazard in some areas on long smooth slopes. Improving the organic-matter content and maintaining soil fertility are important concerns in management. Lime is needed in some areas for alfalfa. Occasional stones and pebbles can damage farm implements.

Farms in this association average about 480 acres. Most farmsteads have access to gravel roads, but roads are poor along many section lines. U.S. Highway No. 81 crosses part of the association. Farm produce is marketed mainly within the county or in Norfolk in adjacent Madison County.

Well Drained and Moderately Well Drained Soils on Uplands

In this group of associations are nearly level to strongly sloping silty soils. Three associations are in this group.

4. *Moody-Bazile-Trent association*

Deep, nearly level to gently sloping, silty soils formed in loess and outwash sand

This association consists mainly of nearly level to gently sloping, long, smooth areas on uplands. It also consists of nearly level areas near the heads of wide upland drainageways and on stream terraces.

This association occupies about 40,000 acres, or about 11 percent of the county. Moody soils make up about 55 percent of this association, Bazile soils 25 percent, and Trent soils 12 percent. The remaining 8 percent is minor soils.

Moody soils are in long, smooth areas on uplands. These soils are nearly level to gently sloping and well drained. They have a surface layer of dark grayish-brown and grayish-brown silty clay loam and a subsoil of brown and pale-brown silty clay loam. The underlying material, at a depth of 41 inches, is very pale brown silt loam.

Bazile soils are in long, smooth areas on uplands and stream terraces. These soils are nearly level to gently sloping and well drained. They have a surface layer of dark grayish-brown silt loam and a subsoil of grayish-brown light silty clay loam. The underlying material, at a depth of 27 inches, is very pale brown sand.

Trent soils are in the lower areas near the heads of wide upland drainageways and on stream terraces. These soils are nearly level and moderately well drained. They have a surface layer of dark-gray and dark grayish-brown silty clay loam and a subsoil of grayish-brown to pale-brown silty clay loam. The underlying material, at a depth of 55 inches, is pale-brown silt loam.

Minor soils in this association are mainly of the Butler, Fillmore, Loretto, Nora, and Simeon series. Butler soils are in upland basins and have very slow surface drainage. Fillmore soils are in upland depressions and are ponded. Loretto soils are nearly level to gently sloping and are on uplands. Nora soils are gently sloping on narrow ridgetops and moderately sloping on hillsides. Simeon soils are in narrow, convex areas on ridgetops below areas of Bazile soils, mainly near Plainview.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, soybeans, oats, and alfalfa are the main crops. The soils are mainly under dryland cultivation. A considerable acreage west of the North Fork Elkhorn River in the area north of Osmond is irrigated by sprinklers. High-producing, deep wells can be readily drilled in this area. East of the North Fork Elkhorn River in the area north of Osmond, the potential for irrigation is poor because most well yields are low. Livestock wells are also difficult to obtain on some farms in this area. Most pastures are small and are mainly on the less extensive Butler, Fillmore, and Simeon soils. Some livestock is fattened and marketed.

The hazard of water erosion is slight or moderate on the gently sloping soils. Surface drainage is needed in cultivated areas of Fillmore soils. Maintaining soil fertility is a concern in management.

Farms in this association average about 320 acres. Gravel or improved dirt roads are along most section

lines. Highways that cross the association are paved. Farm produce is marketed mainly within the county or in adjacent counties.

5. *Crofton-Nora-Moody association*

Deep, very gently sloping to steep, silty soils formed in loess

This association is on uplands. It consists of gently sloping ridgetops and long, moderately sloping to strongly sloping side slopes. It also consists of a few, short, steep side slopes that border upland drainageways (fig. 3).

This association occupies about 67,000 acres, or about 18 percent of the county. Crofton soils make up about 40 percent of this association, Nora soils 37 percent, and Moody soils 10 percent. The remaining 13 percent is minor soils.

Crofton soils are mainly in narrow, convex areas on ridgetops and hillsides and in a few areas on short slopes that border upland drainageways. These soils are gently sloping to steep and well drained. They

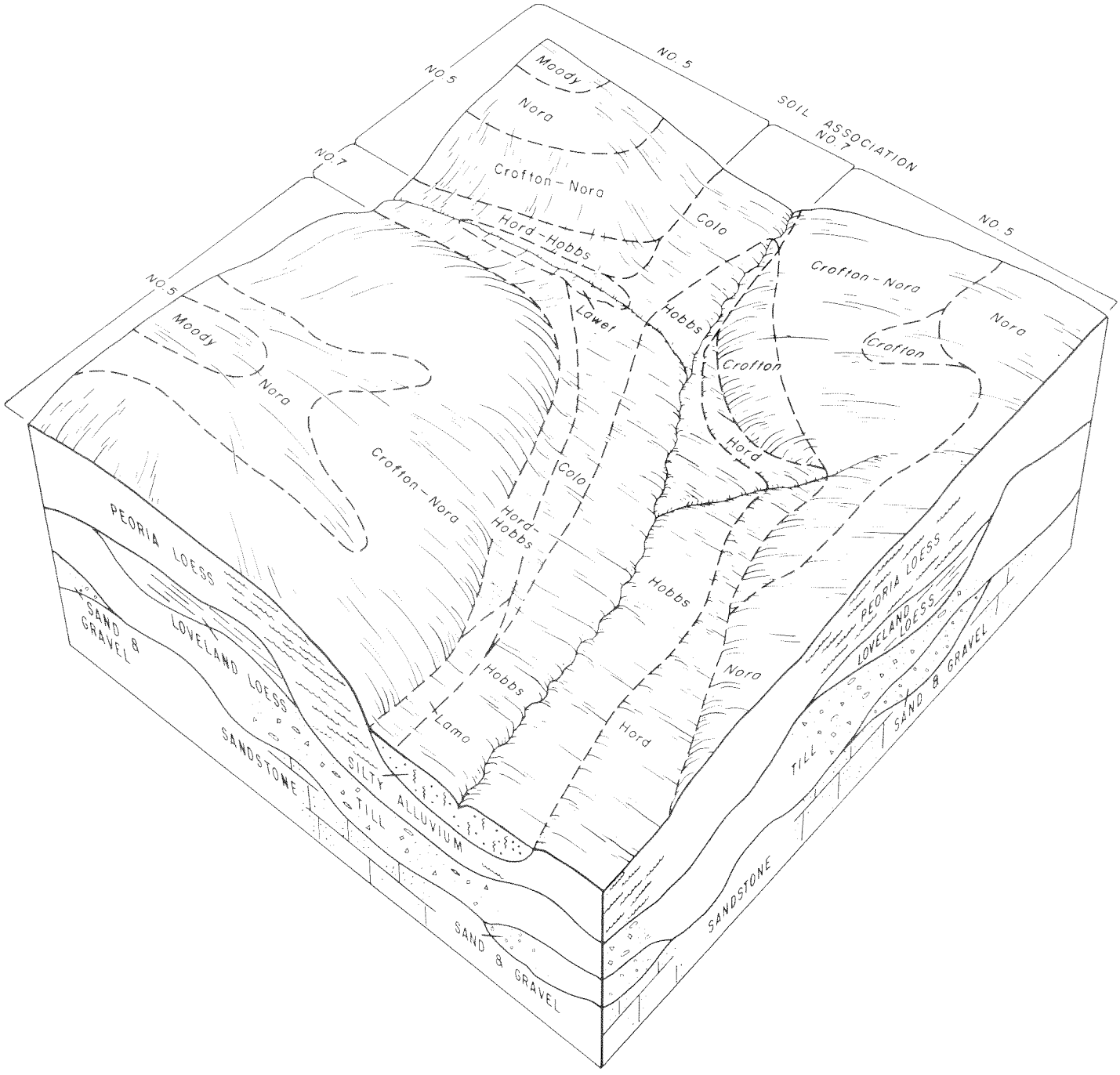

Figure 3.—Pattern of soils and parent material in Crofton-Nora-Moody association (5) and Hobbs-Hord-Colo association (7).

have a thin surface layer of pale-brown silt loam. The underlying material, at a depth of 6 inches, is pale-brown and very pale brown silt loam. The soils are calcareous throughout.

Nora soils are in smooth areas on upland ridgetops and hillsides. These soils are very gently sloping to strongly sloping and well drained. They have a surface layer of dark grayish-brown silt loam and a subsoil of brown and pale-brown silt loam. The underlying material, at a depth of 35 inches, is very pale brown silt loam.

Moody soils are in long, smooth areas on ridgetops and the lower part of hillsides. These soils are gently sloping and well drained. They have a surface layer of dark grayish-brown and grayish-brown silty clay loam and a subsoil of brown and pale-brown silty clay loam. The underlying material, at a depth of 41 inches, is very pale brown silt loam.

Minor soils in this association are mainly of the Hobbs and Hord series and Silty alluvial land. Hobbs soils are in narrow drainageways. Hord soils are on lower colluvial foot slopes below areas of Crofton and Nora soils and on stream terraces. Silty alluvial land is along the meandering creek channels on frequently flooded bottom lands.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, soybeans, oats, and alfalfa are the main crops. The soils are mainly under dryland cultivation. A minor acreage is irrigated by sprinklers. Bromegrass is the main grass seeded for pasture on the gently sloping to strongly sloping soils. The steep Crofton soils are in native grass, and a few areas are seeded to bromegrass or alfalfa. On most farms irrigation is not feasible because of topography. Well yields are generally low to high. Many farms have dairy herds, and some livestock is fattened and marketed.

Water erosion is a hazard on the cultivated soils. Maintaining soil fertility is an important concern in management.

Farms in this association average about 400 acres. Gravel or improved dirt roads are along most section lines. Highways that cross the association are paved. Farm produce is marketed within the county or in adjacent counties.

6. *Clarno-Nora-Betts association*

Deep, very gently sloping to strongly sloping, silty and loamy soils formed in glacial till and loess

This association consists of areas on gently sloping ridgetops and long, moderately sloping to strongly sloping hillsides.

This association occupies about 7,500 acres, or about 2 percent of the county. Clarno soils make up about 30 percent of this association, Nora soils 30 percent, and Betts soils 20 percent. The remaining 20 percent is minor soils.

Clarno soils are mainly in smooth areas on upland ridgetops and northwest-facing hillsides. These soils are gently sloping to moderately sloping and well drained. They have a surface layer of dark grayish-brown loam and a subsoil of grayish-brown and light brownish-gray clay loam. The underlying material, at a depth of 28 inches, is light-gray clay loam. A few stones and pebbles occur throughout the profile.

Nora soils are in smooth areas on upland ridgetops and hillsides. These soils are very gently sloping to strongly sloping and well drained. They have a surface layer of dark grayish-brown silt loam and a subsoil of brown and pale-brown silt loam. The underlying material, at a depth of 35 inches, is very pale brown silt loam.

Betts soils are in convex areas on upland ridgetops and northwest-facing hillsides. These soils are gently sloping to moderately sloping and well drained. They have a surface layer of grayish-brown loam and a subsoil of pale-brown clay loam. The underlying material, at a depth of 18 inches, is light-gray clay loam. These soils contain some stones and pebbles and are calcareous throughout.

Minor soils in this association are mainly of the Bazile, Longford, Moody, and Simeon series. Bazile, Longford, and Simeon soils are on ridgetops and have long gentle slopes above areas of Betts and Clarno soils. Moody soils are nearly level to gently sloping on long, smooth hillsides. They are mainly on the highest parts of the landscape.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, oats, and alfalfa are the main crops. The soils are commonly under dryland cultivation or pasture. A minor acreage is sprinkler irrigated. Irrigation well yields are low to moderate. On most farms irrigation is not feasible because of the moderately sloping and strongly sloping topography and low well yields. Good livestock wells are difficult to obtain in some areas. Bromegrass is seeded for pasture. About 25 percent of the acreage is range. Many farms have dairy herds, and some livestock is fattened and marketed. Gravel is pumped from one pit in this association.

Water erosion is a hazard in cultivated areas. Occasional stones and pebbles can damage farm implements. Small stony or gravelly areas are common and are better suited to range than to other uses. Maintaining soil fertility is an important concern in management.

Farms in this association average about 400 acres. Most farmsteads have access to gravel roads. Graded dirt roads are on many section lines. Highways that cross the association are paved. Farm produce is marketed mainly within the county or in adjacent counties.

Well Drained and Somewhat Poorly Drained Soils on Bottom Lands, Stream Terraces, and Foot Slopes

Only one association is in this group. It consists of mainly nearly level silty soils.

7. *Hobbs-Hord-Colo association*

Deep, nearly level to gently sloping, silty soils formed in alluvium and colluvium

This association consists of nearly level to gently sloping bottom lands, stream terraces, and foot slopes, mainly along the North Fork Elkhorn River,

Yankton Slough, and Middle Branch Logan Creek (see fig. 3).

This association occupies about 46,000 acres, or about 13 percent of the county. Hobbs soils make up about 48 percent of this association, Hord soils 17 percent, and Colo soils 13 percent. The remaining 22 percent is minor soils and land types.

Hobbs soils are on bottom lands. These soils are nearly level and well drained, and they are seldom to occasionally flooded. They have a surface layer of dark grayish-brown, dark-gray, and grayish-brown silt loam about 37 inches thick. The underlying material is brown silt loam.

Hord soils are on stream terraces above the flood plain and on lower colluvial foot slopes below areas of Crofton and Nora soils. These soils are nearly level to gently sloping and well drained. They have a surface layer of dark grayish-brown silt loam about 21 inches thick and a silt loam subsoil that is dark grayish brown in the upper part, grayish brown in the middle part, and pale brown in the lower part. The underlying material, at a depth of 47 inches, is pale-brown silt loam.

Colo soils are mainly at the upper end of wide bottom lands and side drainageways. These soils are nearly level and somewhat poorly drained, and they are seldom to occasionally flooded. They have a surface layer of silt loam about 38 inches thick that is dark grayish brown in the upper part and dark gray and mottled in the lower part. Beneath this is a transitional layer of gray, mottled silty clay loam. The underlying material is grayish-brown, mottled silty clay loam.

Minor soils in this association are mainly of the Clamo, Lamo, Lawet, and Leshara series and Silty alluvial land. Clamo soils are in low areas on wide bottom lands, mainly along the North Fork Elkhorn River. Lamo and Leshara soils are on bottom lands between areas of Hobbs soils and the base of the uplands, mainly along the North Fork Elkhorn River. Lawet soils are near the upper ends of narrow bottom lands. Silty alluvial land is on frequently flooded, lower bottom lands near stream channels.

Farms in this association are diversified, and they are mainly combination cash grain-livestock enterprises. Corn, soybeans, oats, and alfalfa are the main crops. The soils are mainly under dryland cultivation. Some of this association is irrigated. High-producing wells can be drilled, and some farmers pump water from the North Fork Elkhorn River. Gravity irrigation is well suited to most of these soils. Small, tame or native grass pastures are in the occasionally or frequently flooded areas near stream channels. Some livestock is fattened and marketed.

The bottom lands are subject to flooding. Somewhat poorly drained soils in this association have a water table that fluctuates seasonally between depths of 3 and 8 feet. Normally these areas can be farmed without installing drainage tile. Maintaining soil fertility is an important concern in management.

Farms in this association average about 320 acres. Most farmsteads have access to gravel roads. Roads are poor on many other section lines. Highways that cross the association are paved. Farm produce is marketed mainly within the county or in adjacent counties. In this association the North Fork Elkhorn River provides potential for fishing and hunting.

Somewhat Poorly Drained to Very Poorly Drained Soils on Bottom Lands and Stream Terraces and in Basins

In this group of associations are level to very gently undulating sandy and loamy soils. Two associations are in this group.

8. Elsmere-Ovina-Loup association

Deep, nearly level and very gently undulating, sandy and loamy soils formed in alluvium

This association consists of nearly level and very gently undulating bottom lands, stream terraces, and basins. It occurs mainly in areas along Willow Creek and adjacent to the uplands along each side of the lower part of Dry Creek (fig. 4).

This association occupies about 22,000 acres, or about 6 percent of the county. Elsmere soils make up about 42 percent of this association, Ovina soils 20 percent, and Loup soils 16 percent. The remaining 22 percent is minor soils.

Elsmere soils are mainly on stream terraces and in broad basins adjacent to the sandy uplands. These soils are nearly level or very gently undulating and somewhat poorly drained. They have a surface layer of dark grayish-brown loamy fine sand. Beneath this is a thin transitional layer of grayish-brown loamy fine sand. The underlying material, at a depth of 19 inches, is mottled, pale-brown and light-gray fine sand.

Ovina soils are mainly on stream terraces and in broad basins adjacent to the mixed sandy and silty uplands. These soils are nearly level or very gently undulating and somewhat poorly drained. They have a surface layer of dark grayish-brown and very dark grayish-brown fine sandy loam. Below this is a transitional layer of grayish-brown, mottled fine sandy loam. The underlying material, at a depth of 27 inches, is mottled, pale-brown and light brownish-gray loamy fine sand.

Loup soils are on bottom lands along upland drainageways and in wet sandhill depressions. These soils are nearly level and poorly drained or very poorly drained. They have a surface layer of mottled, dark-gray fine sandy loam. The mottled underlying material is light brownish-gray loamy fine sand in the upper part, light brownish-gray fine sand in the middle part, and light-gray fine sand in the lower part.

Minor soils in this association are of the Colo, Ord, and Orwet series and Sandy alluvial land. Colo soils are on stream terraces below the mixed sandy and silty uplands. Ord and Orwet soils are on bottom lands, mainly along Willow Creek. Sandy alluvial land occupies frequently flooded low areas near deepened stream channels.

Farms in this association are diversified, and they are combination cash grain-livestock enterprises. Corn, soybeans, alfalfa, and rye and vetch are the main crops. The soils are under dryland cultivation or are used for bromegrass pasture, range, and meadow.

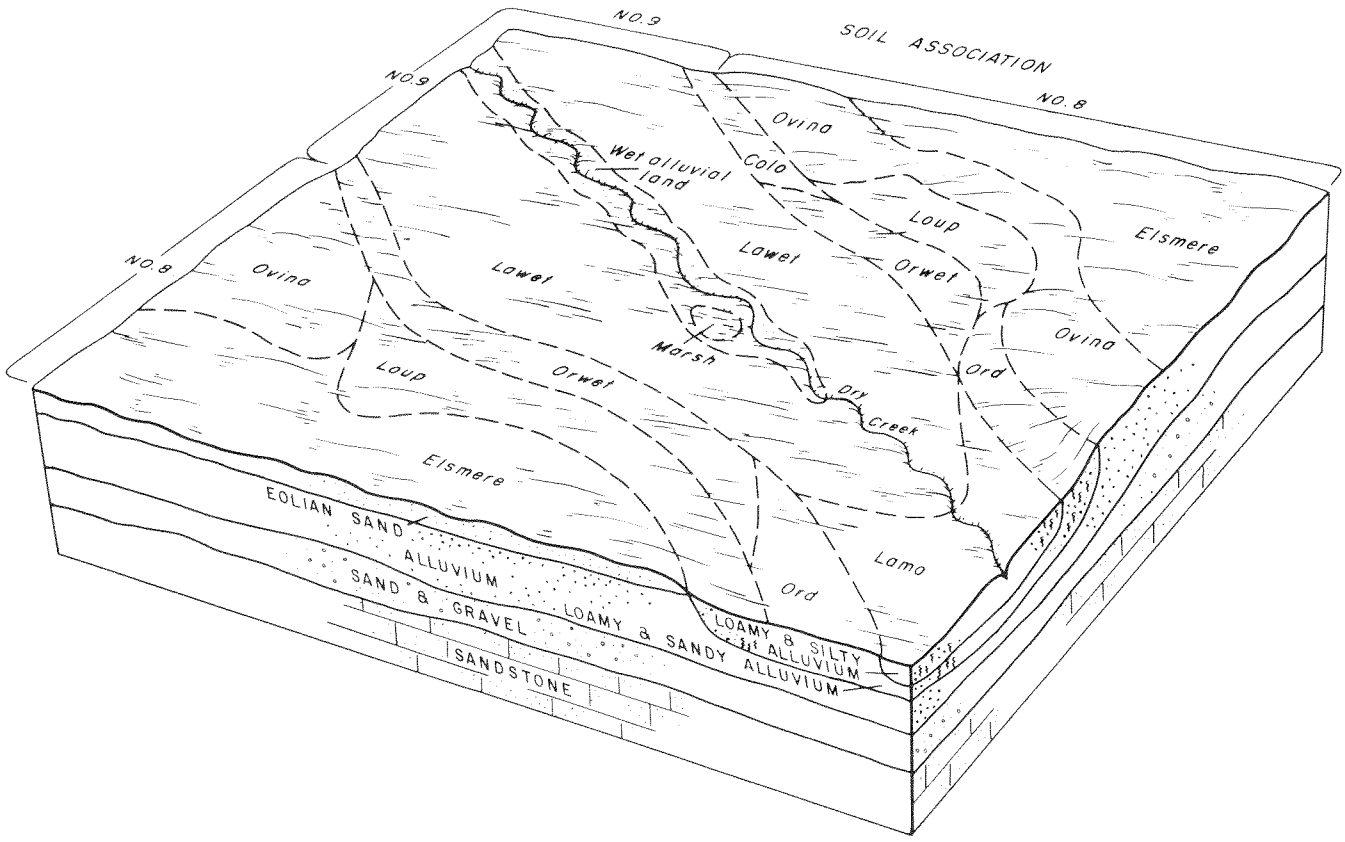

Figure 4.—**Pattern of soils and parent material in Elsmere-Ovina-Loup association (8) and Lawet-Orwet association (9).**

A few acres are irrigated by sprinklers. High-producing wells can be drilled. Where the range is in good condition, it consists mainly of tall native grasses. Most of this association is excellent for hay because of subirrigation from the water table. Livestock is fattened on most farms, and some farms have dairy herds.

Wetness and soil blowing are the main hazards. The somewhat poorly drained soils in this association have a water table that fluctuates seasonally between depths of 3 and 8 feet. Normally these areas can be farmed without installing drainage tiles. The poorly drained and very poorly drained soils have a seasonal high water table within 2 feet of the surface and are better suited to hay and range than to most other uses. Maintaining soil fertility is a concern in management.

Farms in this association average about 400 acres. Most farmsteads have access to gravel roads. State highway No. 13 crosses part of the association near Pierce. Farm produce is marketed mainly within the county or in adjacent counties.

9. *Lawet-Orwet association*

Deep, nearly level, loamy soils formed in alluvium

This association consists of nearly level bottom lands, mainly along Dry Creek, Breslau Creek, and the upper end of Willow Creek (see fig. 4).

This association occupies about 19,500 acres, or about 5 percent of the county. Lawet soils make up about 60 percent of this association and Orwet soils 20 percent. The remaining 20 percent is minor soils.

Lawet soils are on the lower part of bottom lands. These soils are nearly level, poorly drained, and seldom flooded. They have a surface layer that is dark-gray loam in the upper part and gray sandy clay loam in the lower part. The subsoil is gray sandy clay loam. The underlying material, at a depth of 25 inches, is light-gray sandy loam and sandy clay loam that in some areas contains thin layers of sand. These soils are calcareous throughout. The water table fluctuates between depths of 1 foot in spring and 5 feet in fall.

Orwet soils are on bottom lands. These soils are nearly level and poorly drained and are seldom flooded. They have a surface layer of gray, calcareous loam about 18 inches thick. Beneath this is a transitional layer of gray loamy sand. The underlying material is mottled, light-gray sand. The water table fluctuates between depths of 1 foot in spring and 5 feet in fall.

Minor soils in this association are of the Colo and Lamo series and Marsh and Wet alluvial land. Colo and Lamo soils are near moderately entrenched creek channels. Areas of Marsh are in the lowest positions and are under shallow water most of the time. Wet alluvial land is in the upper ends of drainageways where channels are not well formed.

Most of this association is in native grass and is

used as meadow for hay or as range for grazing cattle. Soils in this association are better suited to meadow or range than to most other uses. Where the range is in good condition, it consists mainly of tall native grasses. These soils are excellent for hay because of beneficial subirrigation from the water table. Redtop is an introduced grass that has become one of the main species in many meadows. A minor acreage is under dryland cultivation, mainly corn and soybeans. In cultivated areas crop production ranges from high in dry years to poor in normal or wet years. Wetness is the main limitation. A minor acreage is tile drained, which results in good stands of corn and soybeans. Lack of suitable outlets limits the acreage that can be tiled. The high content of lime in these soils makes maintaining soil fertility an important concern in management. The organic-matter content is high.

Only a few farmsteads are in this association, and most range and meadows are parts of other upland associations. State Highway No. 13 traverses part of this association. Gravel or dirt roads are on many other section lines. Livestock and farm produce are marketed within the county or at other markets.

Descriptions of the Soils

This section describes the soil series and mapping units in Pierce County. A soil series is described in detail, and then, briefly, each mapping unit in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is more detailed and is for those who need to make thorough and precise studies of soils. Unless otherwise stated, color terms are for dry soil. The profile described in the series is representative of 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.

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.

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

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are 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, and windbreak suitability group can be learned 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," and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*5*).

Bazile Series

The Bazile series consists of deep, well-drained, nearly level to gently sloping soils on uplands and stream terraces. These soils formed in Peoria Loess or silty outwash material over wind-deposited sand or sandy outwash material.

In a representative profile the surface layer is dark grayish-brown silt loam about 12 inches thick. The subsoil is about 15 inches of grayish-brown, firm light silty clay loam. The underlying material, between depths of 27 and 60 inches, is very pale brown sand.

Permeability is moderately slow, and available water capacity is moderate. These soils release moisture readily to plants. During years of below-normal rainfall, they are somewhat droughty, particularly in July and August. Organic-matter content is moderate, and natural fertility is medium.

Bazile soils are suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Bazile silt loam, 1 to 7 percent slopes, in a cultivated field, 1,320 feet west and 25 feet north of the southeast corner of sec. 20 T. 27 N., R. 2 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A12—6 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; slightly acid; clear, smooth boundary.

B1—12 to 16 inches, grayish-brown (10YR 5/2) light silty clay loam, dark brown (10YR 3/3) crushing to dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure parting to weak, fine, granular; hard, firm; neutral; clear, wavy boundary.

B2—16 to 27 inches, grayish-brown (10YR 5/2) light silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, subangular blocky structure; hard, firm; neutral; clear, smooth boundary.

IIC—27 to 60 inches, very pale brown (10YR 7/3) sand, pale brown (10YR 6/3) moist; single grained; loose; neutral.

The thickness of the solum and depth to the underlying sandy material range from 20 to 40 inches. The A horizon ranges from 7 to 20 inches in thickness. It is loam, silt loam, fine sandy loam, loamy fine sand, and fine sand that is slightly acid to medium acid. The B horizon ranges from 8 to 20 inches in thickness. It is silt loam or silty clay loam that is slightly acid or neutral. The IIC horizon ranges from loamy sand to medium sand.

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

Soil	Acres	Percent
Bazile loam, terrace, 0 to 1 percent slopes	2,500	0.7
Bazile silt loam, 0 to 1 percent slopes	1,700	.5
Bazile silt loam, 1 to 7 percent slopes	8,500	2.3
Bazile soils, 0 to 1 percent slopes	1,050	.3
Bazile soils, 1 to 7 percent slopes	9,400	2.6
Bazile soils, terrace, 0 to 1 percent slopes	1,100	.3
Betts loam, 3 to 11 percent slopes, eroded	1,650	.5
Blown-out land	135	(1)
Boelus-Loretto complex, 0 to 2 percent slopes	8,600	2.3
Boelus-Loretto complex, 2 to 7 percent slopes	9,600	2.6
Butler silty clay loam	990	.3
Cass fine sandy loam	1,350	.4
Cass loam	630	.2
Clamo silty clay	1,100	.3
Clamo-Slickspots complex	305	.1
Clarno loam, 2 to 7 percent slopes	1,250	.3
Clarno loam, 7 to 11 percent slopes	1,200	.3
Colo fine sandy loam, overblown	1,050	.3
Colo silt loam	6,300	1.7
Crofton silt loam, 3 to 7 percent slopes, eroded	235	.1
Crofton silt loam, 7 to 17 percent slopes, eroded	2,400	.7
Crofton silt loam, 17 to 30 percent slopes	780	.2
Crofton-Nora silt loams, 1 to 7 percent slopes, eroded	5,700	1.6
Crofton-Nora silt loams, 7 to 11 percent slopes, eroded	26,500	7.2
Crofton-Nora silt loams, 11 to 17 percent slopes, eroded	2,950	.8
Elsmere loamy fine sand, 0 to 2 percent slopes	9,800	2.7
Fillmore complex	910	.2
Hadar loamy fine sand, 2 to 7 percent slopes	3,100	.8
Hadar-Thurman complex, 7 to 11 percent slopes	1,300	.4
Hobbs silt loam	12,800	3.5
Hobbs silt loam, calcareous	3,500	.9
Hobbs silt loam, occasionally flooded	2,900	.8
Hord silt loam	5,200	1.4
Hord-Hobbs silt loams, 0 to 7 percent slopes	13,400	3.6
Lamo silty clay loam	3,350	.9
Lawet loam	10,600	2.9
Lawet-Slickspots complex	1,900	.5
Leshara silt loam	2,900	.8
Longford loam, 1 to 5 percent slopes	115	(1)
Longford soils, 2 to 8 percent slopes, eroded	350	.1
Loretto fine sandy loam, terrace, 0 to 2 percent slopes	1,850	.5
Loretto loam, 0 to 1 percent slopes	1,650	.5
Loretto loam, 1 to 7 percent slopes	2,700	.7
Loup fine sandy loam	2,900	.8
Loup soils	870	.2
Marsh	130	(1)
Moody silty clay loam, 0 to 1 percent slopes	2,800	.8
Moody silty clay loam, 1 to 7 percent slopes	22,750	6.2
Nora silt loam, 1 to 7 percent slopes	11,100	3.0
Nora silt loam, 7 to 11 percent slopes	10,500	2.9
Nora silt loam, 11 to 17 percent slopes	680	.2
Nora-Thurman complex, 7 to 11 percent slopes	3,550	1.0
Nora-Thurman complex, 11 to 17 percent slopes	315	.1
Ord fine sandy loam	1,400	.4
Ord loam	910	.2
Ortello fine sandy loam, 0 to 2 percent slopes	3,350	.9
Ortello fine sandy loam, 2 to 7 percent slopes	9,300	2.5
Ortello fine sandy loam, terrace, 0 to 2 percent slopes	7,900	2.2
Ortello loam, terrace, 0 to 1 percent slopes	700	.2
Orwet loam	4,500	1.2
Ovina fine sandy loam, 0 to 2 percent slopes	3,850	1.0
Ovina loam, 0 to 1 percent slopes	350	.1
Ovina-Slickspots complex	320	.1
Paka sandy loam, 3 to 8 percent slopes	530	.1
Paka sandy clay loam, 3 to 8 percent slopes	340	.1
Sandy alluvial land	600	.2
Silty alluvial land	3,500	1.0
Simeon sandy loam, 3 to 9 percent slopes	700	.2
Thurman loamy fine sand, 0 to 2 percent slopes	8,700	2.4
Thurman loamy fine sand, 2 to 7 percent slopes	37,750	10.3
Thurman loamy fine sand, terrace, 0 to 2 percent slopes	3,300	.9
Thurman fine sandy loam, 7 to 11 percent slopes	2,400	.7
Thurman and Valentine soils, 1 to 7 percent slopes	8,200	2.2
Trent silty clay loam	5,000	1.4
Valentine fine sand, rolling	7,800	2.1
Valentine and Thurman soils, rolling	21,750	5.9
Wet alluvial land	2,350	.6
Gravel pits	185	.1
Intermittent lakes	105	(1)
Lakes	35	(1)
Total	366,720	100.0

[1] Less than 0.05 percent.

Bazile soils are near Loretto, Moody, Ortello, and Thurman soils. They are coarser textured below a depth of 27 inches than Loretto and Moody soils. They have a B horizon of silty clay loam that is lacking in Ortello and Thurman soils. Also, the material in this horizon is finer textured than the material that is at a comparable depth in those soils.

Bazile loam, terrace, 0 to 1 percent slopes (BaA).—This soil is on stream terraces. Areas range from 5 to 250 acres in size. This soil has a profile simiar to the one described as representative of the series, but the surface layer is loam about 20 inches thick.

Included with this soil in mapping were small areas where the underlying material is mixed coarse sand and gravel and a few areas of Hord and Ortello soils. Also included were a few small alkali spots, depressions, and sand and gravel areas, all of which are identified by spot symbols on the detailed soil map.

In places this soil receives additional water that runs in from higher elevations. In some years this soil is droughty during part of July and August. Runoff is slow. This soil is easy to till.

Most of the acreage is cultivated. Corn, oats, soybeans, and alfalfa are the main crops. A small acreage is irrigated. A small acreage is seeded to bromegrass and is used for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is at a depth of 5 to 15 feet. Capability units IIs-5, dryland, and I-7, irrigated; Silty Lowland range site; windbreak suitability group 4.

Bazile silt loam, 0 to 1 percent slopes (BbA).—This soil is on 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 the surface layer is slightly thicker.

Included with this soil in mapping were a few areas of Loretto and Moody soils. Also included were small depressions and sandy areas, both of which are identified by spot symbols on the detailed soil map.

In some years this soil is droughty during part of July and August. Runoff is slow. This soil is easy to till.

Most of the acreage is cultivated. Corn, oats, soybeans, and alfalfa are the main crops. A small acreage is irrigated. A few small areas are seeded to bromegrass and are used for pasture. Capability units IIs-5, dryland, and I-7, irrigated; Silty range site; windbreak suitability group 4.

Bazile silt loam, 1 to 7 percent slopes (BbC).—This soil has long, plane slopes and is on uplands. Areas range from 5 to 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were many small areas of Loretto and Moody soils and some areas where the surface layer is loam. Also included were a few small sandy areas and outcrops of glacial till, both of which are identified by spot symbols on the detailed soil map.

The hazard of water erosion is slight to moderate. Runoff is medium. This soil is easy to till. It is somewhat droughty during years of below normal rainfall.

Most of the acreage is cultivated. Corn, grain sorghum, oats, soybeans, and alfalfa are the main crops. A small acreage is irrigated by sprinklers. A small acreage is seeded to bromegrass and is used for pasture. Capability units IIIe-1, dryland, and IIIe-7, irrigated; Silty range site; windbreak suitability group 4.

Bazile soils, 0 to 1 percent slopes (BcA).—These soils are on uplands where a thin overblow of moderately coarse textured and coarse textured material covered the loess in which these soils formed. Areas range from 5 to 80 acres in size. These soils have a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam, loamy fine sand, or fine sand about 12 inches thick.

Included with these soils in mapping were small areas of Ortello and Thurman soils, areas of the Boelus-Loretto complex, and some small areas where the surface layer is loam.

These soils are subject to soil blowing. They are somewhat droughty during years of below normal rainfall. Runoff is very slow. The soils are easy to work.

Nearly all of the acreage is cultivated. Corn, soybeans, rye sown with vetch, and alfalfa are the main crops. A small acreage is irrigated. Capability units IIe-6, dryland, and IIe-9, irrigated; Sandy range site; windbreak suitability group 3.

Bazile soils, 1 to 7 percent slopes (BcC).—These soils are on uplands where a thin overblow of moderately coarse textured and coarse textured soil material covered the loess in which these soils formed. Slopes are long and plane in some places and short and undulating in others. Areas range from 5 to 300 acres in size. These soils have a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam, loamy fine sand, and fine sand.

Included with these soils in mapping were irregularly shaped areas of Ortello and Thurman soils, areas of the Boelus-Loretto complex, and some small areas where the surface layer is loam. Also included were a few small outcrops of glacial till, which are identified by spot symbols on the detailed soil map.

These soils are susceptible to soil blowing. Water erosion is a hazard in areas where slopes are long and plane. The hazard of gully erosion is severe near drainageways. These soils are somewhat droughty during years of below normal rainfall. Runoff is slow to medium. The soils are easy to till.

Most of the acreage is cultivated. corn, soybeans, rye sown with vetch, and alfalfa are the main crops. A small acreage is irrigated by sprinklers. A few areas are seeded to bromegrass and are used for pasture. A small acreage is in native grass and is used for range. Capability units IIIe-6, dryland, and IIIe-9, irrigated; Sandy range site; windbreak suitability group 3.

Bazile soils, terrace, 0 to 1 percent slopes (BdA).—These soils are on stream terraces where moderately coarse textured and coarse textured material is about 12 inches thick over the original surface layer. Areas range from 5 to 40 acres in size. These soils have a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam, loamy fine sand, and fine sand about 12 inches thick.

Included with these soils in mapping were small areas of Hord, Loretto, and Ortello soils. Also included were some small areas where the surface layer is loam and a few areas where slopes are 1 to 2 percent.

The hazard of soil blowing is slight to moderate. Runoff is very slow. These soils are somewhat droughty during years of below normal rainfall. Fieldwork is easy to perform.

The large areas are cultivated and are used mainly for corn, soybeans, and alfalfa. A small acreage is irrigated. A few areas are seeded to bromegrass and are used for pasture. Small areas are in native grass and are used for range or hay. Alfalfa and trees receive beneficial subirrigation from the water table, which is 5 to 15 feet below the surface. Capability units IIe-6, dryland, and IIe-9, irrigated; Sandy range site; windbreak suitability group 3.

Betts Series

The Betts series consists of deep, well-drained, calcareous, gently sloping or moderately sloping soils that formed in glacial till. These soils are on narrow ridgetops and smooth to convex hillsides on uplands.

In a representative profile the surface layer is grayish-brown loam about 6 inches thick. The subsoil is about 12 inches of pale-brown, firm clay loam that contains accumulated masses of lime. The underlying material, between depths of 18 and 60 inches, is light-gray, mottled clay loam. The upper part, to a depth of

40 inches, contains accumulated masses of lime. The profile contains a few pebbles and stones and is calcareous throughout.

Permeability is moderate, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderately low, and natural fertility is low. These soils are low in content of available phosphorus and zinc, and they are high in content of calcium.

Betts soils are marginal for dryland and irrigated farming. They are well suited to grass. They are also suited to trees and wildlife habitat.

Representative profile of Betts loam, 3 to 11 percent slopes, eroded, in a cultivated field, 660 feet east and 300 feet north of the southwest corner of the southeast quarter of sec. 8, T. 27 N., R. 2 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; moderate, very fine, granular structure; slightly hard, friable; few pebbles; strong effervescence; moderately alkaline; abrupt, smooth boundary.

Bca—6 to 18 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; common, fine, faint, yellowish-brown (10YR 5/6), relict mottles; weak, fine and very fine, subangular blocky structure; hard, firm; few pebbles; common, fine to coarse, accumulated masses of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—18 to 40 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; many, medium, distinct, yellowish-brown (10YR 5/6), relict mottles; moderate, coarse and fine, angular blocky structure; hard, firm; few pebbles; common, fine to coarse, accumulated masses of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—40 to 60 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; many, medium, distinct, yellowish-brown (10YR 5/6), relict mottles; massive; hard, firm; few pebbles; strong effervescence; moderately alkaline.

The A horizon ranges from 3 to 6 inches in thickness and is loam or clay loam. The B horizon ranges from 4 to 12 inches in thickness and is loam or clay loam. The C2 horizon is at a depth of 20 to 45 inches. In some areas a few boulders are on the surface and throughout the profile.

Betts soils are near Clarno, Crofton, Hadar, and Nora soils. They have a thinner A horizon and are shallower to lime than Clarno or Nora soils. They formed in glacial till, whereas Crofton and Nora soils formed in Peoria Loess. Betts soils are finer textured in the A horizon and in the upper part of the B horizon than Hadar soils.

Betts loam, 3 to 11 percent slopes, eroded (BeD2).—This soil is mainly on hillsides that face northwest and on plane to convex ridgetops on glacial uplands. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were a few areas of soils that have a surface layer of clay loam; a few areas of strongly sloping to steep Betts soils; and small areas of Clarno, Crofton, Nora, and Simeon soils. Also included were a few, small, gravelly areas and a few areas where slopes are short and steep, both of which are identified by spot symbols on the detailed soil map.

Water erosion is a hazard if this soil is cultivated. The hazard of sheet and rill erosion is very severe, and gully erosion is common near drainageways. Runoff is medium to rapid. This soil is somewhat difficult to work, because a few stones and pebbles are on the surface and in the plow layer.

This soil is used for crops, tame pasture, and range. Corn, oats, and alfalfa are the main crops. The acreage under irrigation is small, because good wells are difficult to obtain. Bromegrass is the main grass seeded for pasture. Areas in native grasses are used mainly for range, but a small acreage is mowed for hay. Capability units IVe-9, dryland, and IVe-4, irrigated; Limy Upland range site; windbreak suitability group 5.

Blown-out Land

Blown-out land (1 to 30 percent slopes) (Bn) is in areas of undulating to rolling sandhills that are mostly barren of vegetation. It also is in small bowl-shaped areas that have been hollowed out by northwesterly winds. Areas of Blown-out land range from 5 to 30 acres in size.

Blown-out land consists of loose, brown fine sand that shifts easily as the wind blows. It is medium acid or slightly acid. Runoff is very slow. This land type occurs in areas where the native grasses have been destroyed by cattle trailing, livestock concentration, or cultivation. The hazard of soil blowing is very severe, and sand from the blowouts accumulates in adjacent areas. The side slopes are commonly steep and require some shaping before they can be seeded.

Blown-out land is used for range, but it has very little grass for grazing. Capability unit VIIe-5, dryland; Sands range site; windbreak suitability group 10.

Boelus Series

The Boelus series consists of deep, well-drained, nearly level to gently undulating soils on uplands. These soils formed in a thin layer of eolian sand and the underlying Peoria Loess.

In a representative profile, the surface layer is loamy fine sand about 23 inches thick. It is dark grayish brown in the upper 16 inches and grayish brown in the lower 7 inches. The subsoil is pale-brown, friable silt loam about 24 inches thick. The underlying material, between depths of 47 and 60 inches, is very pale brown, calcareous silt loam.

Permeability is rapid in the upper sandy part of the profile and moderate in the lower silty part. Available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Boelus soils are well suited to dryland and irrigated farming. They are also suited to tame and native grasses, trees, and wildlife habitat.

Representative profile of Boelus loamy fine sand in an area of Boelus-Loretto complex, 2 to 7 percent slopes, in a cultivated field, 1,320 feet east and 575 feet north of the southwest corner of sec. 27, T. 26 N., R. 3 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, granular structure; soft, very friable; medium acid; abrupt, smooth boundary.

A12—7 to 16 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, granular structure; soft, very friable; medium acid; clear, smooth boundary.

A13—16 to 23 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak,

fine and very fine, granular structure; soft, very friable; medium acid; clear, smooth boundary.

IIB2—23 to 35 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10 YR 4/2) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable; neutral; gradual, wavy boundary.

IIB3—35 to 47 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; few, fine, faint, yellow (10YR 7/6) and gray (10YR 6/1), relict mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; gradual, wavy boundary.

IIC—47 to 60 inches, very pale brown (10YR 7/4) silt loam, yellowish brown (10YR 5/4) moist; common, fine, faint, yellow (10YR 7/6) and gray (10YR 5/1), relict mottles; weak, medium, prismatic structure; slightly hard, friable; strong effervescence; few fine and medium lime concretions; moderately alkaline.

The A horizon ranges from 10 to 25 inches in thickness. It is loamy fine sand or fine sand that is medium acid or slightly acid. The IIB2 horizon is silt loam or silty clay loam. Lime is at a depth of 30 to 55 inches.

Boelus soils are near Loretto, Nora, and Thurman soils and have a profile similar to Hadar soils. They have a coarser textured A horizon than Loretto and Nora soils. They have finer textured IIB and IIC horizons than the material that is at a comparable depth in Thurman soils. They have IIB and IIC horizons that formed in Peoria Loess, whereas in Hadar soils these horizons formed in glacial till.

Boelus-Loretto complex, 0 to 2 percent slopes (BoA).—The soils in this complex are on uplands in areas where Peoria Loess has an overblow of eolian sand. Slopes are plane or complex. Areas range from 5 to 150 acres in size. This complex is about 60 percent Boelus loamy fine sand, 30 percent Loretto fine sandy loam, and 10 percent other soils.

The Boelus and Loretto soils have profiles similar to those described as representative of their respective series, but the surface layer is slightly thicker and lime is at a greater depth.

Included with these soils in mapping were small areas of Bazile, Hord, Ortello, Nora, and Thurman soils and some areas of Boelus soils that have a surface layer of fine sand. Also included were small depressions, which are identified by spot symbols on the detailed soil map.

Soil blowing is the principal hazard. Runoff is very slow. The soils are easy to till.

Most of the acreage is cultivated. Corn is the main crop, but a small acreage of soybeans, oats, and alfalfa and of rye sown with vetch is also grown. A few areas are irrigated. A minor acreage is seeded to bromegrass and is used for pasture. A small acreage is in native grass and is used for range and hay. Capability units IIe-6, dryland, and IIe-10, irrigated; Sandy range site; windbreak suitability group 3.

Boelus-Loretto complex, 2 to 7 percent slopes (BoC).—The soils in this complex are on uplands. Slopes are long and plane in some places and undulating in others. These soils occur in areas where Peoria Loess has an overblow of eolian sand. Areas range from 5 to 240 acres in size. This complex is about 65 percent Boelus loamy fine sand, 25 percent Loretto fine sandy loam, and 10 percent other soils.

The Boelus soil has the profile described as representative of the Boelus series. The Loretto soil has a profile similar to the one described as representative of the Loretto series, but the surface layer is slightly thinner.

Included with these soils in mapping were small areas of Bazile, Ortello, Nora, and Thurman soils and some areas of Boelus soils that have a surface layer of fine sand.

These soils are susceptible to water erosion and soil blowing. Gully erosion is a hazard near drainageways. Runoff is slow to medium. The soils are easy to till.

Most of the acreage is cultivated. The main crops are corn and alfalfa, but a smaller acreage is used for soybeans and oats and for rye sown with vetch. Some areas are irrigated by sprinklers. A small acreage is seeded to bromegrass and is used for pasture. A few areas are in native grass and are used for range and hay. Capability units IIIe-6, dryland, and IIIe-10, irrigated; Sandy range site; windbreak suitability group 3.

Butler Series

The Butler series consists of deep, somewhat poorly drained, nearly level soils that formed in loess. These soils are in upland basins that have very slow surface drainage.

In a representative profile the surface layer is dark-gray silty clay loam about 12 inches thick. The subsoil is very firm silty clay about 34 inches thick. It is very dark gray in the upper 16 inches, dark gray in the next 12 inches, and gray in the lower 6 inches. The underlying material, between depths of 46 and 60 inches, is olive-gray silty clay loam.

Permeability is slow, and available water capacity is moderate. The soils are somewhat droughty in summer because moisture cannot readily penetrate the claypan subsoil, and this limits the storage of moisture and the growth of roots. Organic-matter content is moderate, and natural fertility is medium.

Butler soils are suited to dryland and irrigated farming. They are also suited to tame or native grass, trees, and wildlife habitat.

Representative profile of Butler silty clay loam, in a cultivated field, 240 feet east and 20 feet north of the southwest corner of the northwest quarter of sec. 7, T. 28 N., R. 3 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; hard, firm; medium acid; abrupt, smooth boundary.

A12—7 to 12 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; hard, firm; medium acid; abrupt, smooth boundary.

B21t—12 to 28 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; moderate, fine, prismatic structure parting to moderate, medium and fine, angular blocky; very hard, very firm; films on faces of peds; few fine iron or manganese pellets; medium acid; gradual, wavy boundary.

B22t—28 to 40 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak, medium, prismatic structure parting to fine, angular blocky; very hard, very firm; slightly acid; gradual, wavy boundary.

B3—40 to 46 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; weak, medium, prismatic structure parting to very fine, angular blocky; very hard, very firm; slightly acid; clear, wavy boundary.

C—46 to 60 inches, olive-gray (5Y 5/2) silty clay loam, olive gray (5Y 4/2) moist; weak, medium, prismatic structure; hard, firm; neutral.

The solum ranges from 30 to 50 inches in thickness. The A1 horizon ranges from 7 to 14 inches in thickness and is silt loam or silty clay loam. In some areas there is an A2 horizon of gray silt loam 1 to 2 inches thick. The C horizon is mainly Peoria Loess, but in places it includes silty material of the Sappa Formation.

Butler soils have a B horizon that is similar in texture to Clamo and Longford soils, and they are near Fillmore and Trent soils. They do not have the moderately high water table, mottles, and lime in the B3 and C horizons, which are characteristic of Clamo soils. They are more poorly drained and have a grayer B horizon than Longford soils. They are better drained and lack or have a thinner A2 horizon than Fillmore soils. They are more poorly drained and have a more clayey B horizon than Trent soils.

Butler silty clay loam (0 to 1 percent slopes) (Bt).—This soil is on loess uplands. It occurs on the landscape between areas of well-drained, sloping soils and poorly drained soils in depressions. Areas are generally oval in shape and range from 5 to 100 acres in size.

Included with this soil in mapping were small areas of Fillmore and Trent soils and a few small areas of soils that have a surface layer of silt loam. Also included were a few small depressions, which are identified by a spot symbol on the detailed soil map.

Wetness is the principal limitation in cultivated areas. The soil receives additional water as runoff from higher elevations. Runoff is very slow. The slow permeability of the subsoil prevents easy movement of water through the soil. During dry seasons, the clayey subsoil limits the amount of available water to plant roots. This soil is somewhat difficult to till because it is firm when moist and stays wet for fairly long periods after rain.

Most of the acreage is cultivated or in tame pasture. Corn and alfalfa are the main crops, but a small acreage is in soybeans, grain sorghum, and oats. Corn is the main irrigated crop. Bromegrass is the main grass seeded for pasture. A small acreage is in native grass and is used for range and hay. Open-land wildlife feed in areas of this soil. Capability units IIw-2, dryland, and IIw-1, irrigated; Clayey Overflow range site; windbreak suitability group 2.

Cass Series

The Cass series consists of deep, well-drained, nearly level soils on bottom lands, mainly in the valley of the North Fork Elkhorn River. These soils formed in alluvium.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 20 inches thick. The underlying material to a depth of 60 inches is 15 inches of grayish-brown loamy fine sand, 11 inches of dark grayish-brown very fine sandy loam, and 14 inches of light brownish-gray sand. The soil is mottled below a depth of 35 inches.

Permeability is moderately rapid, and available water capacity is moderate. The water table ranges in depth from 8 feet in spring to about 15 feet in fall. These soils absorb moisture easily and release it readily to plants. They are flooded about once every 3 years, mainly in spring after a rapid snowmelt or heavy rain. Organic-matter content is moderately low, and natural fertility is medium.

Cass soils are well suited to cultivated crops and grass. They respond well to irrigation. Trees and shrubs grow well in windbreaks, and the soils can also be used for wildlife habitat.

Representative profile of Cass fine sandy loam, in a cultivated field, 530 feet west and 20 feet north of the southeast corner of the southwest quarter of sec. 7, T. 25 N., R. 1 W.:

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, fine and very fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—6 to 13 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

A13—13 to 20 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, very fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

C1—20 to 35 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, very fine, crumb structure; soft, very friable; neutral; clear, smooth boundary.

Ab—35 to 46 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) moist; few, fine, faint, yellowish-brown (10YR 5/8) mottles; weak, very fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

IIC—46 to 60 inches, light brownish-gray (10YR 6/2) sand, grayish brown (10YR 5/2) moist; few, fine, distinct, yellow (10YR 7/8) mottles; single grained; loose; neutral.

The A horizon ranges from 10 to 20 inches in thickness. In places a slightly lighter colored layer of overwash material is on the surface. The A horizon is loam or fine sandy loam and ranges from medium acid to neutral. The C horizon ranges from very fine sandy loam to sand, but in places it contains thin layers of sandy clay loam and loam. Buried soils are in many areas. Gray clay is at a depth of 6 to 10 feet in many places.

Cass soils are near Elsmere, Hobbs, Ord, and Ovina soils. They have a lower water table than Elsmere, Ord, and Ovina soils. In addition, they are not so coarse textured in the upper part of the C horizon as Elsmere soils. They are coarser textured throughout than Hobbs soils.

Cass fine sandy loam (0 to 2 percent slopes) (Ca).—This soil is adjacent to meandering stream channels. In places there are low hummocks, and in other places there are narrow swales. Areas range from 5 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Hobbs silt loam, Ord fine sandy loam, and Sandy alluvial land. Also included were a few small areas where the surface layer is loamy fine sand and a few areas that are occasionally flooded. Small depressions are identified by a spot symbol on the detailed soil map.

This soil is droughty during midsummer unless rain is timely. Soil blowing is a hazard unless the soil is adequately protected. Runoff is very slow.

Most of the acreage is cultivated. Corn is the main crop, but soybeans, oats, and alfalfa are also grown. A small acreage is irrigated. Capability units IIs-6, dryland, and IIs-8, irrigated; Sandy Lowland range site; windbreak suitability group 3.

Cass loam (0 to 2 percent slopes) (Cb).—This soil is on bottom lands. Areas range from 5 to 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is loam about 8 inches thick.

Included with this soil in mapping were small areas of Hobbs silt loam, Cass fine sandy loam, and Ord loam. Also included were areas of Sandy alluvial land near the channels of the North Fork Elkhorn River and areas where lighter colored overwash is on the surface.

This soil is well suited to cultivated crops. During years of below-normal rainfall, crops can be under moisture stress during July and August. Runoff is slow.

Almost all the acreage is cultivated. Only a small part is irrigated, but the response of crops to the additional water is good. Corn, soybeans, and alfalfa are the main crops. Capability units I-1, dryland, and I-8, irrigated; Sandy Lowland range site; windbreak suitability group 1.

Clamo Series

The Clamo series consists of deep, somewhat poorly drained, nearly level soils that formed in clayey alluvium. These soils are on bottom lands of the North Fork Elkhorn River and at the upper end of Willow Creek.

In a representative profile the surface layer is silty clay about 20 inches thick. It is dark gray in the upper 7 inches and very dark gray in the lower 13 inches. The subsoil is very firm silty clay about 28 inches thick. It is dark gray in the upper 18 inches and gray mottled with yellow in the lower 10 inches. The underlying material, between depths of 48 and 60 inches, is light olive-gray, mottled silty clay. The soil is calcareous below a depth of 38 inches.

Clamo soils have slow permeability and moderate available water capacity. These soils absorb moisture slowly and release it slowly to plants. They are difficult to work because they are very hard when dry and very sticky when wet. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderate, and natural fertility is medium.

Clamo soils are suited to dryland and irrigated farming. They can be used for native or tame grass, trees and shrubs in windbreaks, and wildlife habitat.

Representative profile of Clamo silty clay, in a cultivated field, 480 feet west and 100 feet south of the northeast corner of the northwest quarter of sec. 36, T. 26 N., R. 2 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate, fine, granular structure; very hard, very firm; neutral; abrupt, smooth boundary.

A12—7 to 20 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; strong, medium and fine, granular structure; very hard, very firm; neutral; clear, smooth boundary.

B2—20 to 38 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong, medium, prismatic structure parting to strong, fine, angular blocky; very hard, very firm; neutral; clear, smooth boundary.

B3gca—38 to 48 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; common, fine, distinct, yellow (5Y 7/6) mottles; strong, medium, prismatic structure parting to strong, fine, angular blocky; very hard, very firm; many small lime concretions (2 percent lime); violent effervescence; moderately alkaline; clear, smooth boundary.

Cg—48 to 60 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 5/2) moist; many, medium, distinct, yellow (5Y 7/6) mottles; massive; very hard, very firm; few small lime concretions (2 percent lime); violent effervescence; moderately alkaline.

The A horizon ranges from 15 to 30 inches in thickness. It is mainly silty clay, but in places it is silty clay loam and clay. It is very dark gray or dark gray and is neutral or mildly alkaline. The B horizon ranges from 10 to 30 inches in thickness. Depth to lime ranges from 20 to 45 inches. Buried soils are in many areas.

Clamo soils are near Colo, Lamo, and Hobbs soils. They are finer textured than these soils, and they have a B horizon whereas the others do not. In addition, they have a higher water table than Hobbs soils.

Clamo silty clay (0 to 1 percent slopes) (Cc).—This soil is on bottom lands. Areas range from 5 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Lamo and Leshara soils and a few small areas where the surface layer is silty clay loam or clay. Small depressions and alkali areas are identified by spot symbols on the detailed soil map.

In spring the water table is at a depth of about 3 feet, but it recedes to a depth of 6 to 8 feet late in summer and in fall. Fieldwork is commonly delayed by wetness in spring. This soil is flooded about once every 3 years. The flooding is from stream overflow after a rapid snowmelt or heavy rain. The slow intake of moisture and slow permeability cause the wetness hazard. During summer and early in fall, when rainfall is normally low, the soil becomes dry, cracks, and is droughty. This soil is difficult to work because it is sticky when wet and very hard when dry.

Most of the acreage is cultivated. Only a small acreage is irrigated. The most common crops are corn, soybeans, and alfalfa. Alfalfa does well because it can benefit from the moderately high water table. Capability units IIIw-1, dryland, and IIIw-1, irrigated; Subirrigated range site; windbreak suitability group 2.

Clamo-Slickspots complex (0 to 2 percent slopes) (Cd).—The soils in this complex are on bottom lands, mainly along the upper end of Willow Creek. This complex is about 75 percent Clamo silty clay and 25 percent Slickspots. The Clamo soil is nearly level and is at slightly higher elevations than areas of Slickspots. Slopes are plane. Slickspots are in scattered microdepressions that are irregular in shape, but range roughly from 5 to 15 feet in diameter.

The Clamo soil has a profile similar to the one described as representative of the series, but the lower part is slightly higher in alkalinity and lime is closer to the surface. Also, the water table is slightly higher than in areas of the normal Clamo soil. In this complex Slickspots have a texture of silty clay throughout. The surface layer is black and puddled when moist and has a thin, light-gray crust when dry. It ranges from strongly alkaline to very strongly alkaline.

The alkalinity of the Slickspots is the soil characteristic that determines the use of these areas. In range areas water remains in the microdepressions until it slowly seeps away or evaporates. The high content of sodium is toxic to many plants, and crop growth is poor on Slickspots in cultivated fields. Soil structure breaks down in cultivated areas of Slickspots. The areas are commonly dry and cloddy on the surface

when dry, but the soil can be wet a few inches beneath the dry surface. Slickspots are difficult to manage. Runoff is slow.

Nearly all of the acreage of this complex is in native grass. Only a few areas are cultivated. Capability unit IVs-1, dryland; Clamo part in Subirrigated range site and windbreak suitability group 2; Slickspots part in Saline Subirrigated range site and windbreak suitability group 10.

Clarno Series

The Clarno series consists of deep, well-drained, gently sloping or moderately sloping soils on uplands. These soils formed in glacial till.

In a representative profile the surface layer is dark grayish-brown loam about 11 inches thick. The subsoil is firm clay loam about 17 inches thick. The upper 5 inches of the subsoil is grayish brown, and the lower 12 inches is light brownish gray and contains some accumulated masses of lime. The underlying material, between depths of 28 and 60 inches, is light-gray clay loam. In the upper 25 inches it is mottled and contains some accumulated masses of lime. This soil contains a few pebbles and stones throughout the profile.

Permeability is moderate, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderate, and natural fertility is medium. These soils are high in content of calcium in the lower part of the subsoil and in the underlying material.

Clarno soils are suited to dryland and irrigated farming. They are excellent for grass. They are also suited to trees and wildlife habitat.

Representative profile of Clarno loam, 2 to 7 percent slopes, in a cultivated field, 620 feet south and 150 feet west of the northeast corner of sec. 19, T. 28 N., R. 2 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; slightly hard, friable; few pebbles; slightly acid; abrupt, smooth boundary.

A3—7 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; few pebbles; slightly acid; clear, wavy boundary.

B2—11 to 16 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine and very fine, subangular blocky structure; hard, firm; few pebbles; neutral; clear, wavy boundary.

B3ca—16 to 28 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; hard, firm; few pebbles; common, fine to medium, accumulated masses of lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—28 to 53 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; many, medium, distinct, light olive-brown (2.5Y 5/6), relict mottles; weak, medium, prismatic structure parting to weak, medium, angular blocky; hard, firm; few pebbles; common, fine to medium, accumulated masses of lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2—53 to 60 inches, light-gray (5Y 7/2) clay loam, light olive gray (5Y 6/2) moist; massive; very hard, very firm; few pebbles; violent effervescence; moderately alkaline.

The A horizon ranges from 7 to 14 inches in thickness. It is mainly loam, but in a few areas it is silty clay loam. It is mainly glacial till, but in some places it includes a small amount of Peoria Loess. The B horizon ranges from 10 to 30 inches in thickness. Depth to lime ranges from 12 to 30 inches. In some areas a few boulders are on the surface and throughout the profile.

Clarno soils are near Betts, Hadar, Nora, and Moody soils. They have a thicker A horizon and are deeper to lime than Betts soils. They are finer textured in the A horizon and upper part of the B horizon than Hadar soils. They formed in glacial till, whereas Nora and Moody soils formed in Peoria Loess.

Clarno loam, 2 to 7 percent slopes (CeC).—This soil is on glacial till uplands. Slopes are long and plane. Areas range from 5 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of nearly level or very gently sloping soils. Also included were small areas of Bazile, Betts, and Moody soils. A few small exposures of reddish loess, sandy soils, and stony areas are identified by spot symbols on the detailed soil map.

The hazard of water erosion is moderate in cultivated areas. Runoff is medium. This soil is somewhat difficult to work. Occasional stones and pebbles on the surface and in the plow layer can damage farm implements.

Most of the acreage is cultivated or in tame pasture. Corn, soybeans, oats, and alfalfa are the main crops. The acreage of irrigated crops is small, because good wells are difficult to obtain. Bromegrass is the main grass seeded for pasture. A small acreage is in native grass and is used for range and hay. Capability units IIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

Clarno loam, 7 to 11 percent slopes (CeD).—This soil is on long plane hillsides in glacial till uplands. Areas range from 5 to 30 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thinner.

Included with this soil in mapping were a few areas where water erosion has removed the original surface layer, exposing the grayish-brown subsoil, and small areas of Betts, Crofton, Hadar, and Nora soils. Also included were a few small areas of sandy soils and stony areas, all of which are identified by special symbols on the detailed soil map.

The hazard of sheet and rill erosion is severe in cultivated areas. Runoff is medium. This soil is somewhat difficult to work. A few stones and pebbles on the surface and in the plow layer can damage farm implements.

This soil is used for crops, tame pasture, and range. Corn, oats, and alfalfa are the main crops. The acreage of irrigated crops is small, because good wells are difficult to obtain. Bromegrass is the main grass seeded for tame pasture. Areas in native grass are used mainly for range, but a small acreage is mowed for hay. Capability units IIIe-1, dryland, and IVe-4, irrigated; Silty range site; windbreak suitability group 4.

Colo Series

The Colo series consists of deep, somewhat poorly

drained, nearly level soils on narrow bottom lands and low stream terraces. These soils formed mainly in silty alluvium, but in some areas the surface layer is loamy.

In a representative profile the surface layer is silt loam about 38 inches thick. The upper 12 inches of the surface layer is dark grayish brown, and the lower 26 inches is dark gray. Beneath this is a transitional layer of gray, mottled silty clay loam about 12 inches thick. The underlying material, between depths of 50 and 60 inches, is grayish-brown, mottled silty clay loam.

Permeability is moderately slow, and available water capacity is high. These soils absorb moisture easily and release it readily to plants. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderate, and natural fertility is high.

Colo soils are suited to dryland and irrigated farming. They are also suited to native or tame grass, trees and shrubs, and wildlife habitat.

Representative profile of Colo silt loam, in a cultivated field, 535 feet west and 70 feet south of the northeast corner of sec. 19, T. 28 N., R. 2 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; friable, slightly hard; slightly acid; abrupt, smooth boundary.

A12—7 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; friable, slightly hard; slightly acid; clear, smooth boundary.

A13—12 to 38 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; few, fine, distinct, reddish-brown (5YR 5/4) mottles; moderate, fine, granular structure; friable, slightly hard; slightly acid; gradual, wavy boundary.

AC—38 to 50 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; few, fine, distinct, reddish-brown (5YR 5/3) mottles; weak, very fine, granular structure; firm, hard; slightly acid; clear, smooth boundary.

C—50 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; many, medium, prominent, reddish-yellow (7.5YR 6/6) mottles; massive; firm, hard; water table at depth of 55 inches; neutral.

The A horizon ranges from 20 to 40 inches in thickness. The upper part is most commonly silt loam, but in some areas it is silty clay loam and fine sandy loam. The AC horizon ranges from dark gray to brown. Depth to lime ranges from 36 inches to more than 60 inches.

Colo soils are near Lamo, Leshara, Clamo, and Hobbs soils. They are leached of lime to a greater depth than Lamo and Leshara soils. In addition, they are finer textured in the AC and C horizons than Leshara soils. They are not so fine textured as Clamo soils. They have a higher water table than Hobbs soils.

Colo fine sandy loam, overblown (0 to 2 percent slopes) (Cf).—This soil is on low stream terraces. Areas range from 10 to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the upper part of the surface layer is gray fine sandy loam about 14 inches thick.

Included with this soil in mapping were small areas of Ovina fine sandy loam and Ortello fine sandy loam. A few small alkali areas are identified by a spot symbol on the detailed soil map. Also included are areas of soils that have grayish silty material between depths of 40 and 60 inches in places and reddish loamy material in other places.

The moderately high water table causes wetness in spring, which delays tillage. Soil blowing is a hazard unless the surface is adequately protected.

Most of the acreage is cultivated, but some areas are in native range and others are in tame grass pasture. Corn, soybeans, and alfalfa are the main crops. Capability units IIw-6, dryland, and IIw-5, irrigated; Subirrigated range site; windbreak suitability group 2.

Colo silt loam (0 to 1 percent slopes) (Co).—This soil is on bottom lands and low stream terraces. Areas range from 5 to 200 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of Lamo silty clay loam and Lawet loam. Also included were a few small areas of Moody soils in areas where the Colo soil is near foot slopes. A few small alkali areas are identified by a spot symbol on the detailed soil map.

Wetness from the moderately high water table commonly delays tillage in spring. This soil warms up more slowly than better drained soils. Also, it is flooded by overflow from streams after heavy rain. During summer, when rainfall is lowest, the water table is beneficial to deep-rooted crops.

This soil is used mainly for cultivated crops. Corn, soybeans, and alfalfa are the main crops. A small acreage is in native grass and is used for pasture and hay. Capability units IIw-4, dryland, and IIw-4, irrigated; Subirrigated range site; windbreak suitability group 2.

Crofton Series

The Crofton series consists of deep, well-drained, gently sloping to steep, calcareous soils that formed in Peoria Loess. These soils are on narrow ridgetops and plane to convex hillsides.

In a representative profile the surface layer is pale-brown silt loam about 6 inches thick that contains a few lime concretions. The underlying material, which extends to a depth of 60 inches, is silt loam. The upper 15 inches is pale brown and contains many lime concretions, and the lower part is very pale brown and contains few lime concretions. The profile is calcareous throughout.

Permeability is moderate, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderately low, and natural fertility is low. These soils are low in available phosphorus, sulfur, and zinc; and they are high in calcium.

Gently sloping to strongly sloping Crofton soils are suited to dryland crops and tame pasture. Gently sloping Crofton soils are also suited to sprinkler irrigation. Steep Crofton soils are better suited to native grass than to other uses.

Representative profile of Crofton silt loam in an area of Crofton-Nora silt loams, 7 to 11 percent slopes, eroded, in a cultivated field, 250 feet east and 140 feet south of the northwest corner of sec. 7, T. 27 N., R. 1 W.:

Ap—0 to 6 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) moist; weak, very fine, granular structure; slightly hard, friable; few fine and medium lime concretions; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1ca—6 to 21 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; slightly hard, friable; common fine and medium lime concretions; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—21 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; many, medium, distinct, yellow (10YR 7/6) and gray (10YR 6/1), relict mottles; weak, medium, prismatic structure; slightly hard, friable; few fine and medium lime concretions; strong effervescence; moderately alkaline.

The A horizon ranges from 3 to 6 inches in thickness and from dark grayish brown to pale brown. The C1ca horizon ranges from 5 to 25 inches in thickness and has weak subangular blocky structure or is massive. The C horizon ranges from light yellowish brown to light gray. Depth to lime ranges from 0 to 10 inches.

Crofton soils are similar to Betts soils and are near Moody and Nora soils. They formed in silty loess, whereas Betts soils formed in clay loam glacial till. They have a thinner A horizon and are shallower to lime than Moody and Nora soils, and they do not have a B horizon, which is characteristic of those soils.

Crofton silt loam, 3 to 7 percent slopes, eroded (CrC2).—This soil is on narrow, convex ridgetops on loess uplands. Areas range from 5 to 20 acres in size.

Included with this soil in mapping were a few small areas of uneroded Crofton soils and a few areas of Nora soils.

Water erosion is the principal hazard. Soil blowing is a hazard unless the surface layer is adequately protected. Runoff is medium. This soil is easy to till.

Most of the acreage is cultivated. Corn, oats, and alfalfa are the main crops. Bromegrass is the main grass seeded for pasture. A small acreage is in native grass and is used for range and hay. Capability units IIIe-9, dryland, and IIIe-6, irrigated; Limy Upland range site; windbreak suitability group 5.

Crofton silt loam, 7 to 17 percent slopes, eroded (CrE2).—This soil is on plane to convex hillsides on loess uplands. Areas range from 5 to 40 acres in size.

Included with this soil in mapping were small areas of uneroded Crofton soils and small areas of Crofton silt loam, 17 to 30 percent slopes. Areas of Hord-Hobbs silt loams, 0 to 7 percent slopes, were included in a few narrow drainageways. Also included were small areas of glacial till and sandy areas, both of which are identified by spot symbols on the detailed soil map.

Water erosion is a very severe hazard if this soil is cultivated. The hazard of sheet and rill erosion is very severe, and gully erosion is common near drainageways. Runoff is medium to rapid. This soil is easy to till; but where it is strongly sloping, this soil is difficult to traverse with farm machinery.

This soil is used mainly for crops and pasture. Corn, oats, and alfalfa are the main crops. Bromegrass is the main grass seeded for pasture. A small acreage is in native grass and is used for range and hay. Capability unit IVe-9, dryland; Limy Upland range site; windbreak suitability group 5.

Crofton silt loam, 17 to 30 percent slopes (CrF).—This soil is on plane to convex side slopes, mainly near the upper end of drainageways on loess uplands. Areas range from 5 to 40 acres in size.

The soil has a profile similar to the one described as representative of the series, but the surface layer is grayish brown. Small areas that have been plowed are eroded. Catsteps and occasional gullies make up a small part of the acreage.

Included with this soil in mapping were areas of soils that have a sandy surface layer and small areas of deep sandy soils; these areas are shown on the detailed soil map by spot symbols. Also included were small areas of Betts soils and areas of Hobbs soils along narrow drainageways.

Runoff is rapid. The hazard of water erosion is generally slight, but small areas that have been cultivated are eroded.

This soil is used mainly for range because it has steep slopes. Most of the acreage is in native grass. A few small areas that have been cultivated are mainly in bromegrass and alfalfa. Capability unit VIe-9, dryland; Limy Upland range site; windbreak suitability group 10.

Crofton-Nora silt loams, 1 to 7 percent slopes, eroded (CsC2).—The soils in this complex are on narrow, convex to plane ridgetops on loess uplands. Areas range from 5 to 40 acres in size. This complex is about 70 percent Crofton silt loam and 30 percent Nora silt loam. The Crofton soil is in the more eroded, convex parts.

The surface layer of the Crofton soil is calcareous and is lighter colored than that of the Nora soil. The Nora soil has a profile similar to the one described as representative of the Nora series, but the surface layer is slightly thicker.

Included with these soils in mapping were small areas of Moody silty clay loam, 1 to 7 percent slopes. Also included were a few small areas of sandy soils, which are indicated by a spot symbol on the detailed soil map.

Water erosion is a hazard on these soils. Runoff is medium. These soils are easy to till. Phosphorus is beneficial to legumes.

Most of the acreage of this complex is cultivated. Corn is the main crop. Oats, alfalfa, soybeans, and grain sorghum are also grown. A small acreage of corn and alfalfa is sprinkler irrigated, and a small acreage is in native grass. Bromegrass is used for tame pasture. Capability units IIIe-9, dryland, and IIIe-6, irrigated; Crofton part in Limy Upland range site and windbreak suitability group 5; Nora part in Silty range site and windbreak suitability group 4.

Crofton-Nora silt loams, 7 to 11 percent slopes, eroded (CsD2).—The soils in this complex are on ridgetops and hillsides on loess uplands. Areas range from 5 to 100 acres in size. The complex is about 70 percent Crofton silt loam and 30 percent Nora silt loam. The Crofton soil is on the upper parts of hillsides and in convex areas, and the Nora soil is on the lower, plane hillsides.

The Crofton soil is calcareous and is lighter colored than the Nora soil. It has the profile described as representative of the Crofton series. The Nora soil has a profile similar to the one described as repre-

sentative of the Nora series, but the surface layer is slightly lighter colored.

Included with these soils in mapping were small areas of Moody silty clay loam, 1 to 7 percent slopes, and some areas of Hord-Hobbs silt loams, 0 to 7 percent slopes, in narrow drainageways. Also included were a few small areas of glacial till, reddish loess, and sandy soils; these areas are indicated on the detailed soil map by spot symbols.

Water erosion is a hazard if the soils are cultivated. The hazard of sheet and rill erosion is severe. Runoff is medium. These soils are easy to till. Phosphorus is beneficial to legumes.

Most of the acreage is cultivated and is used mainly for corn, oats, and alfalfa. A smaller acreage is used for soybeans and grain sorghum, and a small acreage is sprinkler irrigated. Bromegrass is commonly used for tame pasture. A small acreage has been seeded to native grass. Capability units IIIe-9, dryland, and IVe-6, irrigated; Crofton part in Limy Upland range site and windbreak suitability group 5; Nora part in Silty range site and windbreak suitability group 4.

Crofton-Nora silt loams, 11 to 17 percent slopes, eroded (CsE2).—The soils in this complex are on ridgetops and hillsides on loess uplands. Areas range from 5 to 40 acres in size. This complex is about 70 percent Crofton silt loam and 30 percent Nora silt loam. The Crofton soil is on the upper parts of hillsides and in convex areas, and the Nora soil is on the lower, plane hillsides.

The Crofton soil is calcareous and is lighter colored than the Nora soil. The Nora soil has a profile similar to the one described as representative of the Nora series, but the surface layer is slightly lighter colored.

Included with these soils in mapping were small areas of Hord-Hobbs silt loams, 0 to 7 percent slopes, in narrow drainageways. Also included were a few small areas of glacial till, reddish loess, and sandy soils; these areas are indicated on the detailed soil map by spot symbols.

Water erosion is a hazard if these soils are cultivated. The hazard of sheet and rill erosion is very severe, and gully erosion is common near drainageways. Runoff is medium to rapid. Soils of this complex are easy to till, but they are difficult to traverse with farm machinery. Phosphorus is beneficial to legumes.

Most of the acreage is cultivated or is in tame pasture. Corn, oats, and alfalfa are the main crops. Bromegrass is commonly used for tame pasture. A small acreage has been seeded to native grass for range. Capability unit IVe-9, dryland; Crofton part in Limy Upland range site and windbreak suitability group 5; Nora part in Silty range site and windbreak suitability group 4.

Elsmere Series

The Elsmere series consists of deep, somewhat poorly drained, nearly level or very gently undulating soils that formed in eolian material or old alluvium. These soils are in broad basins of the sandhills, in transition areas between the sandhills and loess uplands, and on stream terraces.

In a representative profile the surface layer is dark grayish-brown loamy fine sand about 15 inches thick. Beneath this is a transitional layer of grayish-brown loamy fine sand about 4 inches thick. The underlying material to a depth of 60 inches is mottled fine sand. It is pale brown to a depth of 28 inches. Below this, it is light gray.

Permeability is rapid, and available water capacity is low. These soils absorb moisture easily and release it readily to plants. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderately low, and natural fertility is low.

Elsmere soils are suited to dryland and irrigated farming. They are excellent for grass to be used for range and hay. They also can be used as wildlife habitat and for trees and shrubs in windbreaks.

Representative profile of Elsmere loamy fine sand, 0 to 2 percent slopes, in a cultivated field, 1,060 feet east and 100 feet north of the southwest corner of the southeast quarter of sec. 36, T. 26 N., R. 4 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 15 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; gradual, wavy boundary.

AC—15 to 19 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; gradual, wavy boundary.

C1—19 to 28 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; single grained; loose; neutral; gradual, wavy boundary.

C2—28 to 60 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; common, medium, distinct, yellow (10YR 7/8) mottles; single grained; loose; neutral.

The A horizon ranges from 10 to 20 inches in thickness. Layers of silty alluvial material, 2 to 6 inches thick, are in the C horizon in some areas. Loess and material of the Sappa Formation are below a depth of 48 inches in some places.

Elsmere soils are near Loup, Ovina, Thurman, and Valentine soils. They are better drained than Loup soils because the water table is lower. They have a coarser textured C horizon than Ovina soils. They have a higher water table and, as a result, are not so well drained as Thurman and Valentine soils.

Elsmere loamy fine sand, 0 to 2 percent slopes (EaA).—This somewhat poorly drained soil is in broad basins and on stream terraces. Areas range from nearly level to low and hummocky and from 20 to 200 acres in size.

Included with this soil in mapping were areas of Ovina fine sandy loam, Orwet loam, and Loup fine sandy loam. Also included, in areas adjacent to the sandhills, were areas of Thurman loamy fine sand.

Wetness early in spring delays tillage. The soil warms up more slowly than better drained soils that are not influenced by a moderately high water table. Soil blowing is a hazard in cultivated areas.

This soil is used for hay, range, and cultivated crops. Corn, soybeans, and alfalfa and rye sown with vetch are the main crops. A minor acreage is irrigated by sprinklers. A small acreage is in bromegrass and is used for pasture. Capability units IIIw-5, dryland, and IIIw-11, irrigated; Subirrigated range site; windbreak suitability group 2.

Fillmore Series

The Fillmore series consists of deep, poorly drained, nearly level soils that formed in loess. These soils are in upland depressions and are occasionally ponded by runoff from surrounding areas.

In a representative profile the surface layer is gray silt loam about 9 inches thick. The subsurface layer is light-gray silt loam about 4 inches thick. The subsoil is about 42 inches thick. It is dark-gray and gray, very firm silty clay in the upper 34 inches and grayish-brown, firm silty clay loam in the lower 8 inches. The underlying material, between depths of 55 and 60 inches, is grayish-brown silty clay loam.

Permeability is very slow, and available water capacity is moderate. The soils are somewhat droughty during dry seasons because moisture cannot readily penetrate the clayey subsoil, which limits the storage of moisture and growth of roots. Organic-matter content is moderate, and natural fertility is medium.

Fillmore soils are suited to cultivated crops, grass, and trees. They are also suited to wetland wildlife for short periods during wet seasons.

Representative profile of Fillmore silt loam in an area of Fillmore complex, in a bromegrass pasture, 135 feet east and 50 feet north of the southwest corner of the southeast quarter of sec. 4, T. 28 N., R. 4 W.:

Ap—0 to 9 inches, gray (10YR 5/1) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, granular structure; slightly hard, friable; few, fine, faint iron stains; medium acid; clear, smooth boundary.

A2—9 to 13 inches, light-gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; weak, thin, platy structure parting to weak, fine, granular; slightly hard, friable; slightly acid; abrupt, smooth boundary.

B21t—13 to 38 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate to weak, medium and fine, prismatic structure parting to moderate, medium, angular blocky; very hard, very firm; films on faces of peds; few fine iron or manganese pellets; neutral; gradual, wavy boundary.

B22t—38 to 47 inches, gray (10YR 5/1) silty clay, dark gray (10YR 4/1) moist; moderate, fine, prismatic structure parting to moderate, fine, angular blocky; very hard, very firm; few fine iron or manganese pellets; neutral; gradual, wavy boundary.

B3—47 to 55 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; hard, firm; few fine iron or manganese pellets; neutral; gradual, wavy boundary.

C—55 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to weak, fine, subangular blocky; hard, firm; neutral.

The solum ranges from 45 to 60 inches in thickness. The A1 horizon ranges from 7 to 12 inches in thickness. The A2 horizon ranges from 2 to 8 inches in thickness, but in a few areas it does not occur. The C horizon is mainly Peoria Loess, but in some areas it is silt from the Sappa Formation.

Fillmore soils have a B horizon that is similar in texture to that of Clamo soils. They are near Butler, Moody, and Trent soils. They have an A2 horizon, which is not present in Clamo soils. They do not have a water table, mottles, and lime in the B3 and C horizons, which are characteristic of Clamo soils. In contrast with Butler soils, they have an A2 horizon and are more commonly ponded. They have a finer textured B horizon and formed at lower relative elevations than Moody and Trent soils. In addition, they have an A2 horizon, which is lacking in Moody and Trent soils.

Fillmore complex (0 to 1 percent slopes) (Fm).—This claypan soil is in shallow depressions in the loess uplands. Areas are round or oblong and range from 5 to 100 acres in size. This complex is 40 percent Fillmore soils and 60 percent soils that are similar to Fillmore soils but lack the grayish subsurface layer.

Included with this soil in mapping were small areas of Butler and Trent soils and a few areas of Marsh. Also included were a few small alkali spots, which are identified by a spot symbol on the detailed soil map.

Wetness is the principal limitation. Runoff from adjacent areas ponds on this soil, because there are no natural outlets for surface drainage. The very slow permeability of the subsoil allows only a small part of the ponded water to move through the profile. Most of the surface water evaporates. During some seasons crops are drowned by excess water. During dry seasons, however, this soil is droughty because most of the moisture in the subsoil is held under too much tension to be extracted by plant roots. This soil is difficult to till.

This soil is commonly used for tame pasture and hay or for cultivated crops. The larger areas are generally seeded to bromegrass, orchardgrass, or reed canarygrass and are used for pasture or hay. A small acreage is in native grass. Corn and soybeans are the main crops. Some areas have been drained and irrigated. Capability units IIIw-2, dryland, and IIIw-2, irrigated; Clayey Overflow range site; windbreak suitability group 6.

Hadar Series

The Hadar series consists of deep, well-drained, gently sloping or gently undulating to moderately sloping or gently rolling soils on uplands. These soils formed in a thin layer of eolian sand and in the underlying glacial till.

In a representative profile the surface layer is grayish-brown loamy fine sand about 14 inches thick. The subsoil is about 32 inches thick. The upper 10 inches of the subsoil is pale-brown, very friable loamy sand; the next 3 inches is pale-brown, friable loam; the next 11 inches is light yellowish-brown, firm, mottled clay loam; and the lower 8 inches is light-gray, firm, mottled clay loam. The underlying material, between depths of 46 and 60 inches, is light-gray, mottled, calcareous clay loam. The soil contains a few pebbles and small stones below a depth of 24 inches.

Permeability is rapid in the sandy upper part of the profile and moderately slow in the loamy lower part. Available water capacity is moderate. These soils release moisture readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Hadar soils are well suited to dryland and irrigated farming. They are also suited to tame and native grass, trees, and wildlife habitat.

Representative profile of Hadar loamy fine sand, 2 to 7 percent slopes, in a cultivated field, 600 feet north and 225 feet east of the southwest corner of sec. 3, T. 27 N., R. 3 W.:

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

A12—6 to 14 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; medium acid; gradual, wavy boundary.

B1—14 to 24 inches, pale-brown (10YR 6/3) loamy sand, brown (10YR 5/3) moist; weak, very fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

IIB21—24 to 27 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak, fine, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; few pebbles; neutral; clear, wavy boundary.

IIB22—27 to 38 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4 moist; common, fine, distinct, yellowish-brown (10YR 5/8), relict mottles; moderate, medium and fine, subangular blocky structure; hard, firm; few pebbles; few fine iron or manganese concretions; neutral; gradual, wavy boundary.

IIB3—38 to 46 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; common, medium, distinct, yellowish-brown (10YR 5/8) and reddish-yellow (7.5YR 66), relict mottles; moderate to weak, medium, prismatic structure parting to weak, coarse, angular blocky; hard, firm; few pebbles; few fine iron or manganese concretions; neutral; gradual, wavy boundary.

IIC—46 to 60 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) moist; many, medium, distinct, yellowish-brown (10YR 5/8) and strong-brown (7.5YR 5/6), relict mottles; weak, medium, prismatic structure parting to weak, coarse, angular blocky; hard, firm; few pebbles; few fine iron or manganese concretions; common medium seams and accumulated masses of lime; strong effervescence; moderately alkaline.

The A horizon ranges from 10 to 20 inches in thickness. The A and B1 horizons range from loamy fine sand to sand that is medium acid or slightly acid. Depth to the IIB horizon ranges from 12 to 36 inches. Depth to lime ranges from 30 to 55 inches.

Hadar soils are near Bazile, Betts, Clarno, and Thurman soils. They have coarser textured A and B1 horizons and a finer textured IIC horizon than Bazile soils. They have coarser textured A and B horizons than Betts and Clarno soils. They have a B horizon, which is lacking in Thurman soils. In addition, the material in the IIB and IIC horizons is finer textured than the material at a comparable depth in Thurman soils.

Hadar loamy fine sand, 2 to 7 percent slopes (HaC).—This soil is on uplands. Slopes are long and plane in places and undulating in others. This soil occurs in areas where the glacial till has an overblow of eolian sand. Areas range from 5 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas where the surface layer is fine sand or fine sandy loam and small areas of Bazile, Clarno, and Thurman soils. A few small areas of gravel are indicated on the detailed soil map by a special spot symbol.

The hazards of soil blowing and water erosion are severe in cultivated areas. Gully erosion is a hazard near drainageways. Runoff is slow to medium. This soil is easy to till.

This soil is used for crops, tame pasture, and range. Corn and alfalfa are the main crops. A small acreage is used for soybeans and oats and for rye sown with vetch. A small acreage is irrigated by sprinklers. Bromegrass is commonly used for tame pasture. Capability units IIIe-6, dryland, and IIIe-10, irrigated; Sandy range site; windbreak suitability group 3.

Hadar-Thurman complex, 7 to 11 percent slopes (HaD).—The soils in this complex are on plane and convex hillsides. They occur in transitional areas between soils that formed in eolian sand and soils that formed in glacial till. Areas range from 5 to 30 acres in size. This complex is about 55 percent Hadar loamy fine sand, 35 percent Thurman fine sandy loam, and 10 percent other soils.

The surface layer of the Thurman soil is finer textured than the one in the profile described as representative of the Thurman series.

Included with these soils in mapping were small areas of Clarno and Valentine soils. Also included were a few small gravelly areas, which are identified by a spot symbol on the detailed soil map.

These soils are subject to both soil blowing and water erosion. The hazard of gully erosion is severe near drainageways. Runoff is medium. This soil is easy to till.

This soil is used for range, tame pasture, and crops. About half the acreage is in native grass and is used for range and hay. Bromegrass is commonly seeded for pasture. Corn, oats, alfalfa, and rye sown with vetch are the main crops. Capability unit IVe-6, dryland; Sands range site; windbreak suitability group 3.

Hobbs Series

The Hobbs series consists of deep, well-drained, nearly level soils that formed in alluvium. These soils are on bottom lands, mainly along the North Fork Elkhorn River and Yankton Slough.

In a representative profile the surface layer is silt loam about 37 inches thick. The upper 20 inches is dark grayish brown, the next 10 inches is dark gray, and the lower 7 inches is grayish brown. The underlying material to a depth of 60 inches is brown silt loam.

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

Hobbs soils are suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Hobbs silt loam, in a cultivated field, 1,060 feet east and 25 feet north of the southwest corner of sec. 7, T. 26 N., R. 1 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine and very fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—7 to 11 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

A13—11 to 20 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

A14—20 to 30 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

A15—30 to 37 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, subangular blocky structure parting to moderate, fine, granular; slightly hard, friable; neutral; clear, smooth boundary.

C—37 to 60 inches, brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable; neutral.

The A horizon ranges from 20 to 50 inches in thickness. It is mainly silt loam but ranges to silty clay loam. It ranges from dark gray to grayish brown and is slightly acid or neutral. The C horizon commonly ranges from very fine sandy loam to silty clay loam, but in a few places it is loamy sand or silty clay below a depth of 40 inches.

Hobbs soils are near Cass, Colo, and Hord soils and Silty alluvial land. They are finer textured throughout than Cass soils. They lack the mottles in the C horizon that are typical of Colo soils, and they have a lower water table than those soils. In contrast with Hord soils, they are more stratified and lack a B horizon. They are darker and less stratified than the frequently flooded Silty alluvial land.

Hobbs silt loam (0 to 1 percent slopes) (Hb).—This soil is on wide bottom lands. Areas are commonly large, but they range from 10 to 1,000 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas where the surface layer is fine sandy loam and a few areas where the underlying material is silty clay. Also included were small areas of Cass, Colo, Hord, Lamo, and Leshara soils and Silty alluvial land. Also included were a few small alkali areas and sandy areas, both of which are identified by spot symbols on the detailed soil map.

Floods occur an average of once every 3 years. They occur mainly in spring after rapid snowmelt or in spring or early in summer after excessive rain. Runoff is slow. This soil is easy to till.

Most of the acreage is cultivated and is used mainly for corn. A small acreage is used for soybeans, oats, and alfalfa, and a small acreage is irrigated. Most of this soil has potential for irrigation by the gravity system. A few small areas are seeded to bromegrass and are used for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is 8 to 15 feet below the surface. Capability units I-1, dryland, and I-6, irrigated; Silty Lowland range site; windbreak suitability group 1.

Hobbs silt loam, calcareous (0 to 1 percent slopes) (Hc).—This soil is mainly on wide bottom lands. Areas range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but the underlying material is calcareous below a depth of 35 inches.

Included with this soil in mapping were small areas of Hobbs silt loam, Hord silt loam, Leshara silt loam, and Lamo silty clay loam.

Flooding occurs an average of once every 3 years. Runoff is slow. This soil is easy to till.

Most of the acreage is cultivated and is used mainly for corn and alfalfa. A small acreage is used for soybeans and oats. A small acreage is irrigated, but most of the acreage has potential for irrigation by the gravity system. A few small areas are in bromegrass pasture. Trees grow well, and alfalfa does well because of subirrigation from the water table, which is at a depth of 5 to 10 feet. Capability units I-1, dryland, and I-6, irrigated; Silty Lowland range site; windbreak suitability group 1.

Hobbs silt loam, occasionally flooded (0 to 1 percent slopes) (Hd).—This soil is on bottom lands, mainly along narrow upper drainageways. Channels in the area are poorly developed, and runoff from adjacent soils spreads over the entire area. Areas range from 5 to 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is stratified, dark- and light-colored silt loam 10 to 25 inches thick.

Included with this soil in mapping were a few areas where sandy material is at a depth of 30 to 60 inches and small areas of Cass, Colo, and Hord soils and Silty alluvial land. Also included were a few, short, steep slopes, which are identified by a spot symbol on the detailed soil map.

Occasional flooding is the principal hazard, but it is nearly always of short duration. A total crop loss seldom occurs, but it may be necessary to reseed the crop or to delay tillage and harvest. Runoff is slow. This soil is easy to work, except for short periods when it is wet after flooding.

Most of the acreage is cultivated or in tame pasture. Corn is the main crop. A small acreage is used for soybeans and alfalfa. Oats are rarely grown because of the hazard of flooding in spring. Bromegrass is seeded for tame pasture. A small acreage is in native grass and is used for range and hay. Capability units IIw-3, dryland, and IIw-6, irrigated; Silty Overflow range site; windbreak suitability group 1.

Hord Series

The Hord series consists of deep, well-drained, nearly level to gently sloping soils on foot slopes and stream terraces. These soils formed in colluvium derived from loess and old alluvium.

In a representative profile the surface layer is dark grayish-brown silt loam about 21 inches thick. The subsoil is friable silt loam about 26 inches thick. It is dark grayish brown in the upper 6 inches, grayish brown in the next 11 inches, and pale brown in the lower 9 inches. The underlying material, between depths of 47 and 60 inches, is pale-brown, calcareous silt loam.

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

Hord soils are well suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Hord silt loam, in a cultivated field, 800 feet east and 120 feet north of the southwest corner of sec. 35, T. 27 N., R. 1 W.:

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

A12—7 to 21 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; slightly hard, friable; neutral; gradual, smooth boundary.

B1—21 to 27 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure parting to weak, very fine, granular; slightly hard, friable; neutral; clear, smooth boundary.

B2—27 to 38 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium and

fine, subangular blocky structure; slightly hard, friable; neutral; gradual, smooth boundary.

B3—38 to 47 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, fine, prismatic structure; slightly hard, friable; neutral; gradual, smooth boundary.

C—47 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable; few small lime concretions; slight effervescence; mildly alkaline.

The A horizon ranges from 20 to 30 inches in thickness and is slightly acid or neutral. The B horizon is slightly acid or neutral, and the C horizon ranges from neutral to moderately alkaline. Depth to lime ranges from 35 to 60 inches.

Hord soils are near Hobbs and Ortello soils and are similar to Loretto and Trent soils. They have a B horizon, which is lacking in Hobbs soils. They have a thicker A horizon and are finer textured than Ortello soils. They have a thicker A horizon and are less coarse textured in the upper part of the profile than Loretto soils. They contain less clay in the A and B horizons than Trent soils.

Hord silt loam (0 to 1 percent slopes) (He).—This soil is on stream terraces. Areas range from 10 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Bazile, Hobbs, Loretto, and Ortello soils and a few areas of very gently sloping soils. Also included were a few small depressions and alkali areas, which are identified by spot symbols on the detailed soil map.

This is one of the best soils in Pierce County for cultivated crops. In places the soil receives additional water as runoff from higher elevations. Runoff is slow. This soil is easy to till.

Nearly all of the acreage of this soil is cultivated. Corn, soybeans, oats, and alfalfa are the main crops. A small acreage is irrigated. A few areas have been seeded to bromegrass and are used for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is 5 to 15 feet below the surface. Capability units I-1, dryland, and I-6, irrigated; Silty Lowland range site; windbreak suitability group 4.

Hord-Hobbs silt loams, 0 to 7 percent slopes (HhC).—The soils in this complex have plane slopes and are in narrow upland drainageways. They occur below the steeper uplands. This complex is about 50 to 70 percent Hord silt loam, 25 to 45 percent Hobbs silt loam, and 5 percent other soils. The Hord soil is on foot slopes that are on each side of the Hobbs soil. The Hobbs soil is on narrow bottom lands. Areas range from 5 to 40 acres in size.

The Hord soil has a profile similar to the one described as representative of the Hord series, but free lime is higher in the profile. The Hobbs soil has a profile similar to the one described as representative of the Hobbs series, but the upper 10 inches of the surface layer is more stratified and is calcareous in a few areas.

Included with these soils in mapping were small areas of Cass loam; Colo silt loam; Hobbs silt loam, occasionally flooded; and Moody silty clay loam.

Gully erosion is a hazard near drainageways on Hord soils. Minor flooding is a slight hazard on Hobbs soils. Runoff is slow to medium. These soils are easy to till.

Most of the acreage is cultivated. Corn is the main crop. A small acreage is used for soybeans, oats, and alfalfa. Bromegrass is sown for tame pasture. A small acreage is irrigated. Capability units IIe-1, dryland, and IIe-6, irrigated; both parts in Silty Lowland range site; Hord part in windbreak suitability group 4, and Hobbs part in windbreak suitability group 1.

Lamo Series

The Lamo series consists of deep, somewhat poorly drained, nearly level soils on bottom lands. These soils formed in silty and loamy alluvium. They are mainly in the valley of the North Fork Elkhorn River.

In a representative profile the surface layer is silty clay loam about 36 inches thick. It is dark gray in the upper 11 inches and gray in the lower 25 inches. The underlying material is gray, mottled silty clay loam to a depth of 46 inches and gray, mottled loam between depths of 46 and 60 inches. The profile is calcareous between depths of 11 and 46 inches.

Permeability is moderately slow, and available water capacity is high. The water table ranges in depth from 3 feet in spring to 8 feet in fall. These soils absorb moisture somewhat slowly, but they release it readily to plants. The organic-matter content is moderate, and natural fertility is high.

Lamo soils are suitable for both dryland and irrigated farming. They can be used for grass, trees, shrubs, and wildlife habitat.

Representative profile of Lamo silty clay loam, in a cultivated field, 950 feet east and 195 feet south of the northwest corner of sec. 9, T. 26 N., R. 2 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, very fine, granular structure; hard, firm; neutral; abrupt, smooth boundary.

A12—7 to 11 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and very fine, granular structure; hard, firm; neutral; clear, smooth boundary.

A13—11 to 17 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate, very fine, subangular blocky structure parting to moderate, fine, granular; hard, firm; strong effervescence (3 percent lime); moderately alkaline; gradual, smooth boundary.

A14—17 to 36 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate, medium, subangular blocky structure parting to moderate, very fine, subangular blocky; hard, very firm; streaks of disseminated lime; strong effervescence (1 percent lime); moderately alkaline; gradual, smooth boundary.

C1—36 to 46 inches, gray (10YR 6/1) silty clay loam, dark gray (10YR 4/1) moist; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium or fine, subangular blocky structure; hard, firm; slight effervescence; moderately alkaline; gradual, smooth boundary.

C2—46 to 60 inches, gray (5Y 6/1) loam, dark gray (5Y 4/1) moist; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; slightly hard, friable; mildly alkaline.

The A horizon ranges from 18 to 40 inches in thickness. Below a depth of 40 inches, the profile is commonly silty clay loam, but in places it ranges from sand to silty clay. Depth to lime ranges from 0 to 15 inches.

Lamo soils are near Colo, Leshara, Clamo, Hobbs, and Lawet soils. They contain more lime than Colo soils, which are noncalcareous. They are finer textured than Leshara soils, but they are not so fine textured as Clamo soils. They are finer textured and have a higher water table than Hobbs soils. They contain less lime and have a lower water table than Lawet soils.

Lamo silty clay loam (0 to 1 percent slopes) (Lb).—This soil is on bottom lands. Areas range from 20 to 200 acres in size.

Included with this soil in mapping were small areas of Clamo silty clay in old channels and at other low elevations. Also included were a few areas of Hobbs, Leshara, Colo, and Lawet soils.

Excessive wetness early in spring, caused by the moderately high water table, is the main limitation. In spring the water table is at a depth of less than 3 feet, but it recedes to a depth of 6 to 8 feet by fall. Flooding occurs about once every 2 or 3 years. This soil tends to warm up more slowly in spring than better drained soils. It is easy to work within only a narrow range of moisture content. It is hard when dry and sticky when wet. Runoff is slow.

Nearly all of the acreage is cultivated. Corn, soybeans, and alfalfa are the main crops. Capability units IIw-4, dryland, and IIw-3, irrigated; Subirrigated range site; windbreak suitability group 2.

Lawet Series

The Lawet series consists of deep, poorly drained, nearly level, calcareous soils that formed in loamy alluvium (fig. 5). These soils are on bottom lands mainly along Dry Creek and the upper end of Willow Creek.

In a representative profile the surface layer is about 18 inches thick. It is dark-gray loam in the upper 10 inches and gray sandy clay loam in the lower 8 inches. The subsoil, about 7 inches thick, is gray, firm sandy clay loam. The underlying material, to a depth of 60 inches, is 6 inches of light-gray sandy loam, 24 inches of light-gray sandy clay loam, and 5 inches of light-gray sandy loam. The profile is calcareous throughout.

Permeability is moderately slow, and available water capacity is high. These soils release moisture readily to plants. The water table ranges in depth from 1 foot in spring to 5 feet in fall. Organic-matter content and natural fertility are high.

Lawet soils are well suited to native grass, meadow, and summer range. They also are well suited to dugouts for livestock water and fish ponds. The soils are suited to wildlife habitat. They are marginal for cultivated crops and trees.

Representative profile of Lawet loam, in a native meadow, 510 feet north and 130 feet west of the southeast corner of the northeast quarter of sec. 19, T. 27 N., R. 3 W.:

A1ca—0 to 10 inches, dark-gray (N 4/0) loam, black (10YR 2/1) moist; moderate, fine and very fine, granular structure; slightly hard, friable; violent effervescence (18 percent lime); moderately alkaline; clear, smooth boundary.

A3ca—10 to 18 inches, gray (N 5/0) sandy clay loam, very dark gray (10YR 3/1) moist; moderate, fine and very fine, granular structure; hard, firm; violent effervescence (20 percent lime), moderately alkaline; gradual, smooth boundary.

Bca—18 to 25 inches, gray (N 6/0) sandy clay loam, dark gray (N 4/0) moist; moderate, fine and very fine, granular structure; hard, firm; violent effervescence (20 percent lime); moderately alkaline; clear, smooth boundary.

C1g—25 to 31 inches, light-gray (N 7/0) sandy loam, gray (N 5/0) moist; moderate or weak, very fine, granular structure; slightly hard, very friable; violent effervescence (12 percent lime); moderately alkaline; clear, smooth boundary.

C2g—31 to 55 inches, light-gray (N 7/0) sandy clay loam, light gray (N 7/0) moist; weak, medium and very fine, subangular blocky structure; firm, sticky, slightly plastic; many reddish-brown stains; water table at depth of 45 inches; small lime accumulations; violent

***Figure 5.*—Representative profile of Lawet loam. This deep, poorly drained soil formed in calcareous loamy alluvium on bottom lands.**

effervescence (22 percent lime); moderately alkaline; gradual, smooth boundary.

C3g—55 to 60 inches, light-gray (5Y 6/1) sandy loam, light greenish gray (5GY 7/1) moist; massive; very friable, slightly sticky, slightly plastic; neutral.

The A horizon ranges from 10 to 24 inches in thickness. It is mainly loam, but it is silty clay loam in places. The content of lime is 15 to 28 percent. The B horizon ranges from loam to silty clay loam. The C horizon is mostly sandy clay loam, but it commonly includes sandy loam and silty clay loam.

Lawet soils are near Clamo-Slickspots complex, Lamo soils, Orwet soils, and Wet alluvial land. In contrast with Clamo-Slickspots complex, they are coarser textured and lack the Slickspots. They contain more lime and have a higher water table than Lamo soils. They are finer textured below the A horizon than Orwet soils. They have a lower water table than Wet alluvial land.

Lawet loam (0 to 1 percent slopes) (Lc).—This soil is on bottom lands. Areas range from 5 to 800 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas of poorly drained silty clay soils and a few small areas of Lamo and Orwet soils and Wet alluvial land. Also included were a few areas where grayish clay is at a depth of 4 to 6 feet and a few other areas where loamy sand or sand is at a depth of 40 to 60 inches. A few, small, alkali areas are identified by a spot symbol on the detailed soil map.

Flooding is slight, and runoff is slow. In spring the water table is at a depth of 1 foot to 2 feet, but it recedes to a depth of 3 to 5 feet by midsummer. This soil has a high content of lime except in the lower part of the underlying material. During most years this soil is difficult to till in spring because of wetness. Where tiled, this soil can be productive. Lack of suitable outlets limits the acreage that can be tiled. Some caving can occur during tiling, mainly because of thin sandy layers. Bogs develop if the soil is grazed too early in spring.

A large acreage is in native grass and is used for meadow. A considerable acreage is used for range. A few areas are tiled and cultivated, but small areas that have not been tiled are also cultivated. Corn and soybeans are the main crops. A few dugouts have been constructed on this soil for livestock water and fishponds for recreation. Capability unit IVw-4, dryland; Subirrigated range site; windbreak suitability group 6.

Lawet-Slickspots complex (0 to 2 percent slopes) (Ld).—The soils in this complex are on bottom lands in long, narrow areas that are adjacent to stream terraces or uplands. This complex is about 70 percent Lawet loam, 25 percent Slickspots, and 5 percent other soils. The nearly level Lawet soil has plane slopes. Slickspots are in scattered microdepressions that are irregular in shape and range from 5 to 15 feet in diameter.

The Lawet soil has a profile similar to the one described as representative of the Lawet series, but the water table fluctuates to a lower depth and in some areas the soil contains less lime. In this complex Slickspots have a texture that ranges from loam to light silty clay throughout. The surface layer is commonly black and puddled when moist and has a thin, light-gray crust when dry. Alkalinity ranges from strong to very strong.

Included with these soils in mapping were a few areas of Lamo, Ovina, and Trent soils.

The alkalinity of the Slickspots is the soil characteristic that determines the use of these areas. The high content of sodium is toxic to many plants and native grasses. In cultivated areas Slickspots are difficult to till, because the surface is sticky when wet and very hard and cloddy when dry. Runoff is slow.

Most of the acreage is in native grass and is used for range and hay. A few small areas are cultivated. Corn and alfalfa are the most common crops. Capability unit IVs-1, dryland; Lawet part in Subirrigated range site and windbreak suitability group 6; Slickspots part in Saline Subirrigated range site and windbreak suitability group 10.

Leshara Series

This series consists of deep, somewhat poorly drained, nearly level soils on bottom lands, mainly along the North Fork Elkhorn River. These soils formed in alluvium that is mainly silty.

In a representative profile the surface layer is silt loam about 21 inches thick. The upper 15 inches is very dark gray, and the lower 6 inches is dark gray. Beneath this is a transitional layer of grayish-brown, mottled silt loam 5 inches thick. The mottled underlying material to a depth of 60 inches is 11 inches of light brownish-gray silt loam, 14 inches of light olive-gray silt loam, and 9 inches of light olive-gray, stratified fine sand and silt loam. The profile is calcareous between depths of 15 and 51 inches.

Permeability is moderate, and available water capacity is high. These soils absorb moisture easily and release it readily to plants. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderate, and natural fertility is high.

Leshara soils are suited to dryland and irrigated-farming. They are also suited to native or tame grass, trees, shrubs, and wildlife habitat.

Representative profile of Leshara silt loam, in a cultivated field, 500 feet north and 50 feet west of the southeast corner of the northeast quarter of sec. 7, T. 25 N., R. 1 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; moderate, fine and very fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—8 to 15 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; moderate, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

A13ca—15 to 21 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate, medium, granular structure; slightly hard, friable; violent effervescence (7 percent lime); moderately alkaline; gradual, smooth boundary.

ACca—21 to 26 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; common, medium and fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, granular structure; slightly hard, friable; violent effervescence (7 percent lime); moderately alkaline; gradual, smooth boundary.

C1ca—26 to 37 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; slightly hard, friable; few small lime concretions; violent efferves-

cence (10 percent lime); moderately alkaline; gradual, smooth boundary.

C2—37 to 51 inches, light olive-gray (5Y 6/2) silt loam, olive gray (5Y 5/2) moist; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; slightly hard, friable; slight effervescence; mildly alkaline; clear, smooth boundary.

IIC3—51 to 60 inches, light olive-gray (5Y 6/2), stratified fine sand and silt loam, olive gray (5Y 5/2) moist; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, very fine, platy structure; soft, very friable; neutral.

The A horizon ranges from 10 to 22 inches in thickness. It is mainly silt loam, but in some small areas it is loam and very fine sandy loam. It ranges from neutral to moderately alkaline. Depth to lime commonly ranges from 12 to 20 inches, but in few areas lime is at the surface. Below a depth of 40 inches, the soil material is commonly silt loam, but in places it ranges from sand to clay. The C horizon has mottles that range from faint to prominent.

Leshara soils are near Cass, Hobbs, Lamo, and Ord soils. They are finer textured in the upper part of the C horizon than Cass and Ord soils. In contrast with Cass soils, they have a higher water table, contain more prominent mottles in the C horizon, and have lime. They have a higher water table than Hobbs soils. They are coarser textured than Lamo soils.

Leshara silt loam (0 to 1 percent slopes) (Le).—This silty soil is on bottom lands. Areas range from 5 to 300 acres in size.

Included with this soil in mapping were small areas of Clamo and Lawet soils on low parts of the landscape. Also included, near stream channels, were a few areas of Cass and Hobbs soils.

Excessive wetness early in spring is a moderate limitation. The water table is at a depth of about 3 feet in spring; because spring is also the season of greatest rainfall, tillage and planting are commonly delayed. The water table recedes to a depth of 6 to 8 feet late in summer and in fall. This soil is flooded by stream overflow after rapid snowmelt or heavy rain an average of once every 3 years. The soil warms up more slowly in spring than better drained soils. It is easy to work if it is not too wet.

Almost all of the acreage is in cultivated crops. Corn, soybeans, and alfalfa are the main crops. Only a small acreage of small-grain crops is grown because the hazard of crop loss by flooding is great. A small acreage is irrigated. Capability units IIw-4, dryland, and IIw-6, irrigated; Subirrigated range site; windbreak suitability group 2.

Longford Series

The Longford series consists of deep, well-drained, very gently sloping to moderately sloping soils that formed in Loveland Loess. These soils are on uplands.

In a representative profile the surface layer is dark grayish-brown light silty clay about 9 inches thick. The subsoil is very firm silty clay about 31 inches thick. The upper 5 inches of the subsoil is grayish brown, the next 12 inches is brown, and the lower 14 inches is pale brown. The underlying material is very pale brown silty clay between depths of 40 and 48 inches and very pale brown silty clay loam to a depth of 60 inches.

Permeability is slow, and available water capacity is moderate. These soils are somewhat droughty in dry seasons because moisture cannot effectively penetrate the clayey subsoil, which limits the growth of roots. Organic-matter content is moderate, and natural fertility is medium.

Longford soils are suited to cultivated crops and grass, trees and shrubs in windbreaks, and wildlife habitat.

Representative profile of Longford silty clay in an area of Longford soils, 2 to 8 percent slopes, eroded, in a cultivated field, 300 feet east and 310 feet south of the northwest corner of sec. 31, T. 28 N., R. 1 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) light silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; hard, firm; slightly acid; abrupt, smooth boundary.

A12—6 to 9 inches, dark grayish-brown (10YR 4/2) light silty clay, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; hard, firm; slightly acid; clear, smooth boundary.

B1—9 to 14 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; moderate, very fine, subangular blocky structure; very hard, very firm; slightly acid; clear, wavy boundary.

B2t—14 to 26 inches, brown (10YR 5/3) silty clay, grayish brown (10YR 5/2) moist; moderate, fine, prismatic structure parting to strong, fine, angular blocky; very hard, very firm; few organic stains and films on faces of peds; neutral; gradual, wavy boundary.

B3—26 to 40 inches, pale-brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; very hard, very firm; neutral; clear, wavy boundary.

C1—40 to 48 inches, very pale brown (10YR 7/3) silty clay, pale brown (10YR 6/3) moist; weak, fine, prismatic structure; very hard, very firm; few small lime concretions; mildly alkaline; gradual, wavy boundary.

C2—48 to 60 inches, very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) moist; massive; hard, firm; few small lime concretions; mildly alkaline.

The A horizon ranges from 7 to 12 inches in thickness. It is loam, silty clay loam, or silty clay that is slightly acid or medium acid. The B horizon ranges from 15 to 40 inches in thickness. It ranges from brown to pinkish gray and is slightly acid or neutral. The C horizon ranges from silt loam to silty clay that is neutral or mildly alkaline.

Longford soils are similar to Butler and Clamo soils and are near Clarno and Moody soils. They formed in Loveland Loess, whereas Butler soils formed in Peoria Loess. In addition, they are better drained than Butler soils and lack the dark-gray color in the B horizon that is typical of those soils. They have a lower water table than Clamo soils, and they lack the mottling of those soils. They have a more clayey B horizon than Clarno and Moody soils. In addition, they formed in Loveland Loess, whereas Clarno soils formed in glacial till and Moody soils formed in Peoria Loess.

Longford loam, 1 to 5 percent slopes (LfC).—This soil is on uplands. Slopes are plane. Areas range from 5 to 35 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is loam.

Included with this soil in mapping were small areas of Loretto loam, 1 to 7 percent slopes, and Ortello fine sandy loam, 2 to 7 percent slopes. Also included at lower elevations were a few small alkali areas, which are identified by a spot symbol on the detailed soil map.

Water erosion is the principal hazard. Runoff is medium. The friable surface layer is easy to till, but it is only about 10 inches thick over the very firm subsoil.

Most of the acreage is cultivated or in tame pasture. Corn is the main crop. A smaller acreage is used for oats, soybeans, and alfalfa. A small acreage is irrigated. Bromegrass is used for pasture. Capability

units IIIe-2, dryland, and IIIe-2, irrigated; Clayey range site; windbreak suitability group 4.

Longford soils, 2 to 8 percent slopes, eroded (LgD2).—These soils are on long plane hillsides in the uplands. Areas range from 5 to 50 acres in size. These soils have a profile similar to the one described as representative of the series, but the surface layer is silty clay loam as well as silty clay.

Included with these soils in mapping were a few areas where water erosion has removed the original dark-colored surface layer and small areas of Clarno and Moody soils. Also included were a few small exposures of glacial till, eolian sand, and alkali spots, all of which are identified by spot symbols on the detailed soil map.

Water erosion is the principal hazard. Runoff is medium. The surface layer absorbs moisture slowly, and slow permeability in the subsoil prevents easy movement of water through the soil. These soils are difficult to till because they are firm when moist and become hard and cloddy when dry.

Most of the acreage is cultivated or in tame pasture. Corn, oats, soybeans, and alfalfa are the common crops. Bromegrass is used for pasture. A small acreage is in native grass and is used for range and hay. Capability unit IVe-4, dryland; Clayey range site; windbreak suitability group 4.

Loretto Series

The Loretto series consists of deep, well-drained, nearly level to gently sloping soils on uplands and stream terraces. These soils formed mainly in a thin layer of eolian material and in the underlying Peoria Loess.

In a representative profile the surface layer is fine sandy loam about 18 inches thick. It is grayish brown in the upper 7 inches, dark grayish brown in the next 7 inches, and grayish brown in the lower 4 inches. The subsoil is friable silt loam about 28 inches thick. It is brown in the upper 16 inches and pale brown in the lower 12 inches. The underlying material, between depths of 46 and 60 inches, is pale-brown, calcareous silt loam.

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

Loretto soils are well suited to dryland and irrigated farming. They are also suited to tame and native grass, trees, and wildlife habitat.

Representative profile of Loretto fine sandy loam, terrace, 0 to 2 percent slopes, in a cultivated field, 480 feet east and 75 feet south of the northwest corner of sec. 16, T. 25 N., R. 1 W.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 14 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, fine and very fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

A13—14 to 18 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

IIB1—18 to 23 inches, brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) moist; weak, very fine, subangular blocky structure parting to weak fine, granular; slightly hard, friable; neutral; clear, smooth boundary.

IIB2—23 to 34 inches, brown (10YR 5/3) silt loam, dark grayish brown (10YR 4/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable; neutral; gradual, wavy boundary.

IIB3—34 to 46 inches, pale-brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) moist; weak, medium, prismatic structure; slightly hard, friable; neutral; gradual, wavy boundary.

IIC—46 to 60 inches, pale-brown (10YR 6/3) silt loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable; slight effervescence; mildly alkaline.

The A horizon ranges from 10 to 18 inches in thickness. It is loam or fine sandy loam that is slightly acid or medium acid. The IIB horizon ranges from loam to silty clay loam that is slightly acid or neutral. Depth to lime ranges from 30 to 55 inches.

Loretto soils are near Boelus, Moody, Nora, and Ortello soils. They have a finer textured A horizon than Boelus soils. They have a coarser textured A horizon than Moody and Nora soils, and they formed in two kinds of parent material, whereas those soils formed in Peoria Loess. They have finer textured B and C horizons than Ortello soils.

Loretto fine sandy loam, terrace, 0 to 2 percent slopes (LhA).—This soil is on plane or very gently undulating stream terraces. Areas range from 10 to 50 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Bazile, Hobbs, Hord, and Ortello soils.

The hazard of soil blowing is moderate in cultivated areas. In places the soil receives additional water as runoff from higher elevations. Runoff is very slow. This soil is easy to work.

Most of the acreage is cultivated. Corn, soybeans, oats, and alfalfa and rye sown with vetch are the main crops. A small acreage is irrigated, and a few areas are seeded to bromegrass for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is at a depth of 5 to 15 feet. Capability units IIe-3, dryland, and IIe-5, irrigated; Sandy range site; windbreak suitability group 3.

Loretto loam, 0 to 1 percent slopes (LkA).—This dark-colored soil is on long, plane slopes in the uplands. Areas range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is loam and the subsoil is slightly finer textured.

Included with this soil in mapping were a few areas where slopes are about 2 percent, a few areas where sand is at a depth of 40 to 60 inches, and small areas of Bazile, Moody, and Paka soils. Also included were a few small areas of wind-deposited sand, reddish loess, alkali spots, and depressions, all of which are identified by spot symbols on the detailed soil map.

The hazard of erosion is slight, and runoff is slow. This soil is friable and is easy to work.

Nearly all of the acreage is cultivated and is used mainly for corn, oats, and alfalfa. A smaller acreage is used for soybeans and grain sorghum, and a small acreage is irrigated. Capability units I-1, dryland, and I-4, irrigated; Silty range site; windbreak suitability group 4.

Loretto loam, 1 to 7 percent slopes (LkC).—This soil is on long, plane slopes in the uplands. Areas range from 5 to 150 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is loam and is slightly thinner and the subsoil is slightly finer textured.

Included with this soil in mapping were many places where grayish or reddish loess is at a depth of 5 feet and other areas where sand is at a depth of 40 inches. Also included were small areas of Bazile, Moody, and Paka soils. A few small areas where sandy soils, reddish loess, and alkali spots are on the surface are identified by spot symbols on the detailed soil map.

The hazard of water erosion is moderate, and runoff is medium. This soil is easy to work.

Most of the acreage is cultivated. Corn, oats, and alfalfa are the main crops. A smaller acreage is used for grain sorghum and soybeans. A small acreage is irrigated by sprinklers, and a small acreage is seeded to bromegrass and is used for pasture. Capability units IIe-1, dryland, and IIIe-4, irrigated; Silty range site; windbreak suitability group 4.

Loup Series

The Loup series consists of deep, poorly drained and very poorly drained, nearly level soils that formed in eolian and alluvial material. These soils are on bottom lands of drainageways in the edge of the sandhills, mainly along Willow Creek.

In a representative profile the surface layer is dark-gray fine sandy loam about 10 inches thick. The underlying material extends to a depth of 60 inches. In sequence from the top, it is 8 inches of light brownish-gray loamy fine sand, 10 inches of light brownish-gray fine sand, and 32 inches of light-gray fine sand. The entire profile is mottled.

Permeability is rapid, and available water capacity is low; these characteristics are most important when the water table is lowest or when the soil is to be drained. These soils absorb moisture easily and release it readily to plants. The water table is normally at the surface in spring and at a depth of about 5 feet in fall. Organic-matter content is moderate, and natural fertility is medium.

Loup soils are well suited to native grass. In areas where the water table is low, they are suited to cultivated crops. Trees and shrubs can be grown on these soils, and they are also suited to wildlife habitat.

Representative profile of Loup fine sandy loam, in rangeland, 530 feet south and 40 feet east of the northwest corner of the southwest quarter of sec. 15, T. 25 N., R. 3 W.:

A—0 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) moist; few, fine, faint, reddish-brown (5YR 5/3) mottles; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

C1—10 to 18 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; common, fine, distinct, reddish-brown (5YR 5/3) mottles; weak, very fine, granular structure; soft, very friable; neutral; clear, wavy boundary.

C2—18 to 28 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) moist; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; single grained; loose; water table at depth of 20 inches; mildly alkaline; gradual, wavy boundary.

C3—28 to 60 inches, light-gray (10YR 7/2) fine sand, light brownish gray (10YR 6/2) moist; common, fine, distinct, yellow (10YR 7/8) mottles; single grained; loose; mildly alkaline.

The A horizon ranges from 8 to 20 inches in thickness. It is loam, fine sandy loam, or loamy fine sand. The A horizon is slightly acid to mildly alkaline, and the C horizon is neutral or mildly alkaline. In places there is a layer of organic matter, 1 inch to 2 inches thick, on the surface. In most areas of Pierce County these soils are noncalcareous throughout.

Loup soils are near Elsmere, Ovina, Lawet, and Orwet soils. They have a higher water table than Elsmere and Ovina soils. In addition, they have a coarser textured C horizon than Ovina soils. They are coarser textured in the upper part of the C horizon than Lawet or Orwet soils, and they contain less lime in the A horizon and upper part of the C horizon than those soils.

Loup fine sandy loam (0 to 2 percent slopes) (Lo).—This soil is in basins of the sandy uplands and in the transitional sandhills area. The water table fluctuates seasonally. It is at a depth of 1 foot in spring and 5 feet in fall. Areas range from 10 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Elsmere, Orwet, Lawet, and Ovina soils. Also included were areas where silty layers, 2 to 6 inches thick, are in the underlying material and a few areas where the surface layer is loam and loamy fine sand.

Wetness in spring, when the water table is highest, limits the use of this soil. Bogs develop if the soil is grazed too early in spring. In cultivated areas, wetness delays tillage. Runoff is very slow.

This soil is used mainly for range and meadow. Summer grazing or mowing for hay is the general practice. A few areas are cultivated, and corn and soybeans are the most commonly grown crops. Capability unit IVw-6, dryland; Subirrigated range site; windbreak suitability group 6.

Loup soils (0 to 2 percent slopes) (Lp).—These soils are on bottom lands. Areas are long and narrow and range from 5 to 100 acres in size. The water table is normally at a depth of 0 to 3 feet, but in spring it commonly is above the surface. These soils have a profile similar to the one described as representative of the series, but the surface layer is slightly darker colored and is loam and loamy sand as well as fine sandy loam.

Included with these soils in mapping were a few areas of Sandy alluvial land and places where a layer of partly decayed organic matter, 1 inch to 2 inches thick, is on the surface.

Wetness, caused by the high water table, limits the use of these soils. The soils are flooded occasionally. Some areas are boggy if they are grazed when the water table is at the surface. Runoff is slow.

These soils are used mainly for grazing. A few areas are mowed for hay. The soils are too wet for cultivated crops. They make good habitat for wetland wildlife. Capability unit Vw-7, dryland; Wet Land range site; windbreak suitability group 6.

Marsh

Marsh (Ma) is in low areas along Willow and Dry Creeks. Water stands on the surface and is 2 to 18 inches deep during most of the growing season. During dry seasons water is only a few inches below the surface. Areas range from 2 to 25 acres in size. The vegetation is mainly cattails, rushes, reedgrass, and tall sedges. Open water is in a few places.

Marsh consists of material that ranges from clay to sand. The part near the surface is a mixture of soil and partly decayed organic matter. It is black and ranges from 6 to about 20 inches in thickness. It grades to lighter colored material of varying texture. Snail shells are common.

Marsh is too wet for crops, grass, or trees. It is well suited to wetland wildlife habitat, which is its main use. Suitable outlets for drainage are not common. Capability unit VIIIw-7, dryland; windbreak suitability group 10.

Moody Series

The Moody series consists of deep, well-drained, nearly level to gently sloping soils on uplands. These soils formed in Peoria Loess.

In a representative profile the surface layer is silty clay loam about 10 inches thick. It is dark grayish brown in the upper 7 inches and grayish brown in the lower 3 inches. The subsoil is firm silty clay loam about 31 inches thick. It is brown in the upper 9 inches and pale brown in the lower 22 inches. The underlying material to a depth of 60 inches is very pale brown, calcareous silt loam that contains many lime concretions in the upper 9 inches.

Permeability is moderate, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Moody soils are well suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Moody silty clay loam, 1 to 7 percent slopes, in a cultivated field, 1,060 feet north and 340 feet west of the southeast corner of the northeast quarter of sec. 18, T. 28 N., R. 3 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate, very fine, granular structure; hard, firm; slightly acid; abrupt, smooth boundary.

A12—7 to 10 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, subangular blocky structure parting to moderate, fine, granular; hard, firm; slightly acid; clear, wavy boundary.

B21—10 to 19 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) crushing to dark grayish brown (10YR 4/2) moist; moderate, fine and very fine, subangular blocky structure; hard, firm; neutral; gradual, wavy boundary.

B22—19 to 33 inches, pale-brown (10YR 6/3) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, subangular blocky structure; hard, firm; films on faces of peds; neutral; gradual, wavy boundary.

B3—33 to 41 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; weak, medium, subangular blocky structure; hard, firm; neutral; gradual, wavy boundary.

Cca—41 to 50 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; few, fine, faint, gray (10YR 6/1) and yellowish-brown (10YR 5/6), relict mottles; weak, medium, subangular blocky structure; slightly hard, friable; common small lime concretions; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—50 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/2) moist; common, fine, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/6), relict mottles; weak, medium, prismatic structure; slightly hard, friable; strong effervescence; moderately alkaline.

Thickness of the solum and depth to lime range from 30 to 55 inches. The A horizon ranges from 7 to 16 inches in thickness. It is medium acid to neutral.

Moody soils are near Crofton, Fillmore, Nora, and Trent soils. They have a thicker A horizon and are deeper to lime than Crofton soils, and they have a B horizon, which is lacking in Crofton soils. In contrast with Fillmore soils, they lack the A2 horizon and contain less clay in the B2 horizon. They contain more clay in the solum and are deeper to lime than Nora soils. They have a thinner A horizon than Trent soils.

Moody silty clay loam, 0 to 1 percent slopes (MoA).—This soil is on the loess uplands. Areas range from 5 to 50 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker and lime is deeper.

Included with this soil in mapping were small areas of Butler, Loretto, Nora, and Trent soils and some areas of soils that are leached of lime below a depth of 60 inches. Also included were small depressions and alkali areas, which are identified by spot symbols on the detailed soil map.

Water erosion is a slight hazard. Runoff is slow. This soil is somewhat difficult to till, because it is firm when moist and tends to form clods if tilled when wet.

Nearly all of the acreage is cultivated. Corn, oats, soybeans, and alfalfa are the main crops. A small acreage is irrigated. Capability units I-1, dryland, and I-3, irrigated; Silty range site; windbreak suitability group 4.

Moody silty clay loam, 1 to 7 percent slopes (MoC).—This soil is on long, plane slopes in the loess uplands. Most areas are comparatively large, but they range from 5 to about 400 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Hord, Loretto, Nora, and Trent soils. Also included were small depressions, alkali spots, and exposures of glacial till, reddish loess, and eolian sand, all of which are shown by spot symbols on the detailed soil map.

The hazard of water erosion is slight to moderate. Runoff is medium. This soil is somewhat difficult to till, because it is firm when moist and tends to form clods if tilled when wet.

Most of the acreage is cultivated and is used mainly for corn, oats, and alfalfa. A smaller acreage is used for soybeans, grain sorghum, and wheat. A small acreage is irrigated by sprinklers, and a small acreage is seeded to bromegrass and is used for pasture. Capability units IIe-1, dryland, and IIIe-3, irrigated; Silty range site; windbreak suitability group 4.

Nora Series

The Nora series consists of deep, well-drained, very gently sloping to strongly sloping soils on uplands (fig. 6). These soils formed in Peoria Loess.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil is friable silt loam about 28 inches thick. The upper 9 inches is brown, and the lower 19 inches is pale brown, is calcareous, and contains many lime concretions. The underlying material, between depths of 35 and 60 inches, is very pale brown, calcareous silt loam that contains many lime concretions in the upper 13 inches.

Permeability is moderate, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderate, and natural fertility is medium. These soils are high in calcium in the middle and lower parts of the subsoil and in the underlying material.

Nora soils are well suited to cultivated crops and tame pasture. All but the strongly sloping Nora soils are suited to irrigation. These soils can also be used for grass, trees, and wildlife habitat.

Representative profile of Nora silt loam, 7 to 11 percent slopes, in a cultivated field, 1,320 feet east and 435 feet north of the southwest corner of sec. 4, T. 27 N., R. 1 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, very fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B21—7 to 16 inches, brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak, fine, subangular blocky structure; slightly hard, friable; neutral; gradual, wavy boundary.

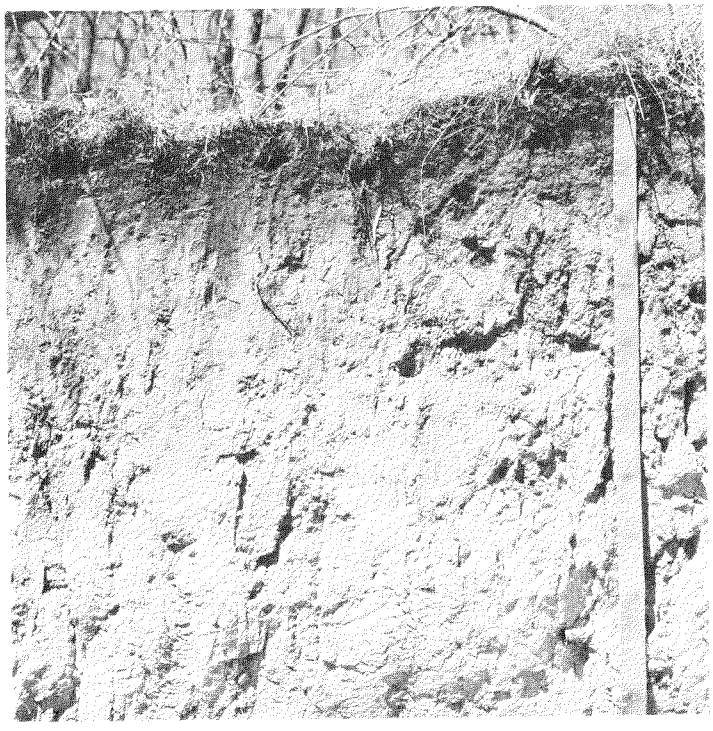

Figure 6.—**Representative profile of Nora silt loam. This deep, friable soil formed in loess, a silty wind-deposited material.**

B22ca—16 to 26 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable; common fine and medium lime concretions; strong effervescence; moderately alkaline; gradual, wavy boundary.

B3ca—26 to 35 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; few, fine, faint, gray (10YR 6/1) and yellowish-brown (10YR 5/6) relict mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; common fine and medium lime concretions; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—35 to 48 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; few, fine, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/6) relict mottles; weak, medium, prismatic structure; slightly hard, friable; common fine and medium lime concretions; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—48 to 60 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; common, fine, distinct, gray (10YR 6/1) and yellowish-brown (10YR 5/6) relict mottles; massive; slightly hard, friable; strong effervescence, moderately alkaline.

The A horizon ranges from 7 to 12 inches in thickness. It is mainly silt loam, but in places it is loam and light silty clay loam. The B21 horizon ranges from loam to light silty clay loam. Depth to lime ranges from 10 to 30 inches.

Nora soils are near Boelus, Clarno, Crofton, and Moody soils. They are finer textured above a depth of 20 inches than Boelus soils. They formed in loess, whereas Clarno soils formed in clay loam glacial till. In contrast with Crofton soils, they have a thicker A horizon, are deeper to lime, and have a B horizon. They contain lime higher in the profile and contain less clay in the solum than Moody soils.

Nora silt loam, 1 to 7 percent slopes (NoC).—This silty soil is on the loess uplands. Where it is near areas of sandy soils, it has long, plane, northwest-facing slopes. Where it is above areas of Crofton soils, it is on narrow, plane ridgetops. 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 the surface layer is thicker and lime is deeper.

Included with this soil in mapping were a few small areas where water erosion has removed the original surface layer, exposing the brown subsoil. Also included were small areas of Moody and Crofton soils and small areas of sandy soils, which are indicated by a spot symbol on the detailed soil map.

The hazard of water erosion is moderate. Runoff is medium. This soil is easy to till.

Nearly all of the acreage is cultivated. Corn is the main crop. Oats, alfalfa, soybeans, and grain sorghum are also grown. A small acreage is irrigated by sprinklers. Areas in bromegrass are used for tame pasture. A small acreage of this soil is in native grass and is used for range and hay. Capability units IIe-1, dryland, and IIIe-6, irrigated; Silty range site; windbreak suitability group 4.

Nora silt loam, 7 to 11 percent slopes (NoD).—This silty soil is on long, plane hillsides in the loess uplands. Areas range from 5 to 80 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas where water erosion has removed the original surface layer, exposing the brown subsoil. Also included were small areas of Crofton and Moody soils. Areas of Hord-Hobbs silt loams, 0 to 7 percent slopes, were included in the bottoms of narrow valleys. Also

included were a few small outcrops of glacial till and wind-deposited sand, both of which are shown by spot symbols on the detailed soil map.

The hazard of water erosion is severe in cultivated areas. Sheet and rill erosion is the principal hazard. Runoff is medium. This soil is easy to till.

Most of the acreage is cultivated and is used mainly for corn, oats, and alfalfa. A smaller acreage is used for soybeans and grain sorghum. A small acreage is irrigated by sprinklers, and a small acreage is used for pasture. Bromegrass is the main grass seeded for pasture. A small acreage is in native grass and is used for range and hay. Capability units IIIe-1, dryland, and IVe-6, irrigated; Silty range site; windbreak suitability group 4.

Nora silt loam, 11 to 17 percent slopes (NoE).—This silty soil is on long, plane slopes in the loess uplands. Areas range from 5 to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are slightly thinner. Also, in a few areas water erosion has removed the original surface layer, exposing the brown subsoil.

Included with this soil in mapping were small areas of Crofton soils and Hord-Hobbs silt loams, 0 to 7 percent slopes. Also included were a few small outcrops of glacial till and eolian sands, both of which are identified by spot symbols on the detailed soil map.

The hazard of water erosion is slight in areas of range but severe in cultivated areas. The potential for sheet and rill erosion is great because of slope. Runoff is medium to rapid. This friable soil is easy to till; but where it is strongly sloping, it is difficult to traverse with farm machinery.

This soil is used for crops and range. Corn, oats, and alfalfa are the main crops, and bromegrass is the main tame grass seeded for pasture. Part of the acreage is in native grass and is used for range and hay. Capability unit IVe-1, dryland; Silty range site; windbreak suitability group 4.

Nora-Thurman complex, 7 to 11 percent slopes (NtD).—The soils in this complex are on plane, convex hillsides in areas where the silty loess soils join the eolian sandy soils. This complex is about 40 to 60 percent Nora silt loam, and the rest is Thurman fine sandy loam. The Thurman soil is mainly on the upper part of hillsides above areas of the Nora soil. Areas range from 5 to 60 acres in size.

The Thurman soil has a profile similar to the one described as representative of the Thurman series, but the surface layer is finer textured.

Included with these soils in mapping were small areas of Boelus, Crofton, and Loretto soils, mainly on the low part of the landscape.

Water erosion and soil blowing are hazards in cultivated areas. The hazard of gully erosion is severe near drainageways. Runoff is medium. These soils are easy to till.

Most of the acreage is cultivated or in tame pasture. Corn, oats, and alfalfa are the main crops, and bromegrass is the main grass seeded for tame pasture. A small acreage is in native grass and is used for range and hay. Capability units IVe-3, dryland, and IVe-8, irrigated; Nora part in Silty range site and windbreak suitability group 4; Thurman part in Sandy range site and windbreak suitability group 3.

Nora-Thurman complex, 11 to 17 percent slopes (NtE).—The soils in this complex are on plane, convex hillsides where the silty loess soils join the eolian sandy soils. This complex is about 40 to 50 percent Nora silt loam, and the rest is Thurman fine sandy loam. The Thurman soil is mainly on the upper part of hillsides above areas of the Nora soil. Areas range from 5 to 40 acres in size.

The Nora soil has a profile similar to the one described as representative of the Nora series, but the subsoil is slightly thinner. The Thurman soil has a profile similar to the one described as representative of the Thurman series, but the surface layer is finer textured.

Included with these soils in mapping were small areas of Boelus, Crofton, and Loretto soils, mainly on the low part of the landscape.

The hazard of water erosion and soil blowing are severe in cultivated areas. The hazard of gully erosion is very severe near drainageways. Runoff is medium to rapid. These soils are easy to till; but where they are strongly sloping, they are difficult to traverse with farm machinery.

These soils are used for range, tame pasture, and crops. The acreage that is in native grass is used for range and hay. Bromegrass is the common tame grass seeded for pasture. Alfalfa is the main crop. Capability unit VIe-3, dryland; Nora part in Silty range site and windbreak suitability group 4; Thurman part in Sandy range site and windbreak suitability group 3.

Ord Series

The Ord series consists of deep, somewhat poorly drained, nearly level soils that formed mainly in mixed loamy and sandy alluvium. These soils are on bottom lands of streams that drain the sandhills and the sandhill transition part of the county.

In a representative profile the surface layer is dark-gray fine sandy loam about 13 inches thick. Beneath this is a transitional layer of grayish-brown fine sandy loam about 10 inches thick. The underlying material extends to a depth of 60 inches. In sequence from the top, it is 7 inches of light brownish-gray fine sand, 4 inches of light brownish-gray coarse sandy loam, 20 inches of white fine sand, and 6 inches of light-gray sandy clay.

Permeability is moderately rapid, and available water capacity is moderate. These soils absorb moisture easily and release it readily to plants. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderate, and natural fertility is medium.

Ord soils are suited to dryland and irrigated farming. They are suited to native and tame grass, trees and shrubs, and wildlife habitat.

Representative profile of Ord fine sandy loam, in a cultivated field, 115 feet west and 45 feet north of the southeast corner of the southwest quarter of sec. 22, T. 26 N., R. 4 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) moist; moderate to weak, fine,

granular structure; soft, friable; neutral; abrupt, smooth boundary.

A12—6 to 13 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

AC—13 to 23 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; few, fine, prominent, reddish-yellow (7.5YR 6/6) mottles; weak, fine, granular structure; soft, very friable; neutral; gradual, smooth boundary.

C1—23 to 30 inches, light brownish-gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) moist; common, medium, prominent, reddish-yellow (7.5YR 6/6) mottles; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

C2—30 to 34 inches, light brownish-gray (2.5Y 6/2) coarse sandy loam, grayish brown (2.5Y 5/2) moist; common, fine, prominent, reddish-yellow (7.5YR 6/6) mottles; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

C3—34 to 54 inches, white (2.5Y 8/2) fine sand, light gray (2.5Y 7/2) moist; single grained; loose; neutral; abrupt, smooth boundary.

IIC4g—54 to 60 inches, light-gray (5Y 6/1) sandy clay, gray (5Y 5/1) moist; massive; very hard, very firm; water table at depth of 60 inches; neutral.

The solum ranges from 20 to 30 inches in thickness. The A horizon ranges from 10 to 20 inches in thickness. This horizon is mainly loam or fine sandy loam, but in a few areas it is silt loam. The soil material ranges from noncalcareous to calcareous throughout. Mottles are common throughout the AC horizon and upper part of the C horizon but can range in depth to the lower part of the C horizon.

Ord soils are near Cass, Elsmere, Ovina, and Loup soils. They have a higher water table than Cass soils. They have a finer textured AC horizon than Elsmere soils. They are better drained than Loup soils because the water table is at a lower depth. They are similar to Ovina soils, but are coarser textured in the upper part of the C horizon.

Ord fine sandy loam (0 to 1 percent slopes) (Of).—This soil is on bottom lands. Areas range from 20 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Ord loam, Leshara silt loam, and Cass fine sandy loam.

The moderately high water table early in spring causes wetness that delays tillage and causes the soil to remain cold longer than better drained soils. The soil is flooded by stream overflow about once every 3 years. Soil blowing is a hazard unless the surface is protected. Runoff is very slow. The soil is easy to work.

Most of the acreage is used for cultivated crops. Corn, soybeans, and alfalfa are the main crops. A smaller acreage is in native grass and is used for grazing. Capability units IIw–6, dryland, and IIw–8, irrigated; Subirrigated range site; windbreak suitability group 2.

Ord loam (0 to 1 percent slopes) (Om).—This soil is mainly along the lower half of Dry Creek and along Willow Creek. Areas range from 20 to 60 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is loam about 14 inches thick and is moderately alkaline in a few areas.

Included with this soil in mapping were a few small areas of Leshara silt loam, Orwet loam, and Cass soils.

This soil is wet during spring when the water table is highest, and tillage is commonly delayed in spring. Flooding from stream overflow occurs an average of once each 3 years. Runoff is slow. This soil is easy to work.

Nearly all of the acreage is used for cultivated crops. Corn, soybeans, and alfalfa are the main crops. A few areas are in native grass. Capability units IIw–4, dryland, and IIw–8, irrigated; Subirrigated range site; windbreak suitability group 2.

Ortello Series

The Ortello series consists of deep, well-drained, nearly level to gently undulating soils on uplands and stream terraces. These soils formed in wind-deposited sandy and loamy material.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 19 inches thick. Next is a transitional layer of grayish-brown fine sandy loam about 7 inches thick. The underlying material to a depth of 60 inches is pale-brown loamy fine sand.

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

Ortello soils are well suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Ortello fine sandy loam, 2 to 7 percent slopes, in a cultivated field, 210 feet south and 210 feet west of the northeast corner of the southeast quarter of sec. 11, T. 27 N., R. 4 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 19 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure parting to weak, very fine, granular; soft, very friable; slightly acid; gradual, wavy boundary.

AC—19 to 26 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky structure parting to weak, very fine, granular; soft, very friable; slightly acid; gradual, wavy boundary.

C—26 to 60 inches, pale-brown (10YR 6/3) loamy fine sand brown (10YR 5/3) moist; single grained; loose; neutral.

The A horizon ranges from 10 to 20 inches in thickness and is fine sandy loam or loam. The AC horizon ranges from 4 to 12 inches in thickness and is sandy loam or fine sandy loam. The C horizon ranges from fine sandy loam to sand that is slightly acid or neutral.

Ortello soils are near Bazile and Thurman soils and are similar to Cass and Ovina soils. They do not have a silty clay loam B horizon, which is characteristic of Bazile soils. They have a finer textured AC horizon than Thurman soils. In contrast with Cass soils, they are not stratified. They lack the mottling in the C horizon that characterizes Ovina soils, and they are better drained than those soils.

Ortello fine sandy loam, 0 to 2 percent slopes (OrA).—This soil is on sandy uplands. Slopes are plane or convex. Areas range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker.

Included with this soil in mapping were small areas of Bazile and Thurman soils and the Boelus-Loretto complex. Also included were small areas where silty,

very pale brown loess is at a depth of 40 to 60 inches. Small depressions are identified by a spot symbol on the detailed soil map.

Soil blowing is a slight hazard, but it is the principal hazard on this soil. Runoff is very slow or slow. This soil is easy to till.

Most of the acreage is cultivated and is used mainly for corn, soybeans, oats, and alfalfa. A small acreage is irrigated by sprinklers. A small acreage has been seeded to bromegrass and is used for pasture. A few small areas are in native grass and are used for range. Capability units IIe-3, dryland, and IIe-8, irrigated; Sandy range site; windbreak suitability group 3.

Ortello fine sandy loam, 2 to 7 percent slopes (OrC).—This soil is on sandy uplands. Slopes range from long and plane to short and undulating. Areas range from 5 to about 250 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Bazile and Thurman soils and the Boelus-Loretto complex and some cultivated areas where soil blowing has removed the original surface layer and the present surface layer is light-colored loamy fine sand or fine sand. Also included were small areas where silty, very pale brown loess and loamy glacial till are below a depth of 40 inches.

Soil blowing and water erosion are the principal hazards in cultivated areas. The hazard of gully erosion is severe near drainageways. Runoff is slow to medium. This soil is easy to till.

Most of the acreage is cultivated and is used mainly for corn, oats, and alfalfa. A smaller acreage of soybeans and grain sorghum and of rye sown with vetch is also grown. Some areas are irrigated by sprinklers. A small acreage has been seeded to bromegrass and is used for pasture. A few areas are in native grass and are used for range. Capability units IIIe-3, dryland, and IIIe-8, irrigated; Sandy range site; windbreak suitability group 3.

Ortello fine sandy loam, terrace, 0 to 2 percent slopes (OsA).—This soil is on stream terraces. Areas range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but in places it is mottled within a depth of 40 to 60 inches.

Included with this soil in mapping were small areas of Bazile, Cass, Loretto, Ovina, and Thurman soils.

Soil blowing is a slight hazard, but it is the principal hazard on this soil. In places the soil receives additional water as runoff from higher elevations. Runoff is very slow. This soil is easy to till.

The largest areas of this soil are cultivated and are used mainly for corn, soybeans, oats, and alfalfa. A small acreage is irrigated by sprinklers. A smaller acreage is in native grass and is used for range. Alfalfa and trees receive some beneficial subirrigation from the water table, which is 5 to 15 feet below the surface. Capability units IIe-3, dryland, and IIe-8, irrigated; Sandy range site; windbreak suitability group 3.

Ortello loam, terrace, 0 to 1 percent slopes (OtA).—This soil is on stream terraces. 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 the surface layer is loam.

Included with this soil in mapping were small areas of Bazile, Cass, Hobbs, and Ovina soils.

In places this soil receives additional water as runoff from higher elevations. Runoff is slow. This soil is easy to till.

Most of the acreage is cultivated. Corn, oats, soybeans, and alfalfa are the main crops. A small acreage is irrigated. A small acreage has been seeded to bromegrass and is used for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is 5 to 15 feet below the surface. Capability units I-1, dryland, and I-8, irrigated; Sandy range site; windbreak suitability group 4.

Orwet Series

The Orwet series consists of deep, poorly drained, nearly level, calcareous soils that formed in loamy and sandy alluvium. These soils are on bottom lands, mainly along the upper end of Willow Creek and along parts of Dry Creek.

In a representative profile the surface layer is gray, calcareous loam about 18 inches thick. Below this is a transitional layer of gray loamy sand about 6 inches thick that is faintly mottled. The underlying material, between depths of 24 and 60 inches, is mottled, light-gray sand.

Permeability is rapid, and available water capacity is moderate. These soils release moisture readily to plants. The water table ranges in depth from 1 foot in spring to 5 feet in fall. Organic-matter content and natural fertility are high.

Orwet soils are well suited to native grass, meadow, and summer range. They also are well suited to dugouts for livestock water and fish ponds. The soils are suited to wildlife habitat. They are marginal for cultivated crops and trees.

Representative profile of Orwet loam, in a native meadow, 570 feet west and 240 feet south of the northeast corner of sec. 30, T. 27 N., R. 3 W.:

A1ca—0 to 18 inches, gray (N 5/0) loam, black (10YR 2/1) moist; moderate, fine and very fine, granular structure; slightly hard, friable; violent effervescence (20 percent lime); moderately alkaline; clear, smooth boundary.

AC—18 to 24 inches, gray (5Y 5/1) loamy sand, dark gray (5Y 4/1) moist; few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, fine and very fine, granular structure; soft, very friable; neutral; gradual, smooth boundary.

C1—24 to 46 inches, light-gray (5Y 6/1) sand, gray (5Y 5/1) moist; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; single grained; loose; many small iron or manganese concretions; water table at a depth of 44 inches; neutral; diffuse, smooth boundary.

C2—46 to 60 inches, light-gray (5Y 6/1) sand, gray (5Y 5/1) moist; many, medium, prominent, yellow (10YR 7/6) mottles; single grained; loose; many small iron or manganese concretions; neutral.

The A1ca horizon ranges from 10 to 20 inches in thickness. It is mainly loam, but it ranges to fine sandy loam and sandy clay loam. The content of lime ranges from 15 to 28 percent. The AC horizon ranges from fine sandy loam to loamy sand that is neutral to moderately alkaline. The C horizon is loamy sand or sand.

Orwet soils are near Loup, Lawet, and Ord soils and Wet alluvial land. They have an A horizon that is higher in

content of lime and finer textured than that of Loup soils. They are coarser textured below the A horizon than Lawet soils. They contain more lime in the A horizon and have a higher water table than Ord soils. They have a lower water table than Wet alluvial land.

Orwet loam (0 to 1 percent slopes) (Ou).—This soil is on bottom lands. Areas range from 5 to 500 acres in size.

Included with this soil in mapping were a few areas where the calcareous surface layer is 20 to 36 inches deep over sand. Also included were small areas of Lawet, Loup, Ord, and Ovina soils and Wet alluvial land. Grayish clay is at a depth of 4 to 6 feet in many areas.

Flooding is slight. Runoff is slow. In spring the water table is at a depth of 1 foot to 2 feet, but it recedes to a depth of 3 to 5 feet by midsummer. This soil has a high content of lime in the surface layer. During most years the soil is difficult to till in spring because of wetness. A lack of suitable outlets limits the acreage that can be tiled, and tiling is difficult because of caving of sand in the trench. Bogs develop if this soil is grazed too early in spring.

Most of the acreage is in native grass and is used for hay. A smaller acreage is used for range. A few small areas are cultivated, and corn and soybeans are the main crops. Some dugouts have been constructed on this soil for livestock water and for fishing. Capability unit IVw-4, dryland; Subirrigated range site; windbreak suitability group 6.

Ovina Series

This series consists of deep, somewhat poorly drained, nearly level or very gently undulating soils on stream terraces, mainly in the valleys of Willow Creek and Dry Creek. These soils also occur in a few areas in basins of areas that are transitional between the sandhills and loess uplands. They formed in loamy and sandy alluvium or in wind-deposited material.

In a representative profile the surface layer is fine sandy loam about 20 inches thick. The upper 7 inches is dark grayish brown, and the lower 13 inches is very dark grayish brown. The next layer is transitional between the surface layer and the underlying material. It is grayish-brown, mottled fine sandy loam about 7 inches thick. The underlying material is pale-brown, mottled loamy fine sand between depths of 27 and 58 inches and light brownish-gray, mottled clay loam to a depth of 60 inches.

Permeability is moderately rapid, and available water capacity is moderate. These soils absorb moisture easily and release it readily to plants. The water table ranges in depth from 3 feet in spring to 8 feet in fall. Organic-matter content is moderate, and natural fertility is medium.

Ovina soils are suited to dryland and irrigated farming. They are excellent for grass. They are also suited to trees and shrubs and wildlife habitat.

Representative profile of Ovina fine sandy loam, 0 to 2 percent slopes, in a cultivated field, 1,320 feet south and 50 feet east of the northwest corner of sec. 12, T. 25 N., R. 3 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 20 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; slightly hard, very friable; neutral; gradual, wavy boundary.

AC—20 to 27 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; few, fine, faint, reddish-yellow (7.5YR 6/6) mottles; weak, fine, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; neutral; gradual, wavy boundary.

C1—27 to 58 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) moist; common, fine, distinct, reddish-yellow (7.5YR 6/6) mottles; single grained; loose; mildly alkaline; clear, smooth boundary.

IIC2—58 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; common, fine, distinct, brownish-yellow (10YR 6/8) mottles; massive; hard, firm; mildly alkaline.

The A horizon ranges from 10 to 20 inches in thickness and includes textures of loam and fine sandy loam. The AC horizon is fine sandy loam or loam. The C horizon is mainly loamy fine sand, but it includes layers of fine sandy loam or fine sand. In places, layers of loam or clay loam are below a depth of 48 inches. Depth to lime ranges from 0 to more than 60 inches.

Ovina soils are near Elsmere, Loup, Ord, and Ortello soils. They are not so coarse textured in the upper part of the C horizon as Elsmere, Loup, and Ord soils. In addition, they lack the stratification of the Ord soils and have a lower water table than Loup soils. They have a higher water table than Ortello soils.

Ovina fine sandy loam, 0 to 2 percent slopes (OvA).—This soil is on stream terraces and in basins of the transitional area adjacent to the sandy uplands. A few areas have low hummocky topography, and a few areas are moderately eroded. Areas range from 10 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas of Ortello fine sandy loam, Elsmere loamy fine sand, and Loup fine sandy loam.

The water table is highest during spring. This seasonal high water table causes wetness and delays tillage. The soil becomes warm more slowly than better drained soils. Soil blowing is a hazard in cultivated areas unless the surface is protected. Runoff is very slow.

This soil is used for crops and range. Corn, soybeans, and alfalfa are the commonly grown cultivated crops. A small acreage is irrigated by sprinklers. A small acreage is seeded to bromegrass and is used for pasture. Capability units IIw-6, dryland, and IIw-8, irrigated; Subirrigated range site; windbreak suitability group 2.

Ovina loam, 0 to 1 percent slopes (OwA).—This soil is on stream terraces. Areas range from 10 to 50 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish-brown loam about 12 inches thick.

Included with this soil in mapping were a few areas of Ortello fine sandy loam and Orwet loam.

The water table causes soil wetness in spring, which delays tillage. The soil becomes warm more slowly in spring than better drained soils. Runoff is slow. The soil is easy to work.

This soil is used for cultivated crops and grazing. Corn, soybeans, and alfalfa are the main crops. A small acreage is seeded to bromegrass. Capability

units IIw–4, dryland, and IIw–8, irrigated; Subirrigated range site; windbreak suitability group 2.

Ovina-Slickspots complex (0 to 2 percent slopes) (Ox).—The soils in this complex are on stream terraces and breaks of stream terraces to bottom lands. Areas are small and range from 5 to 40 acres in size. The water table ranges in depth from 3 feet in spring to 8 feet in fall. This complex is about 70 percent Ovina fine sandy loam, 20 percent Slickspots, and 10 percent other soils. The Ovina soil is at the higher elevations. Slickspots are in irregularly shaped, slight depressions that are roughly 5 to 15 feet in diameter. They hold water following rain.

The Ovina soil has a profile similar to the one described as representative of the Ovina series, but the underlying material is slightly more alkaline. In this complex Slickspots has a surface layer of loam or heavy fine sandy loam about 10 inches thick that is crusted when dry. The underlying material is loam or fine sandy loam in the upper part and fine sand in the lower part. Reaction is generally moderately alkaline in the surface layer, strongly alkaline in the upper part of the underlying material, and moderately alkaline in the lower part. In places Slickspots are very strongly alkaline.

Included with these soils in mapping were small areas of Lawet and Orwet soils. Also included, in areas that have the best surface drainage, were areas of Ortello fine sandy loam.

Although Slickspots make up the smaller part of this complex, the alkalinity of Slickspots is the factor that limits the use of these soils. The strong alkalinity is toxic to most cultivated crops. The moderately high water table causes wetness in spring, which delays tillage. Fertility needs to be balanced, because the alkalinity makes the plants unable to use all plant nutrients. The areas of Slickspots are difficult to till because the excess sodium breaks down soil structure, resulting in a puddled soil condition. Slickspots absorb moisture slowly and release it slowly to plants. Runoff is slow.

Areas of this soil complex are used almost entirely for grass. Most areas are grazed, but some are mowed for hay. Capability units IIIs–1, dryland, and IIIs–8, irrigated; Ovina part in Subirrigated range site and windbreak suitability group 2; Slickspots part in Saline Subirrigated range site and windbreak suitability group 10.

Paka Series

The Paka series consists of deep, well-drained, gently sloping to moderately sloping soils on uplands. These soils formed mainly in silt of the Sappa Formation.

In a representative profile the dark grayish-brown surface layer is about 15 inches thick. It is sandy loam in the upper 8 inches and loam in the lower 7 inches. The light brownish-gray, firm subsoil is about 20 inches thick. It is clay loam in the upper 13 inches and silty clay loam in the lower 7 inches. The underlying material is calcareous, light olive-gray silty clay loam to a depth of 50 inches and light olive-gray silt loam between depths of 50 and 60 inches.

Permeability is moderately slow, and available water capacity is high. These soils release moisture readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Paka soils are suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Paka sandy loam, 3 to 8 percent slopes, in a cultivated field, 1,060 feet east and 300 feet north of the southwest corner of sec. 6, T. 28 N., R. 4 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A12—8 to 15 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; slightly hard, friable; slightly acid; clear, smooth boundary.

IIB21t—15 to 19 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, fine and very fine, subangular blocky structure; hard, firm; slightly acid; clear, smooth boundary.

IIB22t—19 to 28 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak, fine, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, firm; films on faces of peds; slightly acid; gradual, wavy boundary.

IIB3—28 to 35 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; few, fine, prominent, yellow (2.5Y 7/6), relict mottles; weak, fine, prismatic structure parting to weak, fine, subangular blocky; hard, firm; neutral; gradual, wavy boundary.

IIC1ca—35 to 50 inches, light olive-gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2) moist; weak, medium, prismatic structure; hard, firm; disseminated lime throughout; violent effervescence; moderately alkaline; clear, smooth boundary.

IIC2—50 to 60 inches, light olive-gray (5Y 6/2) silt loam, olive gray (5Y 5/2) moist; massive; slightly hard, friable; moderately alkaline.

The A horizon ranges from 7 to 15 inches in thickness and is sandy loam or sandy clay loam. In some places it is eolian in origin, and in other places it formed in silt of the Sappa Formation. The B horizon ranges from 15 to 30 inches in thickness.

Paka soils are near Bazile, Loretto, Ortello, and Thurman soils. They have a grayer B horizon and a finer textured C horizon than Bazile soils. They have grayer B and C horizons and formed in older material than Loretto soils. They are finer textured below the A horizon than Ortello soils. In contrast with Thurman soils, they are finer textured and have a B horizon.

Paka sandy loam, 3 to 8 percent slopes (PaD).—This soil is on uplands. Slopes are long and plane in places and undulating in others. This soil is in areas that have an overblow of loamy or sandy eolian material. Areas range from 5 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were areas where the surface layer is loamy fine sand or fine sand, a few areas of Paka sandy clay loam, and small areas of Bazile, Loretto, Ortello, and Thurman soils. Also included on some lower slopes were a few small alkali spots, which are shown by a spot symbol on the detailed soil map.

The hazards of water erosion and soil blowing are severe in cultivated areas. Gully erosion is a hazard near drainageways. Runoff is slow to medium. These soils are easy to till, except in the included alkali areas.

This soil is used for crops, tame pasture, and range.

Corn and alfalfa are the main crops. A smaller acreage is used for soybeans and oats and for rye sown with vetch. A small acreage is irrigated by sprinklers. Bromegrass is the common grass used for tame pasture. Capability units IIIe–3, dryland, and IIIe–5, irrigated; Sandy range site; windbreak suitability group 3.

Paka sandy clay loam, 3 to 8 percent slopes (PkD).—This soil is on long, plane slopes near ridgetops and on hillsides in the uplands. Areas range from 5 to 30 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is finer textured.

Included with this soil in mapping were a few areas where the subsoil is silty clay and a few areas where water erosion has removed the original dark surface layer, exposing the light brownish-gray subsoil. Also included were small areas of Bazile, Loretto, and Ortello soils. A few small alkali areas were included in some of the lower parts, and they are identified by a spot symbol on the detailed soil map.

Water erosion is the principal hazard on this soil. Gulleys are near some drainageways. Runoff is medium. These soils are easy to till, except in the alkali areas and in places where the subsoil has been incorporated into the plow layer during tillage.

This soil is used for crops, tame pasture, and range. Corn, soybeans, oats, and alfalfa are the main crops. A small acreage is irrigated by sprinklers. Bromegrass is the main grass seeded for pasture. Capability units IIIe–3, dryland, and IIIe–5, irrigated; Silty range site; windbreak suitability group 4.

Sandy Alluvial Land

Sandy alluvial land (0 to 1 percent slopes) (Sx) is in a few gullies and stream channels and on bottom lands that are frequently flooded. The flooding occurs each spring, but it can also occur during other times of the year when the adjacent streams overflow their channels. Areas range from 20 to 100 acres in size.

Sandy alluvial land consists of material that formed in alluvium. The surface layer is light-colored, stratified fine sandy loam, loamy fine sand, or fine sand. The underlying material in most places is sand, but in some places it contains layers and lenses of soil material that ranges from clay to loamy sand. Included in mapping were a few areas of poorly drained soils in the lowest places.

Permeability is moderately rapid or rapid, depending on the coarseness of the material. Available water capacity is generally low. The soil material absorbs moisture easily and releases it readily to plants. Organic-matter content and natural fertility are low. Areas of Sandy alluvial land are not easily worked because they are commonly too wet. The material is very friable. Trash and debris are deposited on the surface of some areas during flooding. Runoff is very slow.

Flooding is a serious hazard and limits the use of these areas. This land is not suited to cultivated crops. Most areas are in grass and are used for grazing. A few are mowed for hay. Sandy alluvial land provides good habitat for some kinds of wildlife. Capability unit VIw–7, dryland; Sandy Lowland range site; windbreak suitability group 10.

Silty Alluvial Land

Silty alluvial land (0 to 1 percent slopes) (Sy) is in a few gullies and on steep streambanks and frequently flooded botom lands. The flooding is most common in spring, but it can occur at other times during the year when the streams overflow their channels after rain. Such overflow occurs every year, and even more frequently in some years. Areas range from 20 to 200 acres in size.

Silty alluvial land consists of alluvium that is generally light colored. The surface layer is stratified silt loam and silty clay loam. The underlying material is commonly silt loam, but in places it contains thin layers of soil material that ranges from clay to sand. Included in mapping were a few small areas of somewhat poorly drained and poorly drained soils in pockets at lower elevations.

Permeability is moderate, and available water capacity is high. Moisture is absorbed easily and is released readily to plants. Organic-matter content and natural fertility are low. Because the soils are in low positions where flooding is frequent and excessive wetness is common, they are not easy to work. The material is friable. Trash and debris are on the surface following some floods. Runoff is slow.

The frequent flooding makes these areas unsuited to cultivated crops. Timely tillage operations are not possible in spring when planting and cultivation are needed. Small crop plants are inundated and damaged by floodwaters. Silty alluvial land is better suited to permanent vegetation than to other uses. Most areas are in native grass. A few areas are cultivated, but cultivated crops are generally not profitable unless they can be protected from flooding. Silty alluvial land provides good habitat for some species of wildlife when it is not flooded. Capability unit VIw–7, dryland; Silty Overflow range site; windbreak suitability group 10.

Simeon Series

The Simeon series consists of deep, excessively drained, gently sloping to moderately sloping soils on uplands. These soils formed mainly in sandy glacial outwash material.

In a representative profile the surface layer is grayish-brown sandy loam 9 inches thick. Beneath this is a 4-inch transitional layer of pale-brown loamy sand. The underlying material, between depths of 13 and 60 inches, is pale-brown medium and coarse sand that contains a few small pebbles.

Permeability is rapid, and available water capacity is low. These soils are droughty. Organic-matter content is moderately low, and natural fertility is low.

Simeon soils are better suited to native or tame grass than to other uses.

Representative profile of Simeon sandy loam, 3 to 9 percent slopes, in a cultivated field, 790 feet south and 190 feet west of the northeast corner of the southeast quarter of sec. 1, T. 26 N., R. 2 W.:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) sandy loam, very

dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A12—6 to 9 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; slightly hard, friable; slightly acid; clear, smooth boundary.

AC—9 to 13 inches, pale-brown (10YR 6/3) loamy sand, dark grayish brown (10YR 4/2) moist; weak, very fine, granular structure; soft, very friable; slightly acid; gradual, smooth boundary.

IIC—13 to 60 inches, pale-brown (10YR 6/3) medium and coarse sand, brown (10YR 5/3) moist; single grained; loose; few small pebbles; slightly acid.

The A horizon ranges from 7 to 10 inches in thickness. It is mainly glacial outwash material, but in some places it includes small amounts of eolian sand and loess. In some areas the A and AC horizons contain a few small pebbles. The AC horizon ranges from 2 to 6 inches in thickness. The IIC horizon is slightly acid or neutral.

Simeon soils are near Bazile and Clarno soils and are similar to Thurman and Valentine soils. They do not have a silty B horizon, which is characteristic of Bazile soils. They formed in sandy glacial outwash, whereas Clarno soils formed in loamy glacial till. They contain a higher percentage of medium and coarse sand and contain more pebbles than Thurman and Valentine soils.

Simeon sandy loam, 3 to 9 percent slopes (SzD).—This soil is on plane to convex ridgetops and hillsides. Areas are mainly long and narrow and range from 5 to 30 acres in size.

Included with this soil in mapping were a few areas where the surface layer is loam or loamy sand. Also included were small areas of Bazile, Clarno, Thurman, and Valentine soils. A few small gravel areas are identified by a spot symbol on the detailed soil map.

Low available water capacity is the principal limitation. The soil is droughty, commonly during part of July and August. Soil blowing is a hazard in cultivated areas. Water erosion is a hazard on some lower side slopes. Runoff is slow.

Where this soil is in small areas within larger areas of tillable soils, it is used for cultivated crops. Because it is droughty, it is better suited to permanent vegetation than to other uses. Larger areas of this soil are in bromegrass pasture or native grass range. Capability unit VIs–4, dryland; Shallow to Gravel range site; windbreak suitability group 10.

Slickspots

Slickspots consist of strongly alkaline and very strongly alkaline soil material. The content of soluble salts ranges from slight to strong. Slickspots are nearly level in small, shallow depressions. Areas are irregular in shape and range from about 5 to 15 feet in diameter. The soil material is deep and somewhat poorly drained. It formed in alluvial or eolian material. Slickspots give the landscape a scabby appearance.

Slickspots occur as a part of three mapping units of Pierce County. It is mapped in complex with soils of the Clamo, Lawet, and Ovina series.

Slickspots have a wide range of soil characteristics. The surface layer is generally thin, but ranges from 1 inch to as much as 10 inches thick. It is silty clay, loam, or fine sandy loam. In undisturbed areas the upper part is commonly grayish brown and the lower part is light gray. The subsoil is light brownish-gray, firm or very firm silty clay to heavy loam. It has columnar or prismatic structure and is calcareous in places. The underlying material is at a depth of 15 to 30 inches. It is calcareous, pale-brown to dark grayish-brown silty clay to loamy fine sand. It is not so strongly alkaline as the subsoil, and it is less alkaline with increasing depth.

In cultivated areas Slickspots are lighter colored on the surface than the associated soils. Areas of Slickspots commonly are hard and cloddy when dry, but in other places they have a smooth surface where drying occurs after they have been puddled. Puddling is common because of high content of sodium, which breaks down the organic matter. In cultivated areas Slickspots are sticky and difficult to work.

Because Slickspots occupy the lowest part of the landscape, runoff is very slow or ponded. In areas of range, water remains in the microdepressions until it evaporates or seeps into the soil. Permeability is very slow. This material has a high available water capacity, but its alkalinity lowers the ability of crop roots to absorb moisture readily. The water table fluctuates between a depth of 2 feet in spring and 8 feet in fall. Organic-matter content and natural fertility are low. Nutrients that are needed for good crop growth commonly are not balanced. Some nutrients are present in adequate amounts but are not available to plants because of the high alkalinity.

Although Slickspots occupy only a small part of the landscape in areas where they are mapped, the alkalinity and poor workability of the material are important factors that determine the use of the soil. Most areas are in native grass, but a few are cultivated. Crops that can tolerate strong alkalinity are better suited than others. A few areas are mowed for hay.

Thurman Series

The Thurman series consists of deep, somewhat excessively drained soils that formed in wind-deposited sand (fig. 7). These soils are mainly gently undulating, but they range from nearly level to gently rolling. They are on uplands and stream terraces.

In a representative profile the surface layer is loamy fine sand 15 inches thick. It is grayish brown in the upper 7 inches and dark grayish brown in the lower 8 inches Beneath this is a 4-inch transitional layer of grayish-brown loamy fine sand. The underlying material, between depths of 19 and 60 inches, is very pale brown fine sand.

Permeability is rapid, and available water capacity is low. These soils release moisture readily to plants. They are somewhat droughty, commonly during part of July and August. Organic-matter content is moderately low, and natural fertility is low. These soils are low in available phosphorus and calcium.

Thurman soils are suited to dryland and irrigated farming. They are well suited to grass, trees and shrubs, and wildlife habitat.

Representative profile of Thurman loamy fine sand, 2 to 7 percent slopes, in a cultivated field, 380 feet north and 150 feet west of the southeast corner of the northeast quarter of sec. 12, T. 26 N., R. 4 W.:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; single

Figure 7.—**Representative profile of Thurman loamy fine sand. This deep, sandy soil formed in eolian sand.**

grained; loose; medium acid; abrupt, smooth boundary.

A12—7 to 15 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; medium acid; gradual, wavy boundary.

AC—15 to 19 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, very fine, granular structure; soft, very friable; medium acid; gradual, wavy boundary.

C—19 to 60 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; single grained; loose; slightly acid.

The A horizon ranges from 7 to 18 inches in thickness and is fine sandy loam or loamy fine sand. The AC horizon ranges from 3 to 10 inches in thickness and is loamy fine sand or fine sand. The A and AC horizons are slightly acid or medium acid. The C horizon ranges from very pale brown to light yellowish-brown loamy fine sand to sand that is medium acid to neutral.

Thurman soils are near Elsmere, Ortello, and Valentine soils and are similar to Simeon soils. In contrast with Elsmere soils, they do not have the mottling in the C horizon and are better drained. They are coarser textured in the A and AC horizons than Ortello sols. They have a thicker A horizon than Valentine soils. They contain more fine sand, less medium and coarse sand, and fewer pebbles than Simeon soils.

Thurman loamy fine sand, 0 to 2 percent slopes (ThA).—This soil is on plane or complex slopes in the sandy uplands. Areas range from 5 to 400 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker and darker.

Included with this soil in mapping were small areas of Elsmere, Hadar, and Ortello soils and the Boelus-Loretto complex. Also included were small areas where silty, very pale brown loess and loamy glacial till are at a depth of 40 to 60 inches. Small depressions are identified by a spot symbol on the detailed soil map.

The hazard of soil blowing is moderate. Low available water capacity and low natural fertility are limitations. Runoff is very slow. This soil is easy to till.

Most of the acreage is cultivated. A small acreage is irrigated by sprinklers. Corn and alfalfa and rye sown with vetch are the main crops. A small acreage is in native grass and is used for range and hay. A few areas have been seeded to bromegrass and are used for pasture. A small acreage is in field windbreaks. Capability units IIIe–5, dryland, and IIIe–11, irrigated; Sandy range site; windbreak suitability group 3.

Thurman loamy fine sand, 2 to 7 percent slopes (ThC).—This soil is on sandy uplands. It is on low, convex ridges and plane to concave slopes. Areas range from 5 to 800 acres in size. This is the most extensive soil in Pierce County. It has the profile described as representative of the series.

Included with these soils in mapping were small areas of Hadar, Ortello, Paka, and Valentine soils and the Boelus-Loretto complex. Also included were some cultivated areas where soil blowing has removed the original surface layer and the present surface layer is lighter colored fine sand. Silty, very pale brown loess and loamy glacial till are at a depth of 40 to 60 inches in some places.

The hazard of soil blowing is generally slight to moderate, but it is severe, particularly in cultivated areas. The hazard of water erosion is slight on the long, plane slopes. The low available water capacity and low natural fertility limit production. Runoff is slow. This soil is easy to till. On some convex ridges it is too loose for easy workability.

Most of the acreage is cultivated and is used mainly for corn and alfalfa and for rye sown with vetch. A few areas are irrigated by sprinklers. About one-fourth of the acreage is in native grass and is used for range and hay. A few cultivated areas are seeded to bromegrass and are used for pasture. A few areas are in field windbreaks. Capability units IVe–5, dryland, and IVe–11, irrigated; Sandy range site; windbreak suitability group 3.

Thurman loamy fine sand, terrace, 0 to 2 percent slopes (TmA).—This soil is on stream terraces. Slopes are plane or complex. Areas range from 5 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is slightly thicker and the underlying material, at a depth of 40 to 60 inches, is lighter colored and has a few yellowish mottles.

Included with this soil in mapping were small areas of Elsmere and Ortello soils. Also included were a few small depressions and wet spots, both of which are identified by spot symbols on the detailed soil map.

The hazard of soil blowing is generally slight or moderate, but it is severe, particularly where the soil is not adequately protected. In places this soil receives additional water as runoff from higher elevations. Runoff is very slow. Low available water capacity and low natural fertility are limitations. This soil is easy to till.

Nearly all of the acreage is cultivated or is used for pasture and range. A small acreage is irrigated by sprinklers. Corn and alfalfa and rye sown with vetch are the main crops. Bromegrass is the main grass seeded for pasture. Alfalfa and trees receive some beneficial subirrigation from the water table, which is

at a depth of 5 to 15 feet. Capability units IIIe–5, dryland, and IIIe–11, irrigated; Sandy range site; windbreak suitability group 3.

Thurman fine sandy loam, 7 to 11 percent slopes (TnD).—This soil is on plane or complex slopes in the sandy uplands. Areas range from 5 to about 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer is finer textured.

Included with this soil in mapping were areas of Thurman loamy fine sand and a few areas where erosion has removed practically all of the original surface layer. In some areas a small acreage of Clarno, Nora, Paka, and Valentine soils was included.

Water erosion and soil blowing are the principal hazards. The hazard of gully erosion is severe near drainageways. Low available water capacity and low natural fertility are limitations. Runoff is slow to medium. This soil is easy to till.

This soil is used for crops, tame pasture, and range. Alfalfa, oats, and corn and rye sown with vetch are the main crops. Bromegrass is the common grass seeded for tame pasture. Capability unit IVe–3, dryland; Sandy range site; windbreak suitability group 3.

Thurman and Valentine soils, 1 to 7 percent slopes (TvC).—The soils in this mapping unit are on complex slopes, low convex ridges, and plane to concave side slopes on uplands. They formed in eolian sand. Areas range from 5 to 300 acres in size. This mapping unit consists of Thurman loamy fine sand and Valentine fine sand. Most areas have both soils in varying proportions, but a few areas contain only one soil. The Thurman soil is mainly on slightly concave, lower side slopes; and the Valentine soil is on convex ridges and upper side slopes.

The Thurman and Valentine soils have profiles similar to the ones described as representative of their respective series, but the Thurman soil has a slightly lower amount of silt, clay, and organic matter, and the Valentine soil has a lighter colored surface layer in cultivated areas.

Included with these soils in mapping were small areas of the Boelus-Loretto complex. Also included were small blowouts, which are identified by a spot symbol on the detailed soil map.

The hazard of soil blowing is severe in cultivated areas and in range where the native grass is overgrazed or sparse. These soils have low available water capacity. The areas of Valentine soils are droughty where they are used for crops. Runoff is very slow, and natural fertility is low. These soils are low in available phosphorus and lime. Also, the most severely eroded areas are low in sulfur and zinc. Soils in this mapping unit are commonly too loose for easy workability.

These soils are used for crops, tame pasture, and range. Corn and alfalfa and rye sown with vetch are the main crops. A small acreage is sprinkler irrigated. A considerable acreage has been seeded to bromegrass and native grasses. About 30 percent of the acreage is in native grass and is used for range and hay. Capability units IVe–5, dryland, and IVe–11, irrigated; both parts in Sandy range site; Thurman part in windbreak suitability group 3, and Valentine part in windbreak suitability group 7.

Trent Series

The Trent series consists of deep, moderately well drained, nearly level soils that formed in Peoria Loess, colluvium, or alluvium. These soils occur on low parts of the landscape near the heads of upland drainageways and on stream terraces.

In a representative profile the surface layer is silty clay loam about 21 inches thick. The upper 16 inches is dark gray, and the lower 5 inches is dark grayish brown. The subsoil is firm silty clay loam about 34 inches thick. It is grayish brown in the upper 7 inches, brown in the next 20 inches, and pale brown in the lower 7 inches. The underlying material, between depths of 55 and 60 inches, is pale-brown, calcareous silt loam.

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

Trent soils are suited to dryland and irrigated farming. They are also suited to grass, trees, and wildlife habitat.

Representative profile of Trent silty clay loam, in a cultivated field, 1,320 feet east and 265 feet south of the northwest corner of sec. 3, T. 27 N., R. 1 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; weak, fine, and very fine, granular structure; hard, firm; slightly acid; abrupt, smooth boundary.

A12—6 to 16 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate, fine and very fine, granular structure; hard, firm; slightly acid; clear, smooth boundary.

A3—16 to 21 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, granular structure; hard, friable; slightly acid; gradual, smooth boundary.

B21—21 to 28 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 3/3) moist; moderate, medium, subangular blocky structure parting to fine and very fine, subangular blocky; hard, firm; slightly acid; gradual, smooth boundary.

B22—28 to 48 inches, brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, firm; neutral; gradual, smooth boundary.

B3—48 to 55 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; weak, medium, prismatic structure parting to weak, fine, subangular blocky; hard, firm; neutral; clear, smooth boundary.

C—55 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak, medium, prismatic structure; slightly hard, friable; disseminated lime and few small concretions; strong effervescence; moderately alkaline.

The A horizon ranges from 20 to 30 inches in thickness and is slightly acid or medium acid. The B horizon ranges from 20 to 40 inches in thickness. Depth to lime ranges from 40 to 60 inches. The C horizon ranges from neutral to moderately alkaline.

Trent soils are near Butler, Fillmore, Hord, and Moody soils. They contain less clay in the B2 horizon than Butler and Fillmore soils. They are finer textured in the solum than Hord soils. They have a thicker A horizon than Moody soils, and they formed in a lower relative position on the landscape than those soils.

Trent silty clay loam (0 to 1 percent slopes) (Tw).—This soil is near the heads of wide upland drainageways and on stream terraces. Areas range from 5 to 100 acres in size.

Included with this soil in mapping were a few small areas of Butler, Hord, and Moody soils. Also included were small depressions and alkali areas, both of which are identified by spot symbols on the detailed soil map.

In places this soil receives additional water as runoff from higher elevations. Runoff is slow. This soil is somewhat difficult to till, because it is firm when moist and tends to form clods if it is tilled when wet.

Most of the acreage is cultivated. Corn, soybeans, oats, and alfalfa are the main crops. A small acreage is irrigated. A small acreage is seeded to bromegrass and is used as pasture and hay. Alfalfa and trees receive some beneficial subirrigation from the water table, which is at a depth of 5 to 15 feet. Capability units I–1, dryland, and I–3, irrigated; Silty Lowland range site; windbreak suitability group 4.

Valentine Series

The Valentine series consists of deep, excessively drained, gently undulating to rolling soils on uplands. These soils formed in eolian sand.

In a representative profile the surface layer is grayish-brown fine sand about 5 inches thick. The underlying material to a depth of 60 inches is very pale brown fine sand.

Permeability is rapid, and available water capacity is low. Organic-matter content and natural fertility are low.

Valentine soils are better suited to native grass and rangeland wildlife habitat than to other uses. They are droughty where they are used for cultivated crops under dryland management. Very gently undulating to gently undulating Valentine soils are suited to cultivated crops under sprinkler irrigation.

Representative profile of Valentine fine sand, rolling, in rangeland, 725 feet west and 125 feet north of the southeast corner of sec. 6, T. 25 N., R. 3 W.:

A—0 to 5 inches, grayish-brown (10YR 5/2) fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; medium acid; clear, wavy boundary.

C—5 to 60 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) moist; single grained; loose; medium acid.

The A horizon ranges from 3 to 10 inches in thickness. In most areas it is fine sand, but in a few areas it is loamy fine sand. This horizon is slightly acid or medium acid. In some areas there is an AC horizon of brown fine sand 3 to 6 inches thick. The C horizon ranges from very pale brown to light yellowish-brown fine sand or sand that is medium acid to neutral.

Valentine soils are near Blown-out land and Elsmere and Thurman soils, and they are similar to Simeon soils. They have a grayish-brown A horizon that is not present in Blown-out land. They have a thinner, coarser textured A horizon than Elsmere and Thurman soils. Also, they do not have a moderately high water table, which is characteristic of Elsmere soils. They contain more fine sand, less medium and coarse sand, and fewer pebbles in the C horizon than Simeon soils.

Valentine fine sand, rolling (1 to 17 percent slopes) (VaE).—This soil has complex slopes and is in the sandhills. It is dominantly rolling, but in a few small areas it is gently undulating. Areas range from 5 to 1,000 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Thurman loamy fine sand and Elsmere loamy fine sand on lower slopes and areas that were once active blowouts but have been stabilized and now provide limited grazing. Also included were small blowouts and intermittent lakes, both of which are identified by spot symbols on the detailed soil map.

The hazard of soil blowing is generally slight, but it is severe where the native grass is overgrazed or plowed. Runoff is slow or very slow, and most precipitation soaks into the porous sand.

Most of the acreage is in native grass, which is used for range. A small acreage is mowed for hay. Some areas that were once used for crops have been reseeded to native grass. A small acreage has been seeded to bromegrass. A few small areas of gently undulating soils are cultivated. Corn and alfalfa and rye sown with vetch are the main crops. Capability unit VIe–5, dryland; Sands range site; windbreak suitability group 7.

Valentine and Thurman soils, rolling (2 to 17 percent slopes) (VtE).—The soils in this mapping unit are mainly on plane, round-topped sandhills. Areas range from 5 to 1,500 acres in size. This mapping unit consists of Valentine fine sand and Thurman loamy fine sand. Most areas have both soils in varying proportions, but a few areas contain only one soil. The Valentine soil is commonly on ridgetops and the upper part of side slopes, and the Thurman soil is in concave areas and on the lower part of the landscape.

Included with these soils in mapping were small areas of Elsmere loamy fine sand. Also included were a few small blowouts and intermittent lakes, both of which are indicated by spot symbols on the detailed soil map.

The hazard of soil blowing is generally slight, but it is severe where the native grass is overgrazed or plowed. Runoff is very slow. Available water capacity is low.

Nearly all of the acreage is in native grass and is used for range. A small acreage is mowed for hay. A few areas of gently undulating soils that were farmed have been reseeded, mainly to native grass. A small acreage is used for corn and alfalfa and rye sown with vetch. Under sprinkler irrigation, a few areas of gently undulating soils are cultivated and corn is the main crop. Capability unit VIe–5, dryland; Sands range site; windbreak suitability group 7.

Wet Alluvial Land

Wet alluvial land (0 to 1 percent slopes) (Wx) is in low areas, mainly near the upper ends of Willow, Dry, and Breslau Creeks. It is very poorly drained because the water table is generally at the surface in spring and at a depth of 2½ feet in fall. The water table, however, is highest in spring, when it is a few inches above the surface. Areas are long and narrow and range from 5 to 100 acres in size.

Wet alluvial land formed mainly in alluvium. The upper part of the soil material is dark-colored, calcareous silt loam that is generally mottled. It commonly contains snail shells. The lower part ranges from silt loam to clay.

Included in mapping were small areas of Orwet, Loup, and Lawet soils and a few small areas of Marsh. Also included, where the stream channel is deep, are areas of Silty alluvial land and Sandy alluvial land.

Permeability is moderate, and available water capacity is high, but these characteristics are significant only when the water table becomes lower or the areas are drained. Runoff is slow or nonexistent. Moisture is released readily to plants. Organic-matter content is moderate or high, and natural fertility is high.

The high water table limits the use of this land. Wet alluvial land is subject to occasional flooding.

Unless Wet alluvial land is drained, it is not suited to the commonly grown crops. It is suited to grass, and nearly all the areas are used for grazing or are mowed for hay. Bogs form if this land is grazed too early in spring. These areas provide good habitat for wetland wildlife. Capability unit Vw–7, dryland; Wet Land range site; windbreak suitability group 10.

Use and Management of the Soils

This section provides information on the use and management of the soils for irrigated and dryland crops. The section on range management gives information on the range sites of the different soils in the county, their management, and the amount of forage that can be expected when the site is in excellent condition. The woodland and windbreaks section gives information on the native woodland, suitability of the soils for windbreaks, and the trees suitable for each windbreak group. The section on wildlife discusses the wildlife in each soil association and the potential of each association for producing wildlife habitat. Finally, various engineering evaluations and test data are given for the soils in the county, and their effect on the use of the soils for engineering purposes is described.

Crops and Pasture[2]

Most soils in Pierce County are fertile and well suited to crops. If the problems and hazards are recognized and suitable management practices are used, many of the soils are well suited to cultivated crops. Water erosion, flooding adjacent to streams, damage to the soils and to crops from soil blowing, and the loss of fertility by erosion and leaching are the principal concerns of management.

Less than 3 percent of the soils in Pierce County have slopes of more than 11 percent. Some small areas of steep Crofton soils have previously been cultivated but are now in grass for pasture and hay. Water erosion on the upland soils, which results in the deposition of soil material in the valleys, has occurred in many places. Both sheet erosion and gully erosion are evident in many areas. Excessive runoff after heavy rain on the steeper soils causes floods on the bottom lands and reduces soil fertility.

[2] By ERVIN O. PETERSON, conservation agronomist, Soil Conservation Service.

The major cultivated crop in Pierce County is corn. Oats and rye are also important. Bottom-land soils, such as Cass, Hobbs, Colo, Lamo, and Leshara soils, produce an extensive acreage of row crops. In some years flooding is a hazard on these soils. Soils on the uplands, such as those in the Crofton, Nora, and Moody series, also have a sizable acreage in row crops. Alfalfa for hay is also important. Its acreage is about one-fourth that of corn.

Barley, grain sorghum, and wheat are grown on a small acreage. During each year, a few of the areas generally used for growing crops remain idle and are most commonly diverted under the government crop control program.

Pasture is mainly bromegrass or, in some cases, a mixture of bromegrass and alfalfa and other cool-season grasses. Most pasture is part of a long-time cropping system. Such use is particularly well suited to eroded soils and areas that are frequently or occasionally flooded.

An increasing acreage of cropland is being irrigated in Pierce County. In 1971, a total of more than 19,000 acres was irrigated. Water supply for the irrigated land comes from about 170 wells. Irrigation water is used mainly to supplement natural rainfall during dry years. During normal years less irrigation is used. Soils that are level or very gently sloping are better suited to irrigation than others. If slope is more than 9 percent, irrigation creates serious problems, such as erosion and the loss of water through excessive runoff.

If suitable quantities of underground water are available, there is a potential for increasing the amount of irrigated land. A potential also exists for increasing the acreage of pasture and range and for a greater use of conservation practices, particularly on moderately sloping soils.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require 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 limitation of groups of soils for range, forest trees, or engineering.

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

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I to 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 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.

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

Class VII soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crops and restrict their use to recreation, wildlife, water supply, or 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 some parts of the United States but not in Pierce County, 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 the county can be found in the "Guide to Mapping Units."

Management of the soils for dryfarming

Conservation practices, such as terraces, contour farming, grassed waterways, and a cropping system that includes mulch tillage and limited use of row crops, are suited to the gently sloping and moderately sloping soils, such as the Moody, Nora, and Crofton soils. These practices keep soil losses to a minimum. Soils on bottom lands, such as those of the Cass, Hobbs, Leshara, and Colo series, commonly require some protection from flooding. Using diversions above areas that are subject to flooding and good water conservation practices on the adjacent areas help to reduce wetness.

The steeper soils that are susceptible to erosion, such as those in the Nora-Thurman complex and the Crofton-Nora silt loams, can be managed for pasture and hay crops. Production of an abundance of crop residue to help control erosion is not always possible on these soils. Therefore, grass and hay crops are needed on these areas to provide protection against erosion.

Cultivated soils in Pierce County should be tested to determine their need for commercial fertilizers. A correlation exists between the amount of moisture in the soil and the amount of fertilizer needed. During periods of low rainfall, soils that are dry in the subsoil need a lower rate of fertilizer than they do during periods of normal rainfall. Nearly all the soils in Pierce County respond to nitrogen fertilizer. Eroded soils of the Betts and Crofton series generally respond well to applications of phosphorus and zinc.

Leaving crop residue on the surface of the soils during tillage is a practice that reduces soil losses caused by soil blowing and water erosion. Mulch tillage and till-plant systems of seedbed preparation are management practices that reduce runoff and sediment losses. Where the steeper soils of the county are used for pasture, an adequate growth of grasses is needed to protect the areas from water erosion.

In the following pages the dryland capability units in Pierce County are described.

CAPABILITY UNIT I–1, DRYLAND

This unit consists of nearly level, deep, moderately well drained and well drained soils on uplands, stream terraces, and bottom lands. These soils have a surface layer of loam, silt loam, or silty clay loam. The subsoil is loamy fine sand, fine sandy loam, silt loam, or silty clay loam. The underlying material is sand, loamy fine sand, or silt loam.

Permeability is moderately rapid or moderate, and available water capacity is moderate or high. Runoff is slow. Most of the soils absorb moisture easily, but those that have a surface layer of silty clay loam absorb moisture moderately slowly. The soils readily release moisture to plants. Organic-matter content is moderate to moderately low, and natural fertility is medium or high.

The soils on bottom lands are subject to flooding, and floods occur an average of once every 3 years. Crop losses, however, are generally minor. The soils are generally easy to work, but those that have a surface layer of silty clay loam are firm when moist and tend to clod if they are tilled when wet.

These soils are suited to all crops commonly grown

in the county. They are especially suited to such row crops as corn, soybeans, and grain sorghum. Row crops can be grown year after year if proper amounts of fertilizer are added and if weeds, diseases, and insects are controlled. Crops on these soils respond well to additions of nitrogen fertilizer. These soils are also well suited to pasture.

Grassed waterways help to conduct runoff from these soils. In places, diversion ditches help to intercept runoff from adjacent higher areas. Grassed turn rows help to control weeds along field borders.

CAPABILITY UNIT IIe-1, DRYLAND

This unit consists of very gently sloping to gently sloping, deep, well-drained soils on uplands and foot slopes. These soils have a surface layer of loam, silt loam, or silty clay loam. The subsoil is silt loam, silty clay loam, or clay loam. The underlying material is silt loam or clay loam. In a few areas pebbles and stones are on the surface and throughout the profile.

Permeability is moderate, and available water capacity is high. Runoff is medium. Most of the soils absorb moisture easily, but those that have a surface layer of silty clay loam absorb moisture moderately slowly. The soils readily release moisture to plants. Organic-matter content is moderate, and natural fertility is medium or high.

The hazard of water erosion is slight. In a few areas pebbles and stones are a slight limitation to the use of farm machinery. On some of the lower slopes, small areas of Slickspots are a limitation. The soils are generally easy to work, but those that have a surface layer of silty clay loam are firm when moist and tend to clod if they are tilled when wet.

Many farmsteads are located on the soils in this unit. The soils are suited to corn, wheat, oats, alfalfa, soybeans, and other crops commonly grown in the county. They are well suited to windbreaks, pasture, and garden crops.

A cropping system that includes grasses and legumes helps to control erosion, build a supply of organic matter, maintain fertility, and improve tilth. Keeping crop residue on the surface and using commercial fertilizer also help to maintain fertility. Lime is commonly needed in some areas on uplands. On long slopes, terraces, contour farming, and grassed waterways help to keep water from concentrating.

CAPABILITY UNIT IIe-3, DRYLAND

This unit consists of nearly level to very gently undulating, deep, well-drained soils on uplands and stream terraces. These soils have a surface layer of fine sandy loam. The subsoil is fine sandy loam or silt loam, and the underlying material is loamy fine sand or silt loam.

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

The hazard of soil blowing is slight. The soils are easy to work.

These soils are suited to all crops commonly grown in the county. Terraces, contour farming, and grassed waterways help to control water erosion. A cropping system that includes legumes, grasses, or a mixture of both helps to replenish the organic matter, maintain fertility, and control soil blowing. Keeping a cover of crops and crop residue on the surface helps to improve fertility and control soil blowing.

CAPABILITY UNIT IIe-6, DRYLAND

This unit consists of nearly level or gently undulating, deep, well-drained soils on uplands and stream terraces. These soils have a surface layer of loamy fine sand or fine sandy loam. The subsoil is silt loam or light silty clay loam, and the underlying material is sand or silt loam.

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

Soil blowing is the main hazard. The soils are easy to work.

These soils are suited to all crops commonly grown in the county. Keeping crop residue on the surface helps to control soil blowing. Using commercial fertilizer and a cropping system that includes grasses and legumes also helps to maintain fertility.

CAPABILITY UNIT IIw-2, DRYLAND

Only Butler silty clay loam is in this unit. This is a nearly level, deep, somewhat poorly drained soil in upland basins. It has a surface layer of silty clay loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is slow, and available water capacity is moderate. Runoff is very slow. This soil absorbs moisture moderately slowly in the surface layer and slowly in the subsoil. It releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness is the main limitation. It is caused by a combination of slow internal drainage and the additional water received as runoff from adjacent higher lying soils. During midsummer, droughtiness can be a slight hazard in those years when rainfall is below normal. The soil is somewhat difficult to work because it is firm and tends to clod if it is tilled when wet.

Crops that can withstand drought, such as grain sorghum and winter wheat, are better suited to this soil than other plants. Corn and other row crops can be used if flooding is controlled. The use of diversions helps to prevent runoff from higher lying soils from reaching areas of this soil.

CAPABILITY UNIT IIw-3, DRYLAND

Only Hobbs silt loam, occasionally flooded, is in this unit. This is a nearly level, deep, well-drained soil on narrow bottom lands. It is silt loam throughout.

Permeability is moderate, and available water capacity is high. Runoff is slow. This soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is high.

This soil is subject to occasional flooding. The floodwater remains on the surface for only a short time,

and damage to crops is seldom severe. The soil is easy to work, except when it is wet after flooding.

This soil is suited to most crops commonly grown in the county. Oats are rarely grown, because of the hazard of flooding. Adjacent uplands need to be protected by measures that control erosion. Terracing the adjacent uplands and using diversions help to prevent flooding. Properly managed row crops can be grown year after year. Productivity can be maintained by using fertilizer and by returning crop residue to the soil as mulch material.

CAPABILITY UNIT IIw-4, DRYLAND

This unit consists of nearly level, deep, somewhat poorly drained soils on stream terraces and bottom lands. These soils have a surface layer of loam, silt loam, or silty clay loam. The underlying material ranges from fine sand to silty clay loam.

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

Wetness caused by a water table that fluctuates between depths of 3 and 8 feet is the main limitation to use of these soils. Generally, tiling is not required, but the water table is a concern in management during years of above-normal moisture. The soils on bottom lands are subject to flooding, which occurs an average of once every 3 years. Crop losses are normally minor. The soils are easy to work, except for Lamo silty clay loam, which is firm when moist and tends to clod if it is tilled when wet.

These soils are suited to all crops commonly grown in the county. Corn and soybeans are the main crops. Spring-sown small grain generally is not grown on these soils, because of excessive wetness early in spring. Alfalfa production varies on these soils, because in some years the root zone is restricted by the moderately high water table and in others production is improved by subirrigation to the alfalfa. Some areas of these soils are planted to grasses and are used for pasture.

Where suitable outlets are available, tile drains help to lower the water table and control the wetness of these soils. Shallow drains can be used to remove impounded surface water. Diversions and erosion-control practices in areas above these soils help to reduce potential flood damage.

CAPABILITY UNIT IIw-6, DRYLAND

This unit consists of nearly level to very gently undulating, deep, somewhat poorly drained soils on stream terraces and bottom lands. These soils have a surface layer of fine sandy loam. The underlying material ranges from fine sand to silty clay loam.

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

Wetness caused by a seasonal high water table is the main limitation to use of these soils. Generally, tiling is not needed; but the water table is a concern in management in years of above-normal moisture. The hazard of soil blowing is slight.

These soils are suited to all crops commonly grown in the county. Corn and soybeans are the main crops. Spring-sown small grain generally is not grown on these soils, because of excessive wetness early in spring. Production of alfalfa varies because in some years the root zone is restricted by the water table. Areas of these soils are productive if they are planted to grasses and used for hay or pasture.

Keeping crop residue on the surface helps to reduce the hazard of soil blowing. Where suitable outlets are available, tile drains help to lower the water table and control wetness. Diversions and erosion-control practices in areas above these soils help to reduce potential flood damage.

CAPABILITY UNIT IIs-5, DRYLAND

This unit consists of nearly level, deep, well-drained soils on uplands and stream terraces. These soils have a surface layer of loam or silt loam. The subsoil is light silty clay loam, and the underlying material is sand.

Permeability is moderately slow, and available water capacity is moderate. Runoff is slow. These soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

The droughty underlying material is a slight limitation to the use of these soils. The soils are easy to work.

These soils are suited to corn, grain sorghum, soybeans, oats, and alfalfa. Maintaining fertility is the main concern in management. In some areas the surface layer is low in lime. Soil tests are needed to determine the need for lime and other fertilizers.

CAPABILITY UNIT IIs-6, DRYLAND

Only Cass fine sandy loam is in this unit. This is a nearly level, deep, well-drained soil on bottom lands. It has a surface layer of fine sandy loam. The transitional layer is loamy fine sand, and the underlying material is sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is very slow. This soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

The droughty underlying material is a limitation to the use of this soil, particularly during years of below-normal rainfall. The soil is easy to work.

This soil is suited to all crops commonly grown in the county. Corn is the main crop, but soybeans, grain sorghum, and alfalfa are also grown.

This soil is subject to soil blowing unless crop residue is left on the surface. Using crop residue as a surface mulch helps to reduce soil blowing.

CAPABILITY UNIT IIIe-1, DRYLAND

This unit consists of very gently sloping to moderately sloping, deep, well-drained soils on uplands. These soils have a surface layer of loam or silt loam. The subsoil is silt loam, light silty clay loam, or clay loam. The underlying material is sand, silt loam, or

clay loam. In a few areas some pebbles and stones are on the surface and throughout the profile.

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

Water erosion is the main hazard. Runoff is a moderate limitation. In a few areas stones are a slight limitation to the use of farm machinery. The soils are easy to work.

These soils are suited to all crops commonly grown in the county. The hazard of erosion is more severe if soybeans are grown than if other crops are planted. Erosion can be controlled by terraces, contour farming, and grassed waterways and by mulch tillage, which leaves most of the crop residue on the surface.

CAPABILITY UNIT IIIe-2. DRYLAND

Longford loam, 1 to 5 percent slopes, is the only soil in this unit. This is a very gently sloping and gently sloping, deep, well-drained soil on uplands. It has a surface layer of loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is slow, and available water capacity is moderate. Runoff is medium. This soil absorbs moisture easily in the surface layer but slowly in the subsoil. The subsoil releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

The hazard of water erosion is moderate. Runoff is a limitation to the use of the soil for crops. The soil is somewhat droughty. On some of the lower slopes, a few small areas of Slickspots are a limitation. The surface layer is easy to work.

This soil is suited to all of the crops commonly grown in the county. Terraces, contour farming, grassed waterways, and mulch tillage help to control water erosion. Keeping the rainfall on the land by using these practices also helps to reduce droughtiness.

CAPABILITY UNIT IIIe-3. DRYLAND

This unit consists of gently undulating to gently rolling, deep, well-drained soils on uplands. These soils have a surface layer of sandy loam, fine sandy loam, or sandy clay loam. The subsoil is fine sandy loam or clay loam, and the underlying material is loamy fine sand or silty clay loam.

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

Soil blowing and water erosion are the main hazards. Gully erosion is a hazard in waterways. The soils are easy to work. On some of the lower side slopes, cultivation is difficult in areas of Slickspots.

These soils are suited to the crops commonly grown in the county. They are highly erodible where soybeans are grown.

Terraces, contour farming, stripcropping, and grassed waterways help to control water erosion. Tillage needs to be kept to a minimum. Shelterbelts along field boundaries help to reduce soil blowing. A cropping system that includes legumes or a mixture of grasses and legumes helps to replenish the supply of organic matter, maintain fertility, and control soil blowing. A cropping system that follows row crops with close-growing crops and uses tillage operations that leave most of the crop residue on the surface also helps to improve the organic-matter content and control soil blowing.

CAPABILITY UNIT IIIe-5. DRYLAND

This unit consists of nearly level to very gently undulating, deep, somewhat excessively drained soils on uplands and stream terraces.These soils have a surface layer of loamy fine sand. The transitional layer is loamy fine sand, and the underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is slow. The soils absorb moisture rapidly and release it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

Soil blowing is the main hazard where these soils are used for crops. Low fertility and the somewhat droughty underlying material are moderate limitations. The soils are easy to work.

These soils are suited to most crops commonly grown in the county. Using rye and vetch as a cover crop or green manure helps to control soil blowing. Corn is one of the main crops, and the cover crops can be planted into the cornfields.

Stripcropping, mulch tillage, and planting field windbreaks along fields help to control soil blowing and conserve moisture. The soils in this unit are medium acid, and some areas need lime. Crops grown on these soils respond well if adequate fertilizer is applied and adequate moisture is available.

CAPABILITY UNIT IIIe-6. DRYLAND

This unit consists of nearly level to gently undulating, deep, well-drained soils on uplands. These soils have a surface layer of loamy fine sand or fine sandy loam. The subsoil is silt loam, light silty clay loam, or clay loam, and the underlying material is sand, silty loam, or clay loam.

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

Soil blowing and water erosion are the main hazards. The soils are easy to work.

These soils are used mainly for corn, but they are also used for the other crops commonly grown in the county.

Using rye and vetch as a cover crop helps to control soil blowing. Terraces, grassed waterways, and contour farming help to reduce the hazard of water erosion. Using mulch tillage allows crop residue to remain on or near the surface of the soil and increases the organic-matter content.

CAPABILITY UNIT IIIe-9. DRYLAND

This unit consists of very gently sloping to moderately sloping, deep, well-drained soils on uplands.

These soils are silt loam throughout the profile. They are mainly calcareous at the surface and are eroded.

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

The hazard of water erosion is moderate to severe. Runoff and low fertility are moderate limitations that affect crop growth. The soils are easy to work.

These soils are suited to most crops commonly grown in the county, except soybeans. The soils are highly erodible where planted to row crops.

Growing such soil-building crops as grasses and legumes and returning crop residue to the soil are ways of improving soil structure and the organic-matter content. Contour farming, terraces, grassed waterways, and seeded field borders help to prevent erosion, conserve moisture, restore fertility, and control runoff (fig 8). Loss of fertility through erosion is serious on these soils; and additions of fertilizer, particularly phosphorus, are needed for good crop growth. These soils are also suitable for pasture and range.

CAPABILITY UNIT IIIw-1, DRYLAND

Only Clamo silty clay is in this unit. This is a nearly level, deep, somewhat poorly drained soil on bottom lands. It is silty clay throughout the profile.

Permeability is slow, and available water capacity is moderate. Runoff is slow. The soil absorbs moisture slowly and releases it slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness is the main limitation to the use of this soil. The water table is at a depth of 3 feet in spring and 8 feet in fall. Normally, tiling is not required; but the water table is a concern in years of above-normal moisture. This soil is subject to flooding that occurs an average of once every 3 years. During the dry season this soil is somewhat droughty. It is difficult to work because it is very firm when moist and very hard and cloddy when dry.

This soil is suited to most of the crops commonly grown in the county. Corn and alfalfa are the main crops.

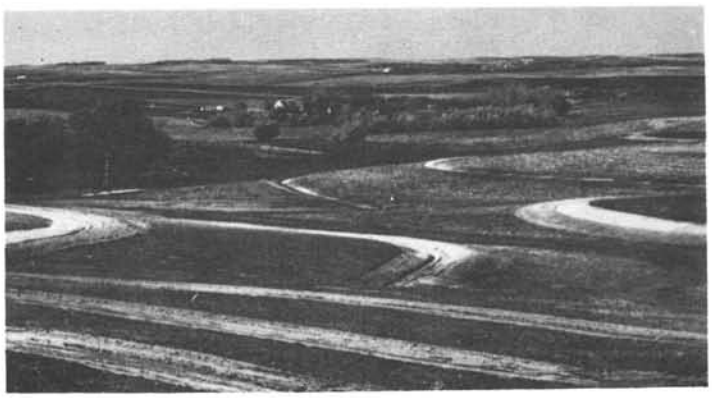

***Figure 8.*—Newly constructed terraces on Crofton-Nora silt loams, 7 to 11 percent slopes, eroded, help to control erosion and prevent runoff.**

Shaping the land improves surface drainage. Tile or open ditches can be used to lower the water table. Where adequate outlets are not available, this soil is better suited to hay and pasture crops than to most other uses. Fertilizers benefit crops and help to maintain fertility. During wet periods, avoiding the operation of heavy machinery or the grazing of livestock helps to reduce soil compaction.

CAPABILITY UNIT IIIw-2, DRYLAND

Only Fillmore complex is in this unit. This is a nearly level, deep, poorly drained soil in upland depressions. It has a surface layer of silt loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is very slow, and available water capacity is moderate. Runoff is ponded. The soil absorbs moisture easily in the surface layer and slowly in the subsoil. The subsoil releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused by very slow internal drainage and by excess moisture as runoff from higher lying soils is the main limitation to the use of this soil. The soil is difficult to work because of wetness. In some years droughtiness is a slight hazard during midsummer.

This soil is fairly well suited to the more common crops grown in the county, especially during years of low rainfall when runoff from adjacent soils is low. It is generally too wet for alfalfa unless drainage is provided. It is also suited to pasture and hay. Where it is used for this purpose, grasses that tolerate some flooding should be planted.

Some method of removing excess water is needed for consistent crop growth. Such conservation practices as terraces, grassed waterways, and diversions can be used on the soils at higher elevations to prevent excess runoff from covering this soil and thus damaging the crops.

CAPABILITY UNIT IIIw-3, DRYLAND

Only Elsmere loamy fine sand, 0 to 2 percent slopes, is in this unit. This is a nearly level to very gently undulating, deep, somewhat poorly drained soil on stream terraces. It has a surface layer of loamy fine sand. The transitional layer is loamy fine sand, and the underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is very slow. This soil absorbs moisture rapidly and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

Wetness is the main limitation to the use of this soil. The water table is at a depth of 3 feet in spring and 8 feet in fall. Normally, tiling is not needed; but wetness is a concern in management during years of above-normal rainfall. Soil blowing is a hazard in cultivated areas. In dry seasons when the water table is lowest, this soil is somewhat droughty. It is easy to work.

This soil is used for cultivated crops, range, and native hay. It is suited to most of the crops commonly grown in the county, but corn and soybeans are the main crops. This soil is also suited to wildlife habitat. Small grain is not well suited because of wetness.

Stripcropping, field windbreaks, mulch tillage, and returning crop residue to the soil help to control soil blowing and maintain fertility. In areas used for range and native hay, proper stocking, deferred grazing, and rotation grazing can be used to maintain the desirable grasses.

CAPABILITY UNIT IIIs-1, DRYLAND

Only Ovina-Slickspots complex is in this unit. This complex consists of nearly level, deep, somewhat poorly drained soils on bottom lands. The Ovina soil has a surface layer of fine sandy loam, a transitional layer of fine sandy loam, and underlying material of loamy fine sand. About 20 percent of the acreage of this complex is areas of Slickspots. These areas are strongly affected by alkali, which causes a breakdown of structure in the surface layer.

Permeability is moderately rapid and available water capacity is moderate in the Ovina soil. Runoff is very slow. Organic-matter content is moderate, and natural fertility is medium. The areas of Slickspots absorb moisture slowly and release it slowly to plants. The Ovina part of the complex absorbs moisture easily and releases it readily to plants.

Strong alkalinity is a limitation in the areas of Slickspots. Also, they are difficult to work. Wetness limitation is slight to moderate. The water table fluctuates between depths of 3 and 8 feet. Normally, tiling is not required, but the water table is a concern in management in years of above-normal rainfall. The hazard of soil blowing is slight.

This complex is only fairly well suited to crops because of the moderately high water table and the strong alkalinity of the Slickspots. It is better suited to range than to most other uses. Crops suited to this soil are those that are resistant to alkalinity, such as tall wheatgrass, wheat, and spring-planted small grain.

Keeping a cover crop on the surface during winter and spring helps to control soil blowing. In most places drainage practices to lower the water table are not feasible because of a lack of suitable outlets.

CAPABILITY UNIT IVe-1, DRYLAND

Only Nora silt loam, 11 to 17 percent slopes, is in this unit. This is a strongly sloping, deep, well-drained soil on uplands. It is silt loam throughout the profile.

Permeability is moderate, and available water capacity is high. Runoff is medium to rapid. This soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Water erosion is the main hazard. Runoff is a moderate limitation because the moisture that is lost is not available for crops. This soil is easy to work.

This soil is used for range, pasture, and cultivated crops. Alfalfa for hay is one of the better uses of this soil. The soil is suited to most crops commonly grown in the county, but it is poorly suited to soybeans. Because the hazard of erosion is high, row crops are commonly not grown continuously in the cropping system. This soil is only marginal for crops because it is strongly sloping.

Growing legumes or grasses about 80 percent of the time in the cropping system, returning crop residue, and adding barnyard manure to the soil help to control erosion, maintain fertility, and improve tilth. Contour farming, terraces, grassed waterways, stripcropping, and grass turn rows help to control water erosion. Erosion is a severe hazard in cultivated areas, unless erosion control practices are used. Using mulch tillage leaves crop residue at or near the surface, helps to reduce runoff, and increases the rate of water intake.

CAPABILITY UNIT IVe-3, DRYLAND

This unit consists of gently rolling, deep, well-drained and somewhat excessively drained soils on uplands. These soils have a surface layer of fine sandy loam or silt loam. The subsoil is loamy fine sand or silt loam, and the underlying material is fine sand or silt loam.

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

Soil blowing and water erosion are the main hazards. The hazard of gully erosion is severe in waterways. The soils are easy to work.

These soils are suited to most crops commonly grown in the county. Slope and the hazard of erosion, however, make the soils better suited to pasture and forage crops than to row crops.

Where feasible, terraces, grassed waterways, and contour farming help to protect these soils from water erosion. Stripcropping and mulch tillage are effective in controlling soil blowing. Grassed waterways are difficult to maintain in areas where the underlying material is sandy. Mulching waterways with an organic mulch immediately after seeding helps to prevent gully erosion during establishment of waterways. Lime is commonly needed for legumes on the more sandy soils.

CAPABILITY UNIT IVe-4, DRYLAND

Only Longford soils, 2 to 8 percent slopes, eroded, are in this unit. These are gently sloping to moderately sloping, deep, well-drained soils on uplands. They have a surface layer of heavy silty clay loam or silty clay. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is slow, and available water capacity is moderate. Runoff is medium. These soils absorb moisture slowly and release it slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

The hazard of water erosion is moderate. The loss of moisture through runoff can reduce crop growth. These soils are somewhat droughty. On some of the lower slopes, areas of Slickspots make cultivation difficult. The soils are difficult to till because they are very firm when moist and very hard and cloddy when dry.

These soils are suited to crops. The main crops grown are corn, grain sorghum, soybeans, oats, and alfalfa. A small acreage is also used for pasture and range.

Terraces, diversions, contour farming, and grassed waterways help to reduce runoff and the hazard of water erosion. Keeping the rain where it falls helps to lower the droughty condition of this soil. Mulch tillage during crop planting helps to increase the intake of moisture. If these soils are wet, tillage can be delayed so that extremely hard clods do not form. A cropping system that includes a legume crop, such as alfalfa, helps to make the soil more friable and easier to work.

CAPABILITY UNIT IVe-5, DRYLAND

This unit consists of very gently undulating to gently undulating, deep, somewhat excessively drained and excessively drained soils on uplands. These soils have a surface layer and transitional layer of fine sand or loamy fine sand. The underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is slow. These soils absorb moisture readily and release it readily to plants. Organic-matter content is low or moderately low, and natural fertility is low.

The hazard of soil blowing is moderate to severe in cultivated areas. Low fertility and the somewhat droughty underlying material are moderate limitations to the use of these soils. Also, the soils are commonly too loose to be easy to work.

These soils are used for range and row crops (fig. 9). Range and pasture are excellent uses for these soils. The soils are marginal for row crops, and such close-growing crops as alfalfa, grass, and small grain are better suited than other plants. Where corn is planted, narrow strips or fields can be alternated with strips of rye and vetch. Close-sown crops are more dependable because they make their best

Figure 9.—**Double rows of cedars planted 20 rods apart, with alternate strips of corn and of rye sown with vetch, on Thurman loamy fine sand, 2 to 7 percent slopes. These practices help to control soil blowing.**

growth in spring when rainfall is greatest and because soil blowing is not so severe in these areas as in others.

A cropping system is needed that keeps the soil covered with crop residue. Planting a row crop in spring and then interplanting with rye and vetch in fall is a system that offers an abundance of crop residue at all times. Narrow plantings of trees in windbreaks help to reduce soil blowing.

CAPABILITY UNIT IVe-6, DRYLAND

Only Hadar-Thurman complex, 7 to 11 percent slopes, is in this unit. These are gently rolling, deep, well-drained and somewhat excessively drained soils on uplands. They have a surface layer of loamy fine sand or fine sandy loam. The subsoil is loamy fine sand or clay loam, and the underlying material is fine sand or clay loam.

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

Soil blowing and water erosion are the main hazards. The hazard of gully erosion is severe in waterways. The soils are easy to work.

These soils are suited to most of the crops commonly grown in the county. They are better suited to close-sown crops, grasses, and legumes than to row crops.

Terraces, contour farming, grassed waterways, and mulch from crop residue help to control water erosion. Using an organic mulch on the surface helps control soil blowing. A cropping system that includes a row crop for a limited number of years followed by close-sown crops and hay and pasture crops helps to reduce soil losses.

CAPABILITY UNIT IVe-9, DRYLAND

This unit consists of gently sloping to strongly sloping, deep, well-drained soils on uplands. These soils have a surface layer of loam or silt loam. The subsoil and underlying material are silt loam or clay loam. The Betts soil in this unit has a few pebbles and stones on the surface and throughout the profile. These soils are generally calcareous at the surface and are eroded.

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

The hazard of water erosion is severe. Runoff and low fertility can severely limit crop growth. The soils are easy to work. In places stones are a hazard to farm machinery.

These soils are suited to most crops commonly grown in the county except soybeans. They are also suited to pasture, range, and wildlife habitat.

Contour farming and terraces help to conserve soil moisture and control runoff, and grassed waterways, grassed turn rows, and seeded field borders are also beneficial. Seeding grass or a mixture of grass and legumes helps to improve fertility and restore the organic-matter content. In a good cropping system row crops are grown infrequently. Close-sown crops, hay, and pasture can be used during most years. Keeping a cover of permanent vegetation, such as grass or trees, on these soils is an effective way of conserving soil and water.

CAPABILITY UNIT IVw-1, DRYLAND

This unit consists of nearly level, deep, poorly drained soils on bottom lands. These soils have a surface layer of loam. The transitional layer is loamy sand or sandy clay loam, and the underlying material is sand or sandy clay loam.

Permeability is rapid or moderately slow, and available water capacity is moderate or high. Runoff is slow. The soils absorb moisture easily and release it readily to plants. Organic-matter content and natural fertility are high.

Wetness is a severe limitation to the use of these soils. The water table is at a depth of 1 foot in spring and 5 feet in fall. Tiling is required to profitably use these soils for cultivated crops. The soils are subject to flooding an average of once every 3 years. They are difficult to work because of wetness.

These soils are better suited to native meadow or pasture than to other uses. Native grasses benefit from the high water table through subirrigation. Only limited use for crops is possible on these soils. Tile drains can lower the water table if suitable outlets can be located, but locating suitable outlets is a problem. Corn is better suited than other row crops. It can be planted late in spring after the high water table has dropped somewhat, and then it can utilize the water table through subirrigation.

In some cultivated areas surface levelling can alleviate the flooding hazard in the lower areas of these soils.

CAPABILITY UNIT IVw-6, DRYLAND

Only Loup fine sandy loam is in this unit. This is a nearly level, deep, poorly drained soil on bottom lands. It has a surface layer of fine sandy loam. The transitional layer is loamy fine sand, and the underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is very slow. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness is a severe limitation to the use of these soils. The water table is at a depth of 1 foot in spring and 5 feet in fall. Tiling is needed to profitably use this soil for crops. The soil is subject to flooding, which occurs about once every 3 years. It is difficult to work because of wetness.

This soil is better suited to native hay meadow than to most other uses. The high water table is an advantage in the production of native hay, because the warm-season meadow grasses are able to utilize moisture from the high water table during the warm summer months. This soil is suitable for crops only where the high water table can be controlled. Unless suitable outlets for a tile drainage system can be obtained, it is difficult to lower the water table. If the water table is lowered and controlled, this soil is

better suited to corn than to most other crops, because corn can be planted late in spring when the soil has dried out somewhat. Also, corn can utilize the high water table during summer through subirrigation.

CAPABILITY UNIT IVe-1, DRYLAND

This unit consists of nearly level, deep, somewhat poorly drained and poorly drained soils and land types on bottom lands. These soils have a surface layer of loam to silty clay. The subsoil and underlying material are sandy clay loam or silty clay. About 25 percent of the area of this unit is Slickspots. The areas of Slickspots are strongly affected by alkali, which breaks down the structure of the surface layer.

Permeability is moderately slow or slow, and available water capacity is moderate or high. Runoff is slow. Organic-matter content is moderate or high, and natural fertility is medium to high. The alkali soil areas absorb moisture slowly and release it slowly to plants. The nonalkali soil areas absorb moisture easily and release it readily to plants.

Moderate and strong alkalinity is the main limitation to the use of the alkali areas. Wetness is a severe limitation because the water table is at a depth of 1 foot in spring and 6 feet in fall. These soils are subject to flooding an average of once every 3 years. The soils are difficult to work.

These soils are better suited to native hay, range, or pasture than to most other uses. The native vegetation in the areas of Slickspots is mostly western wheatgrass and inland saltgrass. In cultivated areas the high water table needs to be lowered and controlled by the use of tile or other drainage. Suitable outlets for drainage ditches or tile are difficult to locate. In cultivated areas these soils are better suited to crops that tolerate alkalinity, such as tall wheatgrass, which can be used for hay and pasture, than to other plants.

CAPABILITY UNIT Vw-7, DRYLAND

This unit consists of nearly level, deep, very poorly drained soils and land types on uplands, in sandhill depressions, and on bottom lands. The soils are variable in texture, ranging from sand to clay.

Permeability is rapid to slow, and available water capacity is low to high. Runoff is slow to very slow. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate to high, and natural fertility is medium to high.

Wetness is a severe limitation to the use of these soils. It is caused by a water table that is above the surface early in spring and is rarely lower than a depth of 30 inches. The soils are subject to occasional flooding.

These soils are best suited to native meadow or summer range. They have limited use for grazing in spring and are too wet for the common cultivated crops. If the soils are used mainly for wetland wildlife, drainage systems should not be installed.

The vegetation on these soils is mostly sedges, reeds, and grasses that tolerate a high degree of wetness. During seasons of heavy rain, the soils are too wet for grazing. Surface drains and tile can be used to help lower the water table and provide drainage, so that more desirable grasses can become established.

CAPABILITY UNIT VIe-3, DRYLAND

Only Nora-Thurman complex, 11 to 17 percent slopes, is in this unit. These are rolling, deep, well-drained and somewhat excessively drained soils on uplands. They have a surface layer of fine sandy loam or silt loam. The subsoil is loamy fine sand or silt loam, and the underlying material is fine sand or silt loam.

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

Soil blowing and water erosion are the main hazards. The hazard of gully erosion is severe. The soils are easy to work.

These soils are generally not suited to cultivated crops and are better suited to range, pasture, recreation, and wildlife habitat. Areas now in cultivation need to be returned to native vegetation. Trees and shrubs are suitable for windbreaks.

CAPABILITY UNIT VIe-5, DRYLAND

This unit consists of gently undulating to rolling, deep, somewhat excessively drained and excessively drained soils on uplands. These soils have a surface layer of fine sand or loamy fine sand. The transitional layer is fine sand or loamy fine sand, and the underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is slow or medium. The soils absorb moisture rapidly and release it readily to plants. Organic-matter content is low or moderately low, and natural fertility is low.

Water erosion is a slight hazard, but soil blowing is a severe hazard where the soils are overgrazed or cultivated. A few small blowouts are a severe hazard to the surrounding vegetation, because the grass is commonly covered by moving sand.

These soils are generally not suited to cultivated crops. They are better suited to grass (fig. 10), trees, and wildlife habitat. Areas that are presently cultivated need to be returned to native vegetation. Areas of range that have been overgrazed and are now subject to soil blowing in small blowouts can be fenced to exclude livestock. These areas can then be converted to range by reseeding and mulching the blowouts.

CAPABILITY UNIT VIe-9, DRYLAND

Only Crofton silt loam, 17 to 30 percent slopes, is in this unit. This is a steep, deep, somewhat excessively drained soil on uplands. It is calcareous silt loam throughout the profile. A small acreage is eroded.

Permeability is moderate, and available water capacity is high. Runoff is rapid. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

Steep slopes make the hazard of water erosion

Figure 10.—**Native range is excellent use for this Class VI land, Valentine and Thurman soils, rolling.**

severe where the soil is overgrazed or cultivated. The hazard of gully erosion is severe above drainageways.

Most of the acreage is used for range. Because of the erosion hazard, the soil is better suited to native grass than to other plants. When reseeding, it is necessary to maintain a cover on the surface during preparation of the seedbed and during planting time. Mixtures of adapted native grasses similar to those of the climax vegetation are better suited than others. Small isolated areas can be planted to trees and shrubs for wildlife habitat. Good sites for livestock water or recreational dams occur along some drainageways.

Grazing needs to be regulated in areas of range. Only one-half of the current year's growth of desirable species can be safely removed. Weeds and other undesirable plants can be controlled by mowing or spraying.

CAPABILITY UNIT VIw-7, DRYLAND

This unit consists of land types on bottom lands. The soils are variable in texture, ranging from sand to clay, and are deep.

These land types have a wide range of characteristics. Permeability is rapid to slow, and available water capacity is low to high. Runoff is slow or very slow. The soil material absorbs moisture easily and releases it readily to plants. Organic-matter content is low to moderate, and natural fertility is low to high.

Frequent flooding is a severe limitation to the use of these areas. Streambank erosion and sediment and debris from floods are the main limiting factors. The land is better suited to grasses and trees than to most other uses. Flooded areas that lack a ground cover can be reseeded to grass or planted to trees. Wooded and brushy areas that are not used for grazing provide excellent wildlife habitat.

CAPABILITY UNIT VIs-4, DRYLAND

Only Simeon sandy loam, 3 to 9 percent slopes, is in this unit. This is a gently undulating and gently rolling, deep, excessively drained soil on uplands. It has a surface layer of sandy loam. The transitional layer is loamy sand, and the underlying material is medium and coarse sand.

Permeability is rapid, and available water capacity is low. Runoff is slow. This soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

This is a droughty soil. The low available water capacity is a severe limitation to its use. The hazards of soil blowing and water erosion are moderate. The soil is easy to work.

This soil is better suited to grass than to most other uses. It is mainly used for range and pasture and is not generally suited to cultivated crops. Under good range management, an adequate cover of plants can be maintained.

CAPABILITY UNIT VIIe-5. DRYLAND

Only Blown-out land is in this unit. This land type is gently undulating to steep and excessively drained. It is on uplands. It is loose fine sand throughout the profile.

Permeability is rapid, and available water capacity is low. Runoff is slow. This land type absorbs moisture rapidly. Organic-matter content is very low, and natural fertility is low.

The hazard of soil blowing is severe. Steep slopes along the edge of blowouts are also a limitation to the use of this land.

Severe erosion makes areas suitable only for grasses. They have limited use for grazing. Re-establishment of grassland can be accomplished by smoothing and reducing the steep slopes on the edges of blowouts and then reseeding to native grasses.

These areas need to be mulched with plant residue to control soil blowing until the grasses are established. They should be fenced to keep livestock from trampling them until the grass is completely established.

CAPABILITY UNIT VIIIw-7. DRYLAND

Only Marsh is in this unit. This land type consists of deep, very poorly drained soil material on bottom lands. It is variable in texture.

Wetness is a very severe limitation to the use of Marsh. During most of the year it is under shallow water. Organic-matter content is high.

This land type is too wet for crops and range. It is better suited to wetland wildlife. Marsh supports a growth of cattails and rushes. In most places it is difficult to control the water table because no suitable outlets are available.

Management of the soils for irrigation

The irrigated soils of Pierce County are in valleys and on uplands where irrigation water is available. Water for irrigation is derived almost entirely from deep wells.

A different method of irrigation is commonly needed if the kind of crop grown on a particular field is changed. For example, the method used to irrigate a row crop is generally different from that used to irrigate a close-sown crop. Changing the method of irrigation is difficult where slope is more than 1½ percent. Some farmers use bench leveling in irrigated fields to make slopes of less than 1 percent. This practice makes it easier to change the method of irrigation.

Furrow irrigation is the most common method used to irrigate row crops. The water is applied to furrows between the plant rows by gated pipes or siphon tubes. Furrows on nearly level soils, such as Hord silt loam, generally are straight and follow field boundaries. On steeper soils, such as Moody silty clay loam, 1 to 7 percent slopes, contour furrows are generally used to carry irrigation water across the slope rather than down it. In places contour furrows need to be supplemented by terraces.

In the corrugation irrigation method, water is applied in small furrows by gated pipes or siphon tubes. From the small furrows, water is moved laterally through the soil and irrigates the entire field. This method is suited to such close-growing crops as alfalfa.

In the border irrigation method, flooding is controlled by borders or small dikes along the sides of narrow cultivated fields. The irrigation water flows in a thin, uniform sheet and is absorbed by the soil as it advances through the field. For this method to work well, the strips need to be well leveled and have uniform grade. The dikes between the strips need to be low and rounded, so that they can be planted along with the strip. Border irrigation is well suited to such soils as Hobbs silt loam.

In the controlled flooding method, the applied water flows down the slope between field ditches that are closely spaced. Frequent openings in the ditches permit uniform distribution of water over the field. This method is suitable only for close-grown crops and hay crops. It is well suited to the steeper irrigated soils.

In the sprinkler irrigation method, water is applied by sprinklers at a rate that the soil can absorb without runoff. Sprinklers can be used on the more sloping soils as well as the nearly level ones. Some soils, such as Nora silt loam, 7 to 11 percent slopes, are suited to sprinkler irrigation. Because the water can be carefully controlled, sprinklers have special use in conservation, such as establishing new pasture on moderately steep slopes. In summer, however, much water is lost through evaporation. Wind drift can cause uneven application of water under some sprinkler irrigation systems.

Sprinkler systems are of two general kinds: those that operate in sets, which means they are set at a certain location and operate there until a specified amount of water is applied; and the center-pivot type, which is a moving sprinkler system that revolves about a central pivot point.

Soil holds only a limited amount of water. Irrigation water, therefore, is applied at regular intervals to keep the soil profile wet at all times. The interval varies according to the crop and the time of year. The water should be applied only as fast as the soil can absorb it.

Irrigated silty soils in Pierce County hold about 2 inches of available water per foot of soil depth. A soil that is 4 feet deep and planted to a crop that sends its roots to that depth can hold about 8 inches of available water for that crop.

Maximum efficiency is obtained if the irrigation

process is started when about one-half of the stored water has been used by the plants. Thus, if a soil holds 8 inches of available water, irrigation should be started when about 4 inches have been removed by the crop. Irrigation sets or systems should be planned to replace the amount that is used by the crop.

Management is needed that controls or regulates the application of irrigation water in such a way that good crop growth is obtained without wasting water or soil. It is important to adjust the size of the stream to the furrow or to adjust the rate of sprinkler irrigation, so that the application of water thoroughly moistens the soil without excessive runoff or erosion. In a furrow system, water can be applied most efficiently by using a fairly large stream down the row until the water nearly reaches the lower end. Then the stream size can be reduced to about one-half of the original rate and allowed to flow until the soil is irrigated. An irrigation re-use system at the end of both furrow and border fields can help to reduce the loss of water at the end of the field. A re-use system offers an opportunity for recycling runoff irrigation water to reirrigate the same field or to irrigate other fields nearby.

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

Irrigated soils generally produce higher yields than dryfarmed soils. Consequently, more plant nutrients, particularly nitrogen and phosphorus, are removed in the harvest of crops. Returning all crop residue to the soil and adding barnyard manure and commercial fertilizer help to supply needed plant nutrients. Most grain crops in Pierce County respond to nitrogen fertilizer. Soils disturbed during land leveling, particularly if the topsoil has been removed, respond to phosphorus, zinc, and iron. The kinds and amounts of fertilizer needed for specific crops should be determined by soil tests.

The principal irrigated crops in Pierce County are corn and alfalfa. Corn is grown in rows spaced 30 to 40 inches apart. Irrigation water is applied by furrows between the rows. Alfalfa is irrigated by flooding or by a sprinkler system. The sprinkler system can also be used to irrigate corn.

The cropping system on soils well suited to irrigation consists mostly of row crops. A change from corn to grain sorghum and alfalfa or grass helps to control the cycle of disease and insects that are commonly present if the same crop is grown year after year. Gently sloping soils, such as Nora silt loam, 1 to 7 percent slopes, are subject to water erosion if they are irrigated. Such soils are better suited to a cropping system that includes several years of row crops followed by 3 to 5 years of hay, mostly alfalfa or a mixture of alfalfa and grass. Such moderately sloping soils as Crofton-Nora silt loams, 7 to 11 percent slopes, eroded, are better suited to irrigated hay and pasture than to irrigated row crops.

Irrigated soils generally need management that differs from that of dryfarmed soils. In the paragraphs that follow, the capability units include grouped soils that are similar in management requirements. Soil limitations are given and suitable irrigation management needs are discussed. All of the soil series in Nebraska are placed in irrigation design groups. These design groups are described in the Nebraska Irrigation Guide (*8*), which is part of the technical specifications for conservation in Nebraska. Arabic numbers of the irrigation capability unit indicate the irrigation design group to which the soils belong.

CAPABILITY UNIT I-3, IRRIGATED

This unit consists of nearly level, deep, moderately well drained and well drained soils on uplands and stream terraces. These soils have a surface layer and subsoil of silty clay loam. The underlying material is silt loam.

Permeability is moderate, and available water capacity is high. Runoff is slow. The intake rate is low. The soils absorb moisture moderately slowly and release it readily to plants. Organic-matter content is moderate, and natural fertility is medium or high.

These soils have few limitations if they are irrigated. At times runoff from adjacent uplands is a slight limitation in some areas. The soils are somewhat difficult to work, because they are firm when moist and tend to clod if they are tilled when wet.

These soils are suited to most of the irrigated crops commonly grown in the county. Corn is the main crop.

Suitable irrigation systems are borders, furrows, and sprinklers. Some land smoothing is generally needed for satisfactory operation of border and furrow systems. Constructing diversions and terraces helps to control runoff from adjacent higher areas.

CAPABILITY UNIT I-4, IRRIGATED

Only Loretto loam, 0 to 1 percent slopes, is in this unit. This is a nearly level, deep, well-drained soil on uplands. The surface layer is loam, the subsoil is silty clay loam, and the underlying material is silt loam.

Permeability is moderate, and available water capacity is high. Runoff is slow. The intake rate is moderately low. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

This soil has few limitations if it is irrigated. It is easy to work.

This soil is suited to most of the irrigated crops commonly grown in the county. Corn is the main crop.

Suitable irrigation systems include borders, furrows, and sprinklers. Land leveling is needed for satisfactory operation of border and furrow systems. The application rate of irrigation water needs to be adjusted to the intake rate of the soil.

CAPABILITY UNIT I-6, IRRIGATED

This unit consists of nearly level, deep, well-drained soils on stream terraces and bottom lands. These soils are silt loam throughout.

Permeability is moderate, and available water capacity is high. Runoff is slow. The intake rate is moderate. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is high.

These soils have few limitations if they are irri-

gated. At times runoff from adjacent uplands is a slight limitation. Some areas are subject to slight flooding 1 year in 3, but crop losses are generally slight. The soils are easy to work.

These soils are suited to all crops commonly grown in the county. Corn and alfalfa are the main crops (fig. 11).

Fertility of these soils can be maintained by returning crop residue to the soils and by applying fertilizer. Insects and plant diseases need to be controlled. Flooding from adjacent areas can be controlled by the use of diversions and grassed waterways. Land leveling to provide even distribution of irrigation water, to allow uniform drainage, and to reduce the hazard of erosion is needed if border or furrow irrigation is used. Sprinkler irrigation is also suitable.

CAPABILITY UNIT I-7, IRRIGATED

This unit consists of nearly level, deep, well-drained soils on uplands and stream terraces. They have a surface layer of loam or silt loam. The subsoil is light silty clay loam, and the underlying material is sand.

Permeability is moderately slow, and available water capacity is moderate. Runoff is slow. The intake rate is moderate. Organic-matter content is moderate, and natural fertility is medium. These soils absorb moisture easily and release it readily to plants.

These soils have few limitations. They are easy to work. The available water capacity is lower than in soils that have silty underlying material.

Figure 11.—**Gravity-irrigated corn in a field of Hobbs silt loam.**

These soils are suited to most crops commonly grown in the county. Corn and alfalfa are the main crops.

Insects and plant diseases need to be controlled. Because available water capacity is only moderate, an irrigation system is needed that uses smaller amounts of water, shorter runs, and shorter irrigation periods than those in areas of deep silty soils.

CAPABILITY UNIT I-8, IRRIGATED

This unit consists of nearly level, deep, well-drained soils on stream terraces and bottom lands. These soils have a surface layer of loam. The subsoil is loamy fine sand or fine sandy loam, and the underlying material is sand or loamy fine sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow. The intake rate is moderately high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

These soils have few limitations if they are irrigated. They are easy to work. Controlling water erosion and maintaining fertility are concerns in management.

These soils are suited to most of the crops commonly grown in the county. Corn and alfalfa are the main crops.

Because the underlying material is coarse textured, the length of runs needs to be shorter under a gravity irrigation system. Also, if these soils are gravity irrigated, some land leveling is generally needed to provide even distribution of irrigation water and to allow uniform drainage. Sprinkler irrigation is well suited to these soils. Insects and plant diseases need to be controlled. Returning crop residue to the soil, keeping tillage to a minimum, planting windbreaks, and applying fertilizer help to maintain fertility on these soils.

CAPABILITY UNIT IIe-5, IRRIGATED

Only Loretto fine sandy loam, terrace, 0 to 2 percent slopes, is in this unit. This is a nearly level to very gently undulating, deep, well-drained soil on stream terraces. It has a surface layer of fine sandy loam. The subsoil and underlying material are silt loam.

Permeability is moderate, and available water capacity is high. Runoff is very slow. The intake rate is moderate. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

The hazard of soil blowing is slight. The soil is easy to work.

This soil is suited to most of the crops commonly grown in the county. Corn and alfalfa are the main crops.

The irrigation systems suitable for use on these soils include sprinklers and border and furrow gravity systems. If a gravity system is used, land leveling is generally needed to provide even distribution of irrigation water, to allow uniform drainage, and to reduce the hazard of erosion. Returning crop residue to the soil, keeping tillage to a minimum, planting windbreaks, and applying fertilizer help to control soil blowing and maintain fertility.

CAPABILITY UNIT IIc-6, IRRIGATED

Only Hord-Hobbs silt loams, 0 to 7 percent slopes, are in this unit. These are nearly level to gently sloping, deep, well-drained soils on foot slopes. They are silt loam throughout the profile.

Permeability is moderate, and available water capacity is high. Runoff is slow to medium. The intake rate is moderate. These soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is high.

The hazard of water erosion is slight. The soils are easy to work.

These soils are suited to most crops commonly grown in the county. Corn and alfalfa are the main crops.

These soils are suited to sprinkler irrigation systems and to border and furrow gravity systems. If a gravity system is used, land leveling is needed to provide even distribution of irrigation water, to allow uniform drainage, and to reduce the hazard of erosion. Returning crop residue to the soil and keeping tillage to a minimum help to control erosion. Applications of fertilizer help to maintain fertility. A contour irrigation system supplemented with terraces can be used to control water erosion on the steeper soils. Insects and plant diseases need to be controlled. These deep soils have an available water capacity that is as high as that of any soil in the county. Applying irrigation water at a rate that matches the intake rate of the soils and using an irrigation system that recycles irrigation runoff are necessary for efficient irrigation management.

CAPABILITY UNIT IIc-8, IRRIGATED

This unit consists of nearly level to very gently undulating, deep, well-drained soils on uplands and stream terraces. These soils have a surface layer and subsoil of fine sandy loam. The underlying material is loamy fine sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is very slow. The intake rate is moderately high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

The hazard of soil blowing is slight. The soils are easy to work.

These soils are suited to most crops commonly grown in the county. Corn and alfalfa are the main crops.

The length of runs needs to be shorter than that on deep, medium-textured soils because of the moderately coarse textured subsoil and the coarse-textured underlying material. Some land leveling is generally needed for gravity irrigation. Sprinkler irrigation is also suitable. Insects and plant diseases need to be controlled. Returning crop residue to the soil, keeping tillage to a minimum, planting windbreaks, and applying fertilizer help to control erosion and maintain fertility. Irrigation systems that re-use or recycle irrigation runoff help to increase efficiency and to prevent runoff and pollution.

CAPABILITY UNIT IIc-9, IRRIGATED

This unit consists of nearly level, deep, well-drained soils on uplands and stream terraces. These soils have a surface layer of loamy fine sand or fine sandy loam. The subsoil is light silty clay loam, and the underlying material is sand.

Permeability is moderately slow, and available water capacity is moderate. Runoff is very slow. The intake rate is moderately high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Soil blowing is the main hazard. The soils are easy to work.

These soils are suited to the more commonly grown crops in the county. Corn and alfalfa are the main crops, but grasses and hay crops are also suited.

These soils are suitable for irrigation by gravity and sprinkler systems. Sprinkler systems are particularly well suited. Irrigation applications need to be lighter and more frequent on this soil because the coarse-textured underlying material reduces the amount of available water that can be stored in the soil for plant use. The length of runs under a gravity system needs to be short because of the rapid permeability of the underlying material.

CAPABILITY UNIT IIc-10, IRRIGATED

Only Boelus-Loretto complex, 0 to 2 percent slopes, is in this unit. This complex consists of deep, well-drained, nearly level soils on uplands. The surface layer is loamy fine sand or fine sandy loam. The subsoil and the underlying material are silt loam.

Permeability is moderate, and available water capacity is high. Runoff is very slow. The intake rate is high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Soil blowing is the main hazard. Maintaining fertility is a concern in management. The soils are easy to work.

These soils are suited to all crops commonly grown in the county. Corn and alfalfa are the main crops.

Soil blowing can be controlled by stripcropping and by using mulch tillage, which keeps most crop residue on the surface. These soils are best suited to sprinkler irrigation because of the high intake rate. They are also suited to furrow irrigation if land leveling and shorter runs are used.

CAPABILITY UNIT IIw-1, IRRIGATED

Only Butler silty clay loam is in this unit. This is a nearly level, deep, somewhat poorly drained soil in shallow upland basins. It has a surface layer of silty clay loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is slow, and available water capacity is moderate. Runoff is very slow. The intake rate is very low. This soil releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused by a combination of slow internal drainage and water received as runoff is the main limitation to the use of this soil. The principal concerns in management are poor surface drainage and a claypan that restricts movement of air and water.

This soil is firm when it is moist, and it tends to clod if tilled when wet.

This soil is suited to most crops commonly grown in the county. Corn is the main crop, but grass is also suitable. Where alfalfa is grown, movement of water through the soil is increased because the roots tend to open the claypan.

Returning crop residue to the soil and applying fertilizer help to maintain fertility. This soil is suited to sprinkler irrigation, but improvement of surface drainage is needed to keep crops from drowning. Land leveling is needed for gravity irrigation. Borders and furrows are suitable gravity systems. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIw-3, IRRIGATED

Only Lamo silty clay loam is in this unit. This is a deep, somewhat poorly drained soil on bottom lands. It is silty clay loam throughout the profile.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. The soil absorbs moisture slowly but releases it readily to plants. Organic-matter content is moderate, and natural fertility is high.

Wetness caused mainly by a water table that fluctuates between depths of 3 and 8 feet is the main limitation to the use of this soil. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. This bottom-land soil is subject to flooding an average of once every 3 years, but crop losses are normally slight. The soil is somewhat difficult to work, because it is firm when moist and tends to clod if tilled when wet.

This soil is suited to irrigated corn and grass.

Installing a drainage system to lower the water table helps to improve irrigation on this soil. Suitable irrigation methods are border and furrow gravity systems and sprinkler systems. In places, location of suitable outlets is a problem in installing drainage systems. Diversions can be used to prevent flooding of this soil by runoff from higher lying soils.

CAPABILITY UNIT IIw-4, IRRIGATED

Only Colo silt loam is in this unit. This is a deep, somewhat poorly drained soil on bottom lands. It has a surface layer of silt loam and underlying material of silty clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is slow. The intake rate is moderately low. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is high.

Wetness caused mainly by a water table that fluctuates between depths of 3 and 8 feet is the main limitation to the use of this soil. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. This bottom-land soil is subject to flooding an average of once every 3 years, but crop losses are normally small. The soil is easy to work.

This soil is better suited to corn and grass for hay or pasture than to most other uses.

Returning crop residue to the soil and applying fertilizer help to maintain fertility. In most years, wetness in spring delays preparation of a seedbed and planting of early crops. Land leveling to produce smooth fields and using diversions to remove excess runoff water are ways to reduce the flood hazard. Gravity and sprinkler irrigation systems are suitable.

CAPABILITY UNIT IIw-5, IRRIGATED

Only Colo fine sandy loam, overblown, is in this unit. This is a deep, somewhat poorly drained soil on stream terraces. It has a surface layer of fine sandy loam and underlying material of silty clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is very slow. The intake rate is moderate. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is high.

Wetness caused mainly by a water table that fluctuates between depths of 3 feet in spring and 8 feet in fall is the main limitation to the use of this soil. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. The hazard of soil blowing is slight. The soil is easy to work.

This soil is suited to corn and grass.

Land leveling for gravity irrigation systems helps to reduce wetness. Sprinkler and gravity irrigation systems are suitable. Returning all crop residue to the soil and applying fertilizer help to maintain fertility and reduce the hazard of soil blowing. Wetness in spring commonly delays preparation of a seedbed and planting of early crops. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIw-6, IRRIGATED

This unit consists of nearly level, deep, moderately well drained or somewhat poorly drained soils on bottom lands. These soils are silt loam throughout the profile.

Permeability is moderate, and available water capacity is high. Runoff is slow. The intake rate is moderate. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is high.

Wetness from flooding is the main limitation to the use of these soils. The floodwater remains on the soil for only a short time, and damage to crops is seldom severe. Some soils in this unit have a water table that fluctuates between depths of 3 feet in spring and 8 feet in fall. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. The soils are generally easy to work, but they dry slowly after flooding.

These soils are better suited to corn and grass than to other uses, but they are also suited to other commonly irrigated crops.

Land leveling for gravity irrigation systems helps to reduce wetness. Sprinkler and gravity irrigation systems are suited to the soils of this unit. Fertility can be maintained by returning all crop residue to the soil and by adding commercial fertilizers. Managing residue so that it is kept on the surface helps to prevent soil blowing. Planting of early crops is sometimes delayed by wetness in spring.

CAPABILITY UNIT IIw-8, IRRIGATED

This unit consists of nearly level to very gently undulating, deep, somewhat poorly drained soils on stream terraces and bottom lands. These soils have a

surface layer of fine sandy loam or loam. The upper part of the underlying material is fine sandy loam, and the lower part is loamy fine sand or fine sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow to very slow. The intake rate is high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused mainly by a water table that fluctuates between depths of 3 feet in spring and 8 feet in fall is the principal limitation to the use of these soils. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. The hazard of soil blowing is slight. In places the soils are subject to flooding about once in 3 years, but crop losses are normally small. The soils are easy to work.

These soils are suited to corn, grass, and hay.

Where outlets are available, open drains or tile drains can be used to provide drainage. Land leveling helps to improve gravity irrigation and surface drainage, and it increases the efficiency of irrigation. Returning crop residue to the soil and applying fertilizer help to maintain fertility. In some years wetness in spring delays preparation of the seedbed. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIs-8. IRRIGATED

Only Cass fine sandy loam is in this unit. This is a nearly level, deep, well-drained soil on bottom lands. It has a surface layer of fine sandy loam. The upper part of the underlying material is loamy fine sand, and the lower part is sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is very slow. The intake rate is moderately high. Organic-matter content is moderately low, and natural fertility is medium. This soil absorbs moisture easily and releases it readily to plants. It is easy to work.

This soil is suited to most crops commonly grown in the county. Corn and alfalfa are the main crops.

For gravity irrigation the length of runs, the frequency of irrigation, and the amount of water need to be less on this soil because of the coarse-textured underlying material. Land leveling is needed for efficient irrigation if border and furrow gravity systems are used. Returning all crop residue to the soil and applying fertilizer help to maintain the fertility. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-2. IRRIGATED

Only Longford loam, 1 to 5 percent slopes, is in this unit. This is a very gently sloping to gently sloping, deep, well-drained soil on uplands. It has a surface layer of loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is slow, and available water capacity is moderate. Runoff is medium. The intake rate is low. The soil absorbs moisture easily in the surface layer but slowly in the subsoil. The subsoil releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

The hazard of water erosion is slight. The soil is easy to work in the surface layer. On the lower parts of some slopes a few small areas of Slickspots make cultivation difficult.

This soil is suited to all crops commonly grown in the county. Corn, alfalfa, and grass are the main crops.

Water erosion can be controlled under both gravity and sprinkler systems by the use of contour furrows. In some areas contour furrows need to be supplemented by terraces. Land leveling is generally needed for proper distribution of irrigation water. Returning all crop residue to the soil and applying fertilizer help to maintain fertility.

CAPABILITY UNIT IIIe-3. IRRIGATED

Only Moody silty clay loam, 1 to 7 percent slopes, is in this unit. This is a very gently sloping to gently sloping, deep, well-drained soil on uplands. The surface layer and subsoil are silty clay loam, and the underlying material is silt loam.

Permeability is moderate, and available water capacity is high. Runoff is medium. The intake rate is low. The soil releases moisture readily to plants. Organic-matter content is moderate, and natural fertility is medium.

The hazard of water erosion is slight. On the lower part of some slopes, a few small areas of Slickspots make cultivation difficult. Maintaining fertility is a concern in management. The soil is somewhat difficult to work, because it is firm when moist and tends to clod if tilled when wet.

Corn and alfalfa are the main crops. Grasses and other crops are also suited.

If this soil is irrigated by a gravity system, bench leveling can be used to control erosion. Contour furrows and terraces can also be used to irrigate row crops. Where erosion is controlled, these soils are suited to sprinkler irrigation (fig. 12). Returning crop residue to the soil, keeping tillage to a minimum, and applying fertilizer help to control erosion and maintain fertility. Insects and plant diseases need to be controlled.

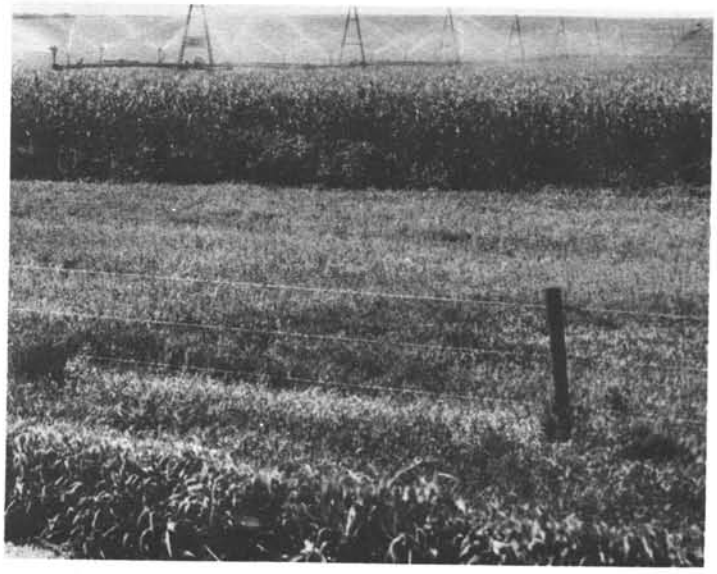

***Figure 12.*—Self-propelled, center-pivot sprinkler system irrigating corn on Moody silty clay loam, 1 to 7 percent slopes.**

CAPABILITY UNIT IIIe-4, IRRIGATED

This unit consists of very gently sloping to gently sloping, deep, well-drained soils on uplands. These soils have a surface layer of loam or silt loam. The subsoil is silty clay loam or clay loam, and the underlying material is silt loam or clay loam. A few pebbles and stones are on the surface and throughout the profile in a few areas.

Permeability is moderate, and available water capacity is high. Runoff is medium. The intake rate is moderately low. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

The hazard of water erosion is slight. In places stones are a slight hazard to farm machinery. On the lower part of some slopes, a few small areas of Slickspots make cultivation difficult. Maintaining fertility is a concern in management. The soils are easy to work.

Corn and alfalfa are the main crops. Grasses and other close-sown crops are also suited.

Where these soils are gravity irrigated, contour furrows supplemented with terraces are needed for irrigating row crops. Bench leveling can be used to shape the surface of the soil so that all gravity systems can be used. If erosion is controlled, these soils are suited to sprinkler systems. Terraces and contour farming help to control erosion. Returning crop residue to the soil, keeping tillage to a minimum, keeping residue on the surface, and applying fertilizer also are important in helping to control erosion and maintain fertility. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-5, IRRIGATED

This unit consists of gently undulating to gently rolling, deep, well-drained soils on uplands. These soils have a surface layer of sandy loam or sandy clay loam. The subsoil is clay loam, and the underlying material is silty clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is medium. The intake rate is moderate. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low or moderate, and natural fertility is medium.

Soil blowing and water erosion are the main hazards. Gully erosion is a hazard in waterways. On some of the lower slopes, a few small areas of Slickspots make cultivation difficult. Maintaining fertility is a concern in management. The soils are easy to work.

Corn and alfalfa are the main crops. The soils are also suited to the other crops commonly grown in the county.

Gravity irrigation systems that use contour furrows or borders on the lower slopes are suitable. Sprinkler systems are also suitable. Water erosion can be controlled by using terraces and grassed waterways. Returning crop residue to the soil, keeping tillage to a minimum, and applying fertilizer help to control erosion and maintain fertility. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-6, IRRIGATED

This unit consists of very gently sloping and gently sloping, deep, well-drained soils on uplands. These soils are silt loam throughout. In many places they are eroded and have a calcareous surface layer, and in others they are not so eroded and have a noncalcareous surface layer.

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

The hazard of water erosion is moderate. Runoff and low to medium fertility are concerns in management. The soils are easy to work.

Corn and alfalfa are the main crops. Grasses and other crops are also suited.

These soils are suited to gravity and sprinkler irrigation systems. Bench leveling, altering the surface of the land so that irrigation flow is at low grades, using contour furrows with or without supplemental terraces, and constructing grassed waterways all help to control erosion. Using a mulch planting system, keeping tillage to a minimum, and applying fertilizer help to control erosion and maintain fertility. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-7, IRRIGATED

Only Bazile silt loam, 1 to 7 percent slopes, is in this unit. This is a very gently sloping to gently sloping, deep, well-drained soil on uplands. It has a surface layer of silt loam. The subsoil is light silty clay loam, and the underlying material is sand.

Permeability is moderately slow, and available water capacity is moderate. Runoff is medium. The intake rate is moderate. The soil absorbs moisture easily and releases it readily to plants. Organic-matter content is moderate, and natural fertility is medium.

Water erosion is the main hazard. Maintaining fertility is a concern in management. The soil is easy to work.

Corn and alfalfa are the main crops. Grasses and other crops are also suited.

Erosion can be controlled on this soil by the use of terraces and grassed waterways. Furrow irrigation can be used if the furrows are at or near the contour of the land. Terraces can be used to supplement contour furrow irrigation. Sprinkler irrigation is also suitable. Because the underlying material in this soil is coarse textured, applications of irrigation water need to be light but frequent. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-8, IRRIGATED

Only Ortello fine sandy loam, 2 to 7 percent slopes, is in this unit. This is a deep, well-drained soil on uplands. It has a surface layer and subsoil of fine sandy loam. The underlying material is loamy fine sand.

Permeability is moderately rapid, and available water capacity is moderate. Runoff is slow to medium. The intake rate is moderately high. The soil absorbs moisture easily and releases it readily to

plants. Organic-matter content is moderately low, and natural fertility is medium.

Soil blowing and water erosion are the main hazards. Gully erosion is a hazard in waterways. Maintaining fertility is a concern in management. The soil is easy to work.

Corn and alfalfa are the main crops. Grasses and other crops are also suited.

This soil can be irrigated by border or furrow gravity systems. Sprinkler irrigation is better suited to this soil than other methods of irrigation. Erosion can be controlled on the longer slopes by using terraces, contour furrows, and grassed waterways to dispose of excess water. Land leveling is needed to help provide even distribution of water and to control erosion where gravity irrigation is used. Using crop residue as surface mulch, stripcropping, and applying fertilizer help to control erosion and maintain fertility. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-9, IRRIGATED

Only Bazile soils, 1 to 7 percent slopes, are in this unit. These are deep, well-drained soils on uplands. They have a surface layer of loamy fine sand or fine sandy loam. The subsoil is light silty clay loam, and the underlying material is sand.

Permeability is moderately slow, and available water capacity is moderate. Runoff is slow to medium. The intake rate is moderately high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Soil blowing and water erosion are the main hazards. Maintaining fertility is a concern in management. The soils are easy to work.

Corn and alfalfa are the main crops. Grasses and other crops are also suited.

These soils are better suited to sprinkler irrigation than to other methods. Erosion can be controlled by terracing, irrigating on the contour, and making maximum use of crop residue as surface mulch. Where gravity irrigation systems are used, some land shaping or leveling is nearly always necessary. Applications of irrigation water need to be lighter and more frequent on this soil than on the soils that have silty underlying material. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe-10, IRRIGATED

This unit consists of gently undulating, deep, well-drained soils on uplands. These soils have a surface layer of loamy fine sand or fine sandy loam. The subsoil and underlying material are silt loam or clay loam.

Permeability is moderate or moderately slow, and available water capacity is moderate or high. Runoff is slow to medium. The intake rate is high. The soils absorb moisture easily and release it readily to plants. Organic-matter content is moderately low, and natural fertility is medium.

Soil blowing and water erosion are the main hazards. Maintaining fertility is a concern in management. The soils are easy to work.

Corn and alfalfa are the main crops grown. These soils are also suited to the other grain, hay, and pasture crops commonly grown in the county.

A good mulch tillage system that keeps most or all of the crop residue on the surface during and after planting helps to control erosion. The high intake rate makes these soils better adapted to sprinkler systems than to furrow and border gravity systems. Gravity systems can be used, but land shaping or land leveling is generally needed.

CAPABILITY UNIT IIIe-11, IRRIGATED

This unit consists of nearly level to very gently undulating, deep, somewhat excessively drained soils on uplands and stream terraces. These soils have a surface layer and transitional layer of loamy fine sand. The underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is slow. The intake rate is very high. The soils absorb moisture rapidly and release it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

Soil blowing is the main hazard. Low fertility is a moderate limitation and is a concern in management. The soils are easy to work.

Corn and alfalfa are the main crops. Close-sown crops, such as small grain and hay or pasture, are also suited. Low residue producing crops, such as sugar beets, potatoes, and soybeans, are less suited to these soils than other crops.

Sprinkler irrigation is well suited to these soils. Soil blowing can be controlled by using a maximum amount of crop residue as a mulch. Stripcropping and using field shelterbelts also help to control soil blowing. Under irrigation, adequate fertilizer needs to be applied to assure production of enough crop residue for controlling erosion and maintaining fertility.

CAPABILITY UNIT IIIw-1, IRRIGATED

Only Clamo silty clay is in this unit. This is a nearly level, deep, somewhat poorly drained soil on bottom lands. It is silty clay throughout.

Permeability is slow, and available water capacity is moderate. Runoff is slow. The intake rate is very low. The soil absorbs moisture slowly and releases it slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused mainly by a water table that fluctuates between depths of 3 feet in spring and 8 feet in fall is the main limitation to the use of this soil. Normally tiling is not required, but wetness is a concern in years of above-normal moisture. This soil is subject to flooding an average of once every 3 years. It is difficult to till, because it is very firm when moist and very hard and cloddy when dry.

This soil is suited to all crops commonly grown in the county. Corn and alfalfa are the main crops.

The soil needs to be leveled if it is to be irrigated by a gravity system. Re-use systems can be installed at the lower end of fields to recycle runoff from irrigation. Sprinkler irrigation is suitable, but the low intake rate of the soil requires a lower application rate than that permitted by the center-pivot system. Sprinklers that operate in sets at one location can be adjusted to provide the proper application rate.

CAPABILITY UNIT IIIw-2, IRRIGATED

Only Fillmore complex is in this unit. This complex consists of nearly level, deep, poorly drained soils in upland depressions. The surface layer is silt loam or silty clay loam. The subsoil is silty clay, and the underlying material is silty clay loam.

Permeability is very slow, and available water capacity is moderate. Runoff is ponded. The intake rate is low. The subsoil releases moisture slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Wetness caused by very slow internal drainage and excess moisture from flooding is the main limitation to the use of these soils. The soils are difficult to work, because they are wet when tillage is necessary.

Corn and alfalfa are the main crops. These soils are also suited to the other crops commonly grown in the county.

Flooding can be controlled by using dikes or diversions, which prevent excess runoff from ponding in areas of these soils. Gravity and sprinkler irrigation systems are suitable. Re-use systems can be installed to recycle excess irrigation water. If suitable outlets are available, these soils can be drained.

CAPABILITY UNIT IIIs-11, IRRIGATED

Only Elsmere loamy fine sand, 0 to 2 percent slopes, is in this unit. This is a nearly level to very gently undulating, deep, somewhat poorly drained soil on stream terraces. It has a surface layer and transitional layer of loamy fine sand. The underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is very slow. The intake rate is very high. The soil absorbs moisture rapidly and releases it readily to plants. Organic-matter content is moderately low, and natural fertility is low.

Wetness caused mainly by a water table that fluctuates between depths of 3 and 8 feet is the main limitation to the use of this soil. Normally tiling is not required, but the water table is a concern in years of above-normal moisture. Soil blowing is a hazard in cultivated areas. Low fertility is a moderate limitation and is a concern in management. In most years, wetness in spring delays preparation of a seedbed and the planting of early spring crops. The soil is easy to work.

This soil is suited to corn, alfalfa, small grain, and grasses.

Wetness can be controlled by the use of open drains or tile drains where suitable outlets are available. Returning all crop residue to the soil in the form of organic mulch and applying fertilizer help to maintain fertility. This soil is suited to gravity or sprinkler irrigation. Where a gravity system is used, land shaping or land leveling is generally necessary to provide even distribution of water. The low available water capacity of this soil requires lighter, more frequent applications of irrigation water.

CAPABILITY UNIT IIIs-8, IRRIGATED

Only Ovina-Slickspots complex is in this unit. This complex consists of nearly level, deep, somewhat poorly drained soils on bottom lands. The Ovina part has a surface layer and transitional layer of fine sandy loam and underlying material of loamy fine sand. About 20 percent of the area of this complex is Slickspots. Areas of Slickspots are strongly affected by alkali, which destroys the structure of the surface layer.

Permeability is moderately rapid and available water capacity is moderate in the Ovina part. Runoff is very slow. The Ovina soil absorbs moisture easily and releases it readily to plants. The Slickspots absorb moisture slowly and release it slowly to plants. Organic-matter content is moderate, and natural fertility is medium.

Slickspots are difficult to work because they do not have good structure. The strong alkalinity of the Slickspots is the main limitation to the use of these soils for crops. Wetness is a slight to moderate limitation. The water table fluctuates between depths of 3 and 8 feet. Normally tiling is not required, but the water table is a concern in years of above-normal moisture. The hazard of soil blowing is slight.

These soils are suited to most of the crops commonly grown in the county. Corn is the main crop. Alkali-tolerant crops, such as tall wheatgrass, can be grown as forage in the more strongly alkaline areas.

Sprinkler irrigation is better suited to these soils than other methods of irrigation. A gravity irrigation system can be used if the land is leveled. Land leveling also helps to eliminate some areas of Slickspots. During leveling, the alkali areas can be covered with fertile soil material. Leveling also helps to reduce wetness. Returning crop residue to the surface in the form of mulch, keeping tillage to a minimum, and applying fertilizer help to control erosion and maintain fertility.

CAPABILITY UNIT IVe-4, IRRIGATED

This unit consists of gently sloping to moderately sloping, deep, well-drained soils on uplands. These soils have a surface layer of loam. The subsoil and underlying material are clay loam. A few pebbles and stones are on the surface and throughout the profile. Some of the soils are calcareous and eroded.

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

The hazard of water erosion is moderate to severe. The soils are easy to work, but stones are a slight hazard to farm machinery.

These soils are suited to the crops commonly grown in the county. Corn and alfalfa are the main crops.

Water erosion can be controlled by using terraces and grassed waterways. If gravity irrigation is used, contour furrows can help to reduce soil loss through erosion. Sprinkler irrigation is also suitable if erosion is controlled.

CAPABILITY UNIT IVe-6, IRRIGATED

This unit consists of moderately sloping, deep, well-drained soils on uplands. These soils are silt loam throughout. In many areas they are eroded and have a calcareous surface layer, and in others they are not

appreciably eroded and have a noncalcareous surface layer.

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

The hazard of water erosion is moderate to severe. Runoff and low to medium fertility are moderate limitations. Fertility needs to be improved and maintained. Excess irrigation water needs to be conserved. The soils are easy to work.

Moderate slopes and the hazard of further erosion make these soils better suited to hay and pasture plants than to cultivated crops.

These soils are suited only to sprinkler irrigation. Other methods are too difficult to manage, and the cost of land preparation for them is high. The rate of water application on these soils needs to be adjusted to the intake rate in order to prevent excessive loss of water. Terraces and grassed waterways help to control erosion. Using a maximum amount of crop residue as a mulch also reduces erosion.

CAPABILITY UNIT IVe-8. IRRIGATED

Only Nora-Thurman complex, 7 to 11 percent slopes, is in this unit. This complex consists of deep, well-drained and somewhat excessively drained soils on uplands. The surface layer is fine sandy loam or silt loam. The subsoil is loamy fine sand or silt loam, and the underlying material is fine sand or silt loam.

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

Soil blowing and water erosion are the main hazards. The hazard of gully erosion is severe in waterways. Fertility is a concern in management. The soils are moderately easy to work, but in places they are loose and lack structure.

Moderate slopes and the hazard of further erosion make these soils better suited to hay and pasture plants than to cultivated crops. Alfalfa, grass, and small grain are the main crops.

Sprinkler irrigation is fairly well suited to these soils. Other methods of irrigation are difficult to manage, and the cost of land preparation for them is high. Terraces can be used to control water erosion, and waterways can be used to carry away excess water. Maintaining a good cover of organic residue on the surface and applying fertilizer help to maintain fertility and reduce erosion. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IVe-11. IRRIGATED

This unit consists of gently undulating, deep, somewhat excessively drained or excessively drained soils on uplands. These soils have a surface layer and transitional layer of fine sand or loamy fine sand. The underlying material is fine sand.

Permeability is rapid, and available water capacity is low. Runoff is slow. The intake rate is very high. The soils absorb moisture rapidly and release it readily to plants. Organic-matter content is low to moderately low, and natural fertility is low.

The hazard of soil blowing is moderate to severe. Low fertility is a moderate limitation and is a concern in management. The soils are commonly too loose to be easy to work.

These soils are suited to alfalfa, pasture, close-growing crops, corn, sorghum, and small grain.

Sprinkler irrigation is better suited to these soils than other methods. Frequent applications of water are needed. The center-pivot system of sprinkler irrigation is particularly well suited. Maintaining a high amount of crop residue on the surface, stripcropping, using field windbreaks, keeping tillage to a minimum, and applying fertilizer all help to control soil blowing and maintain fertility. Insects and plant diseases need to be controlled.

Predicted yields

The predicted acre yields for the principal crops grown on soils in Pierce County are shown in table 2. These predictions are based on average yields over the last 5-year period. They do not represent anticipated yields that might be obtainable in the future 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 the Agricultural Extension Service, and others familiar with the soils and farming 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 taken into consideration.

Crop production is influenced by many factors. Some of the soil characteristics that most influence yields are depth, texture, slope, and drainage. Also important are degree of erosion, available water capacity, permeability, and fertility. Such management practices as the cropping pattern, timeliness of operations, plant population, and crop variety affect crop yields. Weather is also significant, both on a day-to-day basis and for longer seasonal or yearly fluctuations. All of these factors were taken into account in the preparation of table 2.

The yields listed are those predicted where a high level of management is used. This management represents those practices used by the most successful farmers in the county. Under this level of 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 controlled. Under irrigation, water is applied in a timely manner and in the proper amount. Water erosion and soil blowing are controlled. Where needed for production of crops, the soil is drained. Tillage and seeding practices are performed adequately and at the proper time. The soil is protected from deterioration and is used in accordance with its capacity.

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

[Yields are those to be expected over a period of years under a high level of management. Absence of a figure indicates that the crop is not suited to the soil, that it is not commonly grown on the soil, or that irrigation is not practical]

Mapping unit	Corn		Soybeans	Oats	Rye	Alfalfa hay	Tame pasture
	Irrigated	Dryland	Dryland	Dryland	Dryland	Dryland	Dryland
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*AUM*[1]
Bazile loam, terrace, 0 to 1 percent slopes	135	65	30	55		3.5	2.5
Bazile silt loam, 0 to 1 percent slopes	135	65	30	55		3.0	2.5
Bazile silt loam, 1 to 7 percent slopes	[2]130	60	28	50		2.8	2.5
Bazile soils, 0 to 1 percent slopes	125	60	28	50	25	3.0	2.5
Bazile soils, 1 to 7 percent slopes	[2]115	55	25	45	25	2.8	2.5
Bazile soils, terrace, 0 to 1 percent slopes	130	60	25	50	25	3.5	2.5
Betts loam, 3 to 11 percent slopes, eroded		45	15	45		2.5	2.5
Blown-out land							
Boelus-Loretto complex, 0 to 2 percent slopes	130	70	35	55	25	3.5	3.0
Boelus-Loretto complex, 2 to 7 percent slopes	[2]125	65	30	50	25	3.2	3.0
Butler silty clay loam	120	50	20	40		3.0	3.0
Cass fine sandy loam	130	55	28	40	20	3.5	2.5
Cass loam	135	60	30	45		4.0	3.0
Clamo silty clay	120	60	30	40		5.0	3.5
Clamo-Slickspots complex		45	15	25		3.0	3.0
Clarno loam, 2 to 7 percent slopes	120	60	20	55		3.5	3.0
Clarno loam, 7 to 11 percent slopes		55	15	50		3.0	2.5
Colo fine sandy loam, overblown	125	65	35	40	25	5.0	4.5
Colo silt loam	125	70	40	50		5.0	4.5
Crofton silt loam, 3 to 7 percent slopes, eroded	[2]110	50	20	45		3.0	2.5
Crofton silt loam, 7 to 17 percent slopes, eroded		45		40		2.0	2.0
Crofton silt loam, 17 to 30 percent slopes							
Crofton-Nora silt loams, 1 to 7 percent slopes, eroded	[2]115	60	25	55		3.0	3.0
Crofton-Nora silt loams, 7 to 11 percent slopes, eroded		55	20	50		2.6	2.5
Crofton-Nora silt loams, 11 to 17 percent slopes, eroded		45	15	45		2.2	2.0
Elsmere loamy fine sand, 0 to 2 percent slopes	[2]100	45	25	25	20	3.5	4.0
Fillmore complex[3]	60	20	10	10		1.0	1.5
Hadar loamy fine sand, 2 to 7 percent slopes	[2]115	60	25	50	25	3.5	3.0
Hadar-Thurman complex, 7 to 11 percent slopes		50	15	40	20	3.0	2.5
Hobbs silt loam	140	75	40	55		4.0	3.5
Hobbs silt loam, calcareous	140	75	40	55		5.0	3.5
Hobbs silt loam, occasionally flooded	120	60	25	25		2.5	4.0
Hord silt loam	140	75	40	60		4.0	3.5
Hord-Hobbs silt loams, 0 to 7 percent slopes	135	75	40	60		4.0	3.5
Lamo silty clay loam	125	70	40	50		5.0	4.5
Lawet loam[3]		30	10				3.5
Lawet-Slickspots complex[3]		25	10				2.5
Leshara silt loam	125	70	40	50		5.0	4.5
Longford loam, 1 to 5 percent slopes	110	45	20	40		2.0	2.5
Longford soils, 2 to 8 percent slopes, eroded		35	15	30		1.5	2.0
Loretto fine sandy loam, terrace, 0 to 2 percent slopes	130	70	35	55	25	4.0	3.0
Loretto loam, 0 to 1 percent slopes	135	70	35	60		3.5	3.0
Loretto loam, 1 to 7 percent slopes	[2]125	65	30	55		3.3	3.0
Loup fine sandy loam[3]		30	10		10		2.5
Loup soils							
Marsh							
Moody silty clay loam, 0 to 1 percent slopes	135	70	35	60		3.5	3.0
Moody silty clay loam, 1 to 7 percent slopes	[2]125	65	30	55		3.3	3.0
Nora silt loam, 1 to 7 percent slopes	[2]125	65	30	55		3.3	3.0
Nora silt loam, 7 to 11 percent slopes		60	25	50		3.1	2.5
Nora silt loam, 11 to 17 percent slopes		50	15	45		2.5	2.5
Nora-Thurman complex, 7 to 11 percent slopes		55	20	40	20	3.0	2.5
Nora-Thurman complex, 11 to 17 percent slopes							
Ord fine sandy loam	125	65	30	40	20	5.0	4.5
Ord loam	125	65	35	45		5.0	4.5
Ortello fine sandy loam, 0 to 2 percent slopes	130	60	30	45	20	3.5	2.5
Ortello fine sandy loam, 2 to 7 percent slopes	[2]120	55	25	40	20	3.5	2.5
Ortello fine sandy loam, terrace, 0 to 2 percent slopes	130	60	30	45	20	4.0	2.5
Ortello loam, terrace, 0 to 1 percent slopes	135	60	30	45		4.0	2.5
Orwet loam[3]		30	10				3.0
Ovina fine sandy loam, 0 to 2 percent slopes	130	65	30	45		5.0	4.5
Ovina loam, 0 to 1 percent slopes	130	65	35	45		5.0	4.5
Ovina-Slickspots complex	100	50	20	25		4.5	3.5
Paka sandy loam, 3 to 8 percent slopes	[2]130	55	30	50	20	3.5	3.0
Paka sandy clay loam, 3 to 8 percent slopes	[2]115	50	25	45		3.0	2.5

TABLE 2.—*Predicted average yields per acre of principal crops*—Continued

Mapping unit	Corn		Soybeans	Oats	Rye	Alfalfa hay	Tame pasture
	Irrigated	Dryland	Dryland	Dryland	Dryland	Dryland	Dryland
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*AUM*[1]
Sandy alluvial land							3.0
Silty alluvial land							3.5
Simeon sandy loam, 3 to 9 percent slopes							
Thurman loamy fine sand, 0 to 2 percent slopes	[2]115	50	20		15	3.0	2.0
Thurman loamy fine sand, 2 to 7 percent slopes	[2]110	45	15		15	3.0	2.0
Thurman loamy fine sand, terrace, 0 to 2 percent slopes	[2]115	50	20		15	4.0	2.0
Thurman fine sandy loam, 7 to 11 percent slopes		40			15	2.0	2.0
Thurman and Valentine soils, 1 to 7 percent slopes	[2]105	35			10	1.5	1.5
Trent silty clay loam	135	75	40	60		4.0	3.5
Valentine fine sand, rolling							
Valentine and Thurman soils, rolling							
Wet alluvial land							

[1] Animal-unit-month, a term used to express the carrying capacity of pasture. It is the number of animal units, 1,000 pounds of live weight, that can be grazed on an acre of pasture for a period of 30 days without damage to the sod.

[2] Yields are for center-pivot, self-propelled sprinkler systems.

[3] If drainage is provided, increased yields of 50 to 100 percent can be expected.

One of the best uses for the yield table is to compare the productivity of one soil to that of other soils in the county. The table is not intended to give recommendations, and the yields shown do not apply to specific farms.

Yields in any one year on a particular soil may vary considerably from the figures given. This variation can be caused by the effect of weather, sudden infestations of disease 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 these predictions obsolete in a few years. Yield data will then need to be updated as knowledge is gained and improvements in technology are made.

Range[3]

Range covers approximately 22 percent of the farmland in Pierce County. It is scattered throughout the county, but some is concentrated in the sandhills in the southwestern part. Areas of range are generally not suitable for cultivation. The major soil association in range is the Valentine-Thurman association.

Raising livestock, mainly cow and calf herds where the calves are sold in fall as feeders, is the second largest farm industry in the county.

Management and improvement

Management practices that maintain or improve range condition are needed on all range, regardless of other practices used. These practices are proper grazing use, deferred grazing, and planned grazing systems. The proper distribution of livestock in a pasture may be improved by the correct location of fences, livestock water developments, and salting facilities.

Practices that improve the range condition include range seeding. This is the establishment by seeding or reseeding of native grasses, either wild or improved strains, on land suitable for use as range. Soils that should be range seeded are Blown-out land; Valentine and Thurman soils, rolling; and Crofton silt loam, 17 to 30 percent slopes, which are still being used for crops. The most important warm-season grasses used in the seed mixture are big bluestem, little bluestem, switchgrass, indiangrass, and sideoats grama. Little care other than management of grazing is needed to maintain forage production.

The native meadows in Pierce County are somewhat limited to the Wet Land and Subirrigated range sites and the Lawet-Orwet and Elsmere-Ovina-Loup soil associations. Such soils as Lawet loam, Orwet loam, and Loup fine sandy loam are used extensively for native meadow.

Range sites and condition classes

Different kinds of range produce different kinds and amounts of native grasses. To properly manage range, an operator should know the different range sites in his holding and the native plants that each site can grow. Management can then be used that favors the growth of the best forage plants on each site.

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

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

Climax vegetation may be altered by intensive grazing. Livestock graze selectively, constantly seek-

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

ing the more palatable and nutritious plants. Plants react to grazing in one of three ways: 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 weeds that become established after the climax vegetation has been reduced by grazing.

Range condition is expressed in four condition classes to show the present condition of the vegetation on a range site in relation to the vegetation that grew on it originally. 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.

Descriptions of the range sites

The range sites in Pierce County are described in this section. The descriptions include the topography of each site, a brief description of the soils in each site, the dominant vegetation on the site if it is in excellent condition, the dominant vegetation if the site is in poor condition, and the total annual production of the site in favorable and unfavorable years.

The range site of each mapping unit can be determined by referring to "Guide to Mapping Units" at the back of this survey. Marsh is not assigned to a range site, because it is not used for range.

WET LAND RANGE SITE

In this site are nearly level soils mainly in swales and old abandoned creek channels on bottom lands but also in a few wet depressions of the sandhills. These soils are deep and very poorly drained. The surface layer and underlying material range from sandy to clayey and are commonly mottled. The vegetation on this site is mainly the kind that grows in the presence of a seasonal high water table. The water table is at the surface in spring and at a depth of 3 feet in fall.

The climax plant cover is a mixture of such decreaser grasses as prairie cordgrass and reedgrasses, which make up at least 65 percent of the total plant production. Other perennial grasslike plants and forbs account for the rest. Sedges are the principal increasers. If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, dandelion, red clover, redtop, asters, and sparse stands of prairie cordgrass and sedges.

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

SUBIRRIGATED RANGE SITE

In this site are nearly level or very gently sloping soils on bottom lands or stream terraces. These soils are deep and somewhat poorly drained and poorly drained. The surface layer and underlying material range from sandy to clayey, and the underlying material is commonly mottled. The vegetation on this site is mainly the kind that grows in the presence of a seasonal high water table. The water table is at a depth of 1 foot in spring and 8 feet in fall.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, indiangrass, switchgrass, little bluestem, prairie cordgrass, and Canada wildrye, which make up at least 75 percent of the total plant production. Other perennial grasses and forbs account for the rest. Kentucky bluegrass, green muhly, and sedges are the principal increasers. If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, redtop, dandelion, common ragweed, blue verbena, foxtail barley, and sparse stands of western wheatgrass and sedges.

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

SALINE SUBIRRIGATED RANGE SITE

In this site is the land type Slickspots, which occur only in complex with other soils. Areas of Slickspots are nearly level and are on bottom lands or stream terraces. They occur as slight depressions 5 to 15 feet in diameter and are black and puddled when moist. Slickspots consist of deep, somewhat poorly drained or poorly drained soils that are moderately or strongly affected by alkali. The surface layer ranged from loamy to clayey, and the underlying material from sandy to clayey. The vegetation on this site is mainly the kind that grows on alkali-affected soil in the presence of a seasonal high water table. The water table is at a depth of 1 foot in spring and 8 feet in fall.

The climax plant cover is a mixture of such decreaser grasses as western wheatgrass, switchgrass, indiangrass, prairie cordgrass, and Canada wildrye, which make up at least 65 percent of the total plant production. Other perennial grasses and forbs account for the rest. Inland saltgrass and sedges are the principal increasers. If the site is in poor condition, the typical plant community is inland saltgrass, Kentucky bluegrass, dandelion, blue grama, buffalograss, and sedges.

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

SILTY OVERFLOW RANGE SITE

In this site are nearly level soils along narrow upland drainageways and near meandering creek channels on bottom lands. These soils are deep, well drained to moderately well drained, and occasionally flooded to frequently flooded. The surface layer and underlying material are silty. The vegetation on this site is mainly the kind that grows on silty soils in the presence of periodic flooding and high available water capacity.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, switchgrass, indiangrass, little bluestem, and Canada wildrye, which make up at least 70 percent of the total plant production. Other grasses and forbs account for the rest. Western wheatgrass, side-oats grama, Kentucky bluegrass, and sedges are the principal increasers. If the

site is in poor condition, the typical plant community consists of Kentucky bluegrass, western wheatgrass, Baldwin ironweed, and sedges.

If the site is in excellent condition, the total annual production of air-dry herbage ranges from 3,500 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

CLAYEY OVERFLOW RANGE SITE

In this site are nearly level soils in low areas that have slow surface drainage and in depressions on uplands and stream terraces. These soils are deep and somewhat poorly drained to poorly drained. They receive additional water as runoff from higher lying areas. The surface layer is silty, and the subsoil is clayey. The vegetation on this site is mainly the kind that grows in the presence of periodic flooding, a clayey subsoil, and slow permeability.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, switchgrass, indiangrass, little bluestem, and Canada wildrye, which make up at least 50 percent of the total plant production. Other grasses and forbs account for the rest. Western wheatgrass, Kentucky bluegrass, blue grama, buffalograss, and sedges are the principal increasers. If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, blue grama, buffalograss, common ragweed, and sedges.

If the site is in excellent condition, the total annual production of air-dry herbage ranges from 3,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

SANDY LOWLAND RANGE SITE

In this site are nearly level soils on bottom lands. These soils are deep and well drained. Flooding ranges from seldom to frequent. The surface layer is mainly sandy or loamy, but in some areas it is silty. The underlying material is sandy or loamy. The vegetation on this site is mainly the kind that grows on sandy soils in the presence of additional beneficial water, which is the result of periodic flooding.

The climax plant cover is a mixture of such decreaser grasses as sand bluestem, little bluestem, switchgrass, needle-and-thread, indiangrass, and Canada wildrye, which make up at least 70 percent of the total plant production. Other grasses and forbs account for the rest. Prairie sandreed, blue grama, cudweed sagewort, Scribner panicum, sand dropseed, and sedges are the principal increasers. If the site is in poor condition, the typical plant community consists of sand dropseed, blue grama, Scribner panicum, and common ragweed.

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

SILTY LOWLAND RANGE SITE

In this site are nearly level to gently sloping soils on bottom lands, stream terraces, and colluvial slopes. These soils are deep and well drained to moderately well drained. They receive some additional water as runoff from higher lying areas or as a result of major floods. The surface layer and subsoil are silty. The underlying material is mainly silty, but in places it is sandy. The vegetation on this site is mainly the kind that grows on silty soils in the presence of additional water from runoff and moderate to high available water capacity.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, switchgrass, little bluestem, indiangrass, and Canada wildrye, which make up at least 70 percent of the total plant production. Other grasses and forbs account for the rest. Western wheatgrass, blue grama, and side-oats grama are the principal increasers. If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, western wheatgrass, blue grama, Baldwin ironweed, and common ragweed.

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

SANDS RANGE SITE

In this site are very gently undulating to rolling soils on uplands. These soils are deep and somewhat excessively drained or excessively drained. The surface layer and underlying material are sandy. The vegetation on this site is mainly the kind that grows on excessively drained, sandy soils that have low available water capacity.

The climax plant cover is a mixture of such decreaser grasses as sand bluestem, switchgrass, indiangrass, and prairie junegrass, which make up at least 55 percent of the total plant production. Other perennial grasses and forbs account for the rest. Little bluestem, prairie sandreed, needle-and-thread, blue grama, Scribner panicum, sand dropseed, and sand paspalum are the principal increasers. If the site is in poor condition, the typical plant community consists of blue grama, hairy grama, sand dropseed, sand paspalum, Scribner panicum, and western ragweed.

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

SANDY RANGE SITE

In this site are nearly level to strongly sloping soils on uplands and stream terraces. These soils are deep and well drained to somewhat excessively drained. The surface layer is mainly sandy or loamy, but in places it is silty. The subsoil and underlying material range from sandy to silty. The vegetation on this site is mainly the kind that grows on well-drained to somewhat excessively drained soils that have a sandy or loamy surface layer.

The climax plant cover is a mixture of such decreaser grasses as sand bluestem, little bluestem, switchgrass, side-oats grama, and sand lovegrass, which make up at least 65 percent of the total plant production. Other perennial grasses and forbs account for the rest. Blue grama, needle-and-thread, prairie sandreed, sand dropseed, and Scribner panicum are the principal increasers. If the site is in poor condition, the typical plant community consists of

blue grama, Scribner panicum, sand dropseed, windmillgrass, and western ragweed.

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

SILTY RANGE SITE

In this site are nearly level to strongly sloping soils on uplands. These soils are deep and well drained. The surface layer and subsoil are silty. The vegetation on this site is mainly the kind that grows on well-drained, silty soils that have moderate to high available water capacity.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, switchgrass, and indiangrass, which make up at least 65 percent of the total plant production. Other perennial grasses and forbs account for the rest. Side-oats grama, blue grama, western wheatgrass, Kentucky bluegrass, and needle-and-thread are the principal increasers. If the site is in poor condition, the typical plant community consists of blue grama, Scribner panicum, Kentucky bluegrass, blue verbena, and western ragweed.

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

CLAYEY RANGE SITE

In this site are very gently sloping and gently sloping soils on uplands. These soils are deep and well drained. The surface layer is silty or clayey, and the underlying material is clayey. The vegetation on this site is mainly the kind that grows on clayey soils that have slow permeability and moderate available water capacity.

The climax plant cover is a mixture of such decreaser grasses as big bluestem, little bluestem, side-oats grama, switchgrass, indiangrass, and prairie dropseed, which make up at least 55 percent of the total plant production. Other perennial grasses and forbs account for the rest. Western wheatgrass, blue grama, buffalograss, and tall dropseed are the principal increasers. If the site is in poor condition, the typical plant community consists of blue grass, buffalograss, blue verbena, and sparse stands of western wheatgrass and cool-season annual grasses.

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

LIMY UPLAND RANGE SITE

In this site are gently sloping to steep soils on uplands. These soils are deep and well drained. The surface layer and underlying material are silty. The soils are moderately alkaline and contain many lime concretions throughout. The vegetation on this site is mainly the kind that grows on limy soils that are silty and have high available water capacity.

The climax plant cover is a mixture of such decreaser grasses as little bluestem, switchgrass, side-oats grama, indiangrass, and Canada wildrye, which make up at least 75 percent of the total plant production. Other perennial grasses, forbs, and shrubs account for the rest. Blue grama, western wheatgrass, and sedges are the principal increasers. If the site is in poor condition, the typical plant community consists of Kentucky bluegrass, Scribner panicum, blue grama, blue verbena, and western ragweed.

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

SHALLOW TO GRAVEL RANGE SITE

Only Simeon sandy loam, 3 to 9 percent slopes, is in this site. This is a gently sloping to moderately sloping soil on uplands. It is deep and excessively drained. The surface layer is loamy, and the transitional layer and underlying material are sandy but contain a few small pebbles. The vegetation on this site is the kind that grows in the presence of low available water capacity, which results from the gravelly underlying material.

The climax plant cover is a mixture of such decreaser grasses as needle-and-thread, little bluestem, prairie sandreed, sand bluestem, western wheatgrass, and switchgrass, which make up at least 60 percent of the total plant production. Other perennial grasses and forbs account for the rest. Blue grama, hairy grama, Scribner panicum, sand dropseed, and clubmoss are the principal increasers. If the site is in poor condition, the typical plant community consists of clubmoss, sand dropseed, hairy grama, and common ragweed.

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

Woodland and Windbreaks[4]

Native woodland in Pierce County is limited to relatively narrow strips along the larger streams. The most extensive stands are on bottom lands of the North Fork Elkhorn River and Willow Creek. These stands are mostly American elm, boxelder, green ash, hackberry, willow, walnut, cottonwood, and some woody shrubs. They grow mainly on Silty alluvial land along the North Fork Elkhorn River and on Sandy alluvial land along Willow Creek. Many sites are capable of producing commercial quantities of wood, but their value for esthetic purposes, recreation, wildlife, and watershed is even greater.

Early settlers in Pierce 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 a great deal to the natural beauty of Pierce County. Their presence benefits wildlife by producing food and cover.

The most important use for trees in Pierce County is for windbreaks because of the scarcity of native trees and the severe weather that prevails. An accelerated tree planting program in the late 1930's and

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

early 1940's saw approximately 3,000 acres of trees planted in Pierce County as windbreaks. Since then, many areas of trees have been planted each year as windbreaks. Windbreaks help to protect livestock and soil. They also help to reduce home heating costs, control snow drifting, provide shelter for livestock, control soil blowing on cultivated land, improve conditions for wildlife, and beautify the home and countryside.

Narrow windbreaks for screen plantings are also useful in urban areas where they slow the wind, settle dust, and help to reduce noise. Although trees are not easy to establish in Pierce County, the observance of basic rules of tree culture can result in a high degree of tree survival. Healthy seedlings of adapted species that are maintained in good condition and properly planted in a well-prepared site can survive and grow well. They require care after planting if they are to continue to survive.

Table 3 shows the expected height at 20 years of age of trees suitable for windbreaks in this county. Detailed measurements were taken for most tree and shrub species listed in this table; some tree heights and suitability ratings, however, were estimated. Measurements were taken by forestry technicians in windbreaks approximately 20 years old that are on soils in different windbreak suitability groups. The soils in each group are similar in those characteristics that affect the growth of trees.

The suitability ratings shown in table 3 are based on observations of general vigor and on condition of the trees in the windbreak. Those species that have a rating of *good* are suited to windbreaks on soils in windbreak groups that have this rating. 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) may be in the live crown; and evidence of disease, insect, and climatic damage is limited. The rating of *fair* indicates that one or more of the following conditions generally apply: leaves or needles are obviously abnormal in color and growth; substantial amounts of deadwood (tops, branches, and twigs) are in the live crown; evidence

TABLE 3.—*Suitability of adapted trees and shrubs for windbreaks and their height at 20 years of age*

[Height estimates are not given for species rated poor. Ratings are not given for group 10, because soils in this group are not generally suited to windbreaks]

Tree and shrub species	Windbreak suitability group—													
	1		2		3		4		5		6		7	
	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height	Suitability	Height
		Feet		*Feet*		*Feet*		*Feet*		*Feet*		*Feet*		*Feet*
Conifers:														
Austrian pine	Good	32	Fair	26	Good	30	Good	28	Fair	26	Poor		Fair	24
Black Hills spruce	Good	28	Fair	24	Poor		Poor		Poor		Poor		Poor	
Colorado blue spruce	Good	30	Poor		Poor		Fair	24	Poor		Poor		Poor	
Eastern redcedar	Good	26	Good	23	Good	23	Good	24	Good	20	Poor		Good	18
Eastern white pine	Fair	30	Poor		Poor		Poor		Poor		Poor		Poor	
Norway spruce	Good	30	Fair	24	Poor		Fair	26	Poor		Poor		Poor	
Ponderosa pine	Good	32	Poor		Good	31	Good	28	Fair	27	Poor		Good	26
Scotch pine	Good	32	Fair	26	Good	30	Good	28	Fair	26	Poor		Fair	24
Broadleaf trees:														
American sycamore	Good	32	Good	30	Fair	26	Poor		Poor		Poor		Poor	
Black walnut	Good	30	Poor		Fair	24	Poor		Poor		Poor		Poor	
Boxelder	Good	24	Good	20	Poor		Poor		Poor		Poor		Poor	
Bur oak	Good	28	Poor		Fair	24	Good	24	Good	20	Poor		Poor	
Eastern cottonwood	Fair	60	Fair	55	Fair	60	Poor		Poor		Fair	45	Fair	10
Golden willow	Good	32	Good	35	Poor		Poor		Poor		Good	24	Poor	
Green ash	Good	30	Fair	29	Fair	29	Good	26	Poor		Poor		Poor	
Hackberry	Good	30	Fair	26	Fair	28	Good	26	Poor		Poor		Poor	
Honeylocust	Good	35	Fair	35	Fair	31	Fair	30	Poor		Poor		Poor	
Northern red oak	Fair	26	Poor		Poor		Poor		Poor		Poor		Poor	
Pin oak	Fair	28	Fair	26	Poor		Poor		Poor		Poor		Poor	
Russian mulberry	Good	26	Fair	16	Fair	21	Good	24	Poor		Poor		Poor	
Russian-olive	Fair	24	Poor		Fair	18	Fair	21	Fair	16	Poor		Poor	
Silver maple	Good	30	Good	28	Fair	26	Fair	26	Poor		Poor		Poor	
Shrubs:														
American honeysuckle	Good	10	Fair	6	Good	6	Good	8	Fair	6	Poor		Poor	
American plum	Good	10	Good	6	Good	7	Good	8	Fair	6	Poor		Fair	4
Amur maple	Good	12	Fair	8	Fair	8	Fair	10	Poor		Poor		Poor	
Autumn-olive	Good	12	Fair	8	Fair	6	Fair	10	Poor		Poor		Poor	
Buffaloberry	Fair	10	Fair	8	Poor		Poor		Poor		Fair	6	Poor	
Common chokecherry	Good	14	Fair	9	Fair	10	Good	10	Poor		Poor		Poor	
Lilac	Good	8	Good	6	Fair	6	Good	6	Fair	5	Poor		Poor	
Peking cotoneaster	Good	8	Fair	5	Fair	6	Good	6	Poor		Poor		Poor	
Red-osier dogwood	Good	6	Good	6	Poor		Poor		Poor		Fair	6	Poor	
Siberian peashrub	Good	10	Poor		Good	7	Good	8	Fair	6	Poor		Poor	
Skunkbush sumac	Good	10	Poor		Good	6	Good	6	Good	6	Poor		Poor	

of moderate disease, insect, or climatic damage is obvious; and the current year's growth is obviously less than normal. The rating of *poor* indicates one or more of the following conditions generally apply: leaves or needles are very abnormal in color or growth; very large amounts of deadwood (tops, branches, and twigs) are in the live crown; and evidence of extensive disease, insect, or climatic damage is obvious.

The conifers, cedar and pine, are better suited to windbreaks than other trees. The measurements show that eastern redcedar and ponderosa pine, both native to Nebraska, are the most reliable windbreak species. Both rated high in survival and vigor in the studies that were made. They hold their leaves through the winter, thereby giving maximum protection when it is most needed.

The table also indicates several broadleaf tree species that are well suited to windbreaks in Pierce County. The best trees according to the measurements are honeylocust, green ash, and hackberry.

Eastern redcedar can reach a height of 30 to 40 feet at maturity. Rocky Mountain juniper attains a slightly lower height at maturity. Ponderosa pine, Austrian pine, and Scotch pine grow slightly faster and are somewhat taller at maturity. The same is true of broadleaf tree species.

Rate of growth in a windbreak varies widely with soil moisture conditions and soil fertility. Exposure and arrangement of trees within the planting also have a marked effect on growth. Some species grow faster than others. Some make an early fast growth but tend to die young. This is occasionally true of cottonwood. Siberian elm and Russian-olive are vigorous early growers. However, they can spread where they are not wanted and can be short lived. Boxelder and mulberry commonly freeze back in severe winters, and green ash is susceptible to damage by borers.

A good windbreak needs to be designed to fit 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 for Pierce County.

Soils of Pierce County are grouped according to characteristics that affect tree growth. Soils in a group produce similar growth and survive under similar conditions of weather and care. To find the name of all the soils in any group, refer to the "Guide to Mapping Units" at the back of this survey.

In Nebraska soils are grouped into windbreak suitability groups according to a system that is used Statewide. Not all groups are in Pierce County.

Following is a brief description of the windbreak suitability groups in Pierce County.

WINDBREAK SUITABILITY GROUP 1

In this group are nearly level soils on bottom lands. These soils are deep and well drained. The surface layer is loamy or silty, and the underlying material is silty, loamy, or sandy.

These soils generally provide good tree planting sites, and capability for survival and growth of adapted species is good. Moisture competition from weeds and grasses is the main limitation.

WINDBREAK SUITABILITY GROUP 2

In this group are nearly level or very gently undulating soils. Areas of these soils are mostly on bottom lands, but a few are on stream terraces and in upland basins. The soils are deep and somewhat poorly drained. They range from sandy to clayey. In most of these soils, the water table fluctuates between depths of 3 and 8 feet. A few areas receive additional water as runoff from higher lying areas.

These soils generally provide good tree planting sites, and capability for survival and growth is good if the species selected can tolerate occasional wetness. Establishment of seedlings can be difficult during wet years. The abundant and persistent herbaceous vegetation that grows on these sites is a limitation to the establishment and maintenance of trees.

WINDBREAK SUITABILITY GROUP 3

In this group are nearly level to strongly sloping soils on uplands, stream terraces, and bottom lands. These soils are deep and well drained to somewhat excessively drained. The surface layer is sandy or loamy, and the subsoil and underlying material range from sandy to silty.

These soils generally provide fair tree planting sites, and capability for survival and growth of adapted species is fair. Lack of adequate moisture and soil blowing are the main limitations. Soil blowing can be prevented by maintaining strips of sod or other vegetation between the rows. Cultivation generally needs to be restricted to the tree rows.

WINDBREAK SUITABILITY GROUP 4

In this group are nearly level to strongly sloping soils on uplands and stream terraces. These soils are deep and well drained or moderately well drained. The surface layer is mainly silty but ranges from loamy to clayey. The subsoil and underlying material are mainly loamy or silty, but in a few areas they are sandy or clayey.

These soils generally provide good tree planting sites, and capability is good for survival and fair for growth of adapted species. Drought and moisture competition from weeds and grasses are the main limitations. Water erosion is a hazard on the gently sloping to steep soils. On the steeper soils lack of sufficient moisture caused by rapid runoff reduces growth of trees.

WINDBREAK SUITABILITY GROUP 5

In this group are gently sloping to strongly sloping soils on uplands. These soils are deep and well drained. The surface layer, subsoil, and underlying material are loamy or silty. The soils are calcareous throughout and contain many soft pockets or concentrations of lime.

These soils provide fair to poor tree planting sites, and capability for survival and growth of adapted species is fair to poor. Lack of adequate moisture and the calcareous soil condition are the main limitations.

WINDBREAK SUITABILITY GROUP 6

In this group are nearly level soils. Areas of these soils are mostly on bottom lands, but a few are in upland depressions. The soils are deep and poorly drained. They range from sandy to clayey. Most of these soils have a seasonal high water table within a depth of 2 feet. The soils in depressions have water on the surface during wet seasons.

These soils generally provide poor tree planting sites, and capability for survival and growth of adapted species is only fair. Excessive wetness is the main limitation and is a concern in management. Only those trees and shrubs that are tolerant of a high water table or flooding are suitable.

WINDBREAK SUITABILITY GROUP 7

In this group are mainly very gently undulating to rolling soils on uplands. These soils are deep and somewhat excessively drained or excessively drained. They have a sandy surface layer and underlying material.

These soils generally provide fair tree planting sites, and capability for survival and growth of adapted species is fair. The soils are so loose that the trees need to be planted in shallow furrows and not cultivated. Young seedlings may suffer from sand blasting during high winds and can be covered by drifting sand.

WINDBREAK SUITABILITY GROUP 10

In this group are nearly level to steep soils on uplands, stream terraces, and bottom lands. These soils have a wide range of soil characteristics. They range from sandy to clayey and from very poorly drained to excessively drained. In some areas they are moderately or strongly affected by alkali. Most of the alluvial land types are frequently flooded.

TABLE 4.—*Potential of the principal soils in the soil associations for*

Soil associations and soils	Potential for producing—			
	Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs
1. Valentine-Thurman association:				
Valentine	Poor	Poor	Fair	Poor
Thurman	Fair	Fair	Good	Fair
2. Thurman-Ortello-Boelus association:				
Thurman	Fair	Fair	Good	Fair
Ortello	Good	Good	Good	Good
Boelus	Good	Good	Good	Good
3. Thurman-Hadar-Ortello association:				
Thurman	Fair	Fair	Good	Fair
Hadar	Fair	Fair	Good	Fair
Ortello	Good	Good	Good	Good
4. Moody-Bazile-Trent association:				
Moody	Good	Good	Good	Good
Bazile	Good	Good	Good	Good
Trent	Good	Good	Good	Good
5. Crofton-Nora-Moody association:				
Crofton	Fair	Good	Fair	Fair
Nora:				
1 to 7 percent slopes	Good	Good	Good	Good
7 to 17 percent slopes	Fair	Good	Good	Good
6. Clarno-Nora-Betts association:				
Clarno:				
0 to 7 percent slopes	Good	Good	Good	Good
7 to 11 percent slopes	Fair	Good	Good	Poor
Nora:				
1 to 7 percent slopes	Good	Good	Good	Good
7 to 17 percent slopes	Fair	Fair	Good	Good
Betts	Fair	Fair	Fair	Fair
7. Hobbs-Hord-Colo association:				
Hobbs	Good	Good	Good	Good
Hord	Good	Good	Good	Good
Colo	Good	Good	Good	Good
8. Elsmere-Ovina-Loup association:				
Elsmere	Fair	Good	Good	Good
Ovina	Fair	Good	Good	Good
Loup	Very poor	Poor	Fair	Poor
9. Lawet-Orwet association:				
Lawet	Poor	Good	Good	Fair
Orwet	Poor	Good	Good	Fair

These soils generally are 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[5]

Wildlife populations are determined largely by the quality and quantity of vegetation that the land produces. Cover, food, and water, in a proper combination, are the three elements essential to wildlife.

Topography plays a major role in determining wildlife numbers, as do such characteristics as fertility. Fertile soils produce more and better quality wildlife, both game and nongame species. The game species are mainly discussed here, although nongame species are becoming increasingly important. Nongame species also benefit from improved living conditions for game species.

Outdoor interpretations and an appreciation of the natural environment by persons other than hunters and fishermen have increased. This helps people to understand the relationship among plants, animals, and man and how all depend on the soil. Wildlife species can also be used to evaluate the quality of the environment.

In many cases the soils rated highest for wildlife potential do not have the highest wildlife populations. This is not caused by the inability of soils to produce wildlife, but rather by many other factors, such as hunting pressure, clean tillage, and improved methods of harvesting. The potential still remains, and wildlife values can be enhanced with little cost and effort. Wildlife has a place in both rural and urban

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

producing wildlife habitat elements and as habitat for stated kinds of wildlife

Potential for producing—Continued			Potential as habitat for—			
Coniferous plants	Wetland food and cover	Shallow water areas	Open-land wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Poor	Very poor	Very poor	Poor	Poor	Very poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor	Good.
Good	Very poor	Very poor	Fair	Fair	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Good	Very poor	Fair.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Poor	Very poor	Very poor	Fair	Poor	Very poor	Good.
Good	Very poor	Very poor	Good	Good	Very poor	Good.
Good	Very poor	Very poor	Fair	Good	Very poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor	Fair.
Good	Poor	Very poor	Good	Good	Very poor	Good.
Good	Poor	Very poor	Good	Good	Very poor	Good.
Good	Fair	Fair	Good	Fair	Fair	Good.
Fair	Good	Fair	Fair	Fair	Fair	Good.
Good	Fair	Fair	Fair	Good	Fair	Good.
Poor	Good	Good	Very poor	Poor	Good	Fair.
Poor	Good	Good	Poor	Fair	Good	Good.
Poor	Good	Good	Poor	Fair	Good	Good.

settings and should be considered in planning for optimum use of these areas. For example, fish ponds that fill by runoff from fertile fields usually produce more pounds of fish than average because of the increased food production.

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

Steep slopes and rough, irregular topography present hazards to livestock and are poorly suited to crops. In these areas, the undisturbed landscape can become escape cover for wildlife and provide a source of food. In many places where vegetation is lacking, it can be developed by planting flowering and fruiting trees and shrubs.

Wetness, permeability, and available water capacity are important soil characteristics to consider when 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 Pierce County. Table 4 rates the potential for seven elements of wildlife habitat and four kinds of wildlife.

The elements of wildlife habitat are described in the paragraphs that follow.

Grain and seed crops are domestic grain or other seed-producing annuals planted to produce wildlife food. 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 for wildlife cover and food. 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, beggarweed, partridgepea, pokeweed, wheatgrasses, fescues, and gramas.

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

Coniferous plants are cone-bearing trees, shrubs, and ground cover that furnish wildlife cover or supply food 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 consists of annual and perennial wild herbaceous plants on 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 has an average depth of less than 5 feet and is 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.

In the following paragraphs the kinds of wildlife are briefly described.

Open-land 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 that contain either hardwood or coniferous trees and shrubs or a mixture of both. Examples are wild turkey, ruffed grouse, thrushes, 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 all kinds of wildlife habitat potential. Many kinds of wildlife frequent both rangeland and woodland habitat types in Pierce County.

The nine soil associations in Pierce County are discussed in relation to wildlife in the following paragraphs.

The Valentine-Thurman association is mainly in the southwestern part of the county on gently undulating to rolling upland topography. A few scattered prairie grouse are in this association, because sizable tracts of native range still remain. Grasses in this association include prairie sandreed, big bluestem, little bluestem, and switchgrass. These provide cover and nesting habitat for upland game birds. Pheasant and bobwhite quail populations are low. Numbers of cottontail rabbit and fox squirrel are in the medium to high range. Waterfowl and shore birds are common on and around Crystal Lake and other natural wetland areas.

The Thurman-Ortello-Boelus association is on nearly level to gently undulating upland topography. The Thurman-Hadar-Ortello association is on glacial uplands and has populations of wildlife species similar to those of the Valentine-Thurman association, except that prairie grouse are not as abundant in this association.

The Moody-Bazile-Trent, Crofton-Nora-Moody, and Clarno-Nora-Betts associations are on level to strongly sloping topography. Most of the acreage in these associations is farmed. Many farmstead and field windbreaks include plantings of conifers that afford winter cover as well as food for wildlife.

The Hobbs-Hord-Colo association is on nearly level topography on bottom lands and stream terraces, mainly along the North Fork Elkhorn River. The woodlands along the river channel provide cover and travel lanes for deer. Fields of alfalfa and small grains along the bottom lands provide food for wildlife and nesting cover for upland game birds.

The Elsmere-Ovina-Loup and Lawet-Orwet associa-

tions are on nearly level topography in an area where the water table is at the surface in spring and at a depth of 8 feet in fall. The soils provide food and nesting cover for waterfowl (fig. 13). Muskrats are in these areas during years of high rainfall. Cottontail rabbits are common, and fox squirrels are in trees along the streams. Deer, though not abundant, frequent the county mainly in the area along the North Fork Elkhorn River. Some fishing occurs along the Elkhorn River, where the predominant species are catfish, bullhead, and carp. Bass, bluegill, and channel catfish are in many farm ponds in Pierce County.

Wildlife habitat can be improved by fencing small odd areas in corners of fields as well as along streams and low areas. This helps wildlife live through winter. Adequate winter cover is a limiting factor for the wildlife of Pierce County.

Technical assistance is available from the Soil Conservation Service and other State and Federal agencies for designing and installing measures to improve wildlife habitat in Pierce County.

Engineering Uses of the Soils[6]

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

Among properties of soils important in engineering are permeability, strength, compaction characteristics, drainage condition, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect the 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 the 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 to 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 publication, can be used to make interpretations in addition to those given in tables 5 and 6, and it also can be used to make other useful maps.

This information, however, is not intended for use in design and does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or require excavations to depths greater than those shown in the tables, generally depths of more 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 different meanings in soil science than in engineering. The Glossary at the back of this publication defines many of these terms as they are commonly used in soil science.

Figure 13.—**Dugout in area of Lawet loam is stocked with fish and furnishes water for livestock and wildlife.**

[6] SYDNEY H. HAAKENSTAD, civil engineer, Soil Conservation Service, helped to prepare this section.

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table.

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Feet	*Inches*			
Bazile:					
BaA, BbA, BbC	>10; 5–10 in BaA.	0–12	Silt loam or loam	CL	A-6
		12–27	Silty clay loam	CL	A-6 or A-7
		27–60	Sand	SP or SP-SM	A-3
BcA, BcC, BdA	>10; 5–10 in BdA.	0–12	Fine sandy loam or loamy fine sand.	SM or SC	A-2 or A-4
		12–27	Silty clay loam	CL	A-6 or A-7
		27–60	Sand	SP or SP-SM	A-3
Betts: BeD2	>10	0–6	Loam	CL	A-6 or A-7
		6–18	Clay loam	CL	A-7
		18–60	Clay loam	CL	A-7
Blown-out land: Bn	>10	0–60	Fine sand	SP or SP-SM	A-3
*Boelus: BoA, BoC For Loretto part, see Loretto series.	>10	0–23	Loamy fine sand	SM	A-2
		23–47	Silt loam	CL	A-6 or A-7
		47–60	Silt loam	CL	A-6 or A-7
Butler: Bt	[2]>10	0–12	Silty clay loam	CL	A-6 or A-7
		12–46	Silty clay	CH	A-7
		46–60	Silty clay loam	CL	A-6 or A-7
Cass:					
Ca	[2]>8	0–20	Fine sandy loam	SM	A-2 or A-4
		20–46	Loamy fine sand and very fine sandy loam.	SM or SM-SC	A-2 or A-4
		46–60	Sand	SP or SP-SM	A-3
Cb	[2]>8	0–8	Loam	ML	A-4
		8–20	Fine sandy loam	SM	A-2 or A-4
		20–60	Loamy fine sand or sand	SP or SP-SM	A-2 or A-3
Clamo: Cc, Cd Slickspots part of Cd too variable to be rated.	[2]3–5	0–20	Silty clay	CH	A-7
		20–48	Silty clay	CH	A-7
		48–60	Silty clay	CH	A-7
Clarno: CeC, CeD	>10	0–11	Loam	CL	A-6 or A-7
		11–28	Clay loam	CL	A-7 or A-6
		28–60	Clay loam	CL	A-7 or A-6
Colo:					
Cf	[2]3–5	0–14	Fine sandy loam	SM	A-2 or A-4
		14–50	Silty clay loam	CL	A-7 or A-6
		50–60	Silty clay loam	CL	A-7 or A-6
Co	[2]3–5	0–38	Silt loam	CL	A-6 or A-7
		38–50	Silty clay loam	CL	A-7 or A-6
		50–60	Silty clay loam	CL	A-7 or A-6
*Crofton: CrC2, CrE2, CrF, CsC2, CsD2, CsE2 For Nora parts of CsC2, CsD2, and CsE2, see Nora series.	>10	0–6	Silt loam	CL or ML	A-6
		6–21	Silt loam	CL	A-6
		21–60	Silt loam	CL	A-6
Elsmere: EaA	3–5	0–7	Loamy fine sand	SM or SP-SM	A-2 or A-3
		7–19	Loamy fine sand	SM or SP-SM	A-2
		19–60	Fine sand	SP-SM or SM	A-3 or A-2
Fillmore: Fm	[2]>10	0–13	Silt loam	CL or ML	A-4 or A-6
		13–47	Silty clay	CH	A-7
		47–60	Silty clay loam	CL	A-6 or A-7

significant to engineering

such mapping units may have different properties and limitations. For this reason it is necessary to follow carefully the instructions for
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. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
	100	85–100	60–90	30–40	11–20	0.6–2.0	0.20–0.24	5.6–6.5	Moderate.
----------	100	95–100	70–95	30–45	11–25	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
----------	100	51–75	2–10	[1]NP	[1]NP	6.0–20	0.05–0.07	6.6–7.3	Low.
----------	100	60–75	15–50	<20	<10	2.0–20	0.10–0.18	5.6–6.5	Low.
----------	100	95–100	70–95	30–45	11–25	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
----------	100	51–75	2–10	NP	NP	6.0–20	0.05–0.07	6.6–7.3	Low.
95–100	95–100	85–95	60–75	30–45	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
95–100	95–100	85–95	70–80	41–50	20–30	0.6–2.0	0.15–0.17	7.9–8.4	Moderate.
95–100	95–100	85–95	70–80	41–50	20–30	0.6–2.0	0.14–0.16	7.9–8.4	Moderate.
----------	100	75–98	2–10	NP	NP	6.0–20	0.05–0.07	5.6–6.5	Low.
----------	100	70–95	15–30	NP	NP	6.0–20	0.10–0.12	5.6–6.5	Low.
----------	100	90–100	75–95	30–45	15–25	0.6–2.0	0.20–0.22	6.6–7.8	Moderate.
----------	100	95–100	90–100	35–45	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
----------	----------	100	90–100	30–45	15–25	0.2–0.6	0.21–0.23	5.6–6.0	Moderate.
----------	----------	100	95–100	50–70	25–40	0.06–0.2	0.11–0.13	5.6–7.3	High.
----------	----------	100	95–100	30–45	15–25	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
----------	100	60–90	30–50	<20	<10	2.0–6.0	0.16–0.18	5.6–7.3	Low.
----------	100	50–95	15–50	<20	<10	6.0–20	0.09–0.11	6.6–7.3	Low.
----------	100	51–80	2–10	NP	NP	6.0–20	0.05–0.07	6.6–7.3	Low.
----------	100	85–95	51–80	20–40	<10	0.6–2.0	0.20–0.22	5.6–7.3	Low.
----------	100	60–90	30–50	<20	<10	2.0–6.0	0.16–0.18	6.6–7.3	Low.
----------	100	51–90	2–35	NP	NP	6.0–20	0.05–0.11	6.6–7.3	Low.
----------	100	95–100	95–100	50–75	25–45	0.06–0.2	0.12–0.14	6.6–7.8	High.
----------	100	95–100	95–100	50–75	25–45	0.06–0.2	0.11–0.13	6.6–7.8	High.
----------	100	95–100	95–100	50–75	25–45	0.06–0.2	0.10–0.12	7.4–8.4	High.
95–100	95–100	85–95	60–75	30–45	11–25	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
95–100	95–100	85–95	70–80	35–50	20–30	0.6–2.0	0.15–0.17	6.6–8.4	Moderate.
95–100	95–100	85–95	70–80	35–50	20–30	0.6–2.0	0.14–0.16	7.9–8.4	Moderate.
----------	100	60–90	30–50	<25	<10	2.0–6.0	0.16–0.18	6.1–7.3	Low.
----------	100	95–100	85–95	35–50	20–30	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
----------	100	95–100	85–95	35–50	20–30	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
----------	100	90–100	70–95	30–45	11–25	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
----------	100	95–100	85–95	35–50	15–30	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
----------	100	95–100	85–95	35–50	15–30	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
----------	100	97–100	90–100	30–40	11–20	0.6–2.0	0.22–0.24	6.6–8.4	Moderate.
----------	100	97–100	90–100	30–40	11–20	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
----------	100	97–100	90–100	30–40	11–20	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
----------	100	75–95	5–30	NP	NP	6.0–20	0.10–0.12	6.1–7.3	Low.
----------	100	75–95	12–30	NP	NP	6.0–20	0.09–0.12	6.1–7.3	Low.
----------	100	70–95	3–15	NP	NP	6.0–20	0.05–0.07	6.1–7.8	Low.
----------	----------	100	90–100	20–40	2–15	0.6–2.0	0.22–0.24	5.6–6.5	Moderate.
----------	----------	100	95–100	50–70	25–45	<0.06	0.11–0.13	6.1–7.3	High.
----------	----------	100	95–100	30–50	11–25	0.2–0.6	0.18–0.20	6.6–7.8	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Feet	*Inches*			
*Hadar: HaC, HaD	>10	0–24	Loamy fine sand	SM	A–2
For Thurman part of HaD, see Thurman series.		24–46	Clay loam	CL	A–7 or A–6
		46–60	Clay loam	CL	A–7 or A–6
Hobbs: Hb, Hc, Hd	[2]5–10	0–20	Silt loam	CL	A–4 or A–6
		20–37	Silt loam	CL	A–6 or A–7
		37–60	Silt loam	CL	A–6 or A–7
*Hord: He, HhC	5–10	0–21	Silt loam	CL	A–4 or A–6
For Hobbs part of HhC, see Hobbs series.		21–47	Silt loam	CL	A–4 or A–6
		47–60	Silt loam	CL	A–4 or A–6
Lamo: Lb	[2]3–5	0–17	Silty clay loam	CL	A–7 or A–6
		17–36	Silty clay loam	CL	A–7 or A–6
		36–60	Silty clay loam or loam	CL	A–6 or A–7
Lawet: Lc, Ld	[2]1–3	0–10	Loam	CL	A–6 or A–7
Slickspots part of Ld too variable to be rated.		10–25	Sandy clay loam	CL	A–6
		25–60	Sandy clay loam and sandy loam.	SC, CL, ML, or SM	A–4 or A–6
Leshara: Le	[2]3–5	0–15	Silt loam	CL or ML	A–4 or A–6
		15–26	Silt loam	CL or ML	A–4 or A–6
		26–60	Silt loam	CL or ML	A–4 or A–6
Longford:					
LfC	>10	0–8	Loam	CL or ML	A–4 or A–6
		8–48	Silty clay	CH	A–7
		48–60	Silty clay loam	CL	A–6 or A–7
LgD2	>10	0–9	Silty clay	CH	A–7
		9–48	Silty clay	CH	A–7
		48–60	Silty clay loam	CL	A–6 or A–7
Loretto:					
LhA	5–10	0–18	Fine sandy loam	SM or SC	A–2 or A–4
		18–46	Silt loam	CL	A–6 or A–7
		46–60	Silt loam	CL	A–6 or A–7
LkA, LkC	>10	0–14	Loam or silt loam	CL or ML	A–4 or A–6
		14–46	Loam or silt loam	CL or ML	A–4 or A–6
		46–60	Loam or silt loam	CL or ML	A–4 or A–6
Loup: Lo, Lp	[2]0–1 in Lp; 1–3 in Lo.	0–10	Fine sandy loam	SM or SC	A–2 or A–4
		10–18	Loamy fine sand	SM	A–2
		18–60	Fine sand	SP or SP–SM	A–3 or A–2
Marsh: Ma	(2)				
Too variable to be rated.					
Moody: MoA, MoC	>10	0–10	Silty clay loam	CL	A–6 or A–7
		10–41	Silty clay loam	CL or CH	A–7
		41–60	Silt loam	CL	A–6 or A–7
*Nora: NoC, NoD, NoE, NtD, NtE	>10	0–7	Silt loam	CL	A–6 or A–7
For Thurman part of NtD and NtE, see Thurman series.		7–35	Silt loam	CL	A–6 or A–7
		35–60	Silt loam	CL	A–6
Ord:					
Of	[2]3–5	0–13	Fine sandy loam	SM or SC	A–2 or A–4
		13–23	Fine sandy loam	SM or SC	A–2 or A–4
		23–60	Fine sand	SP or SP–SM	A–2 or A–3
Om	[2]3–5	0–14	Loam	ML	A–4
		14–23	Fine sandy loam	SM or SC	A–2 or A–4
		23–60	Fine sand	SP or SP–SM	A–2 or A–3

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	100	50–95	12–25	NP	NP	6.0–20	0.10–0.12	5.6–6.5	Low.
95–100	95–100	85–95	70–80	35–50	20–25	0.2–0.6	0.15–0.17	6.6–7.3	Moderate.
95–100	95–100	85–95	70–80	35–50	20–25	0.2–0.6	0.14–0.16	7.3–8.4	Moderate.
----------	100	95–100	70–95	30–40	10–20	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
----------	100	95–100	70–95	30–45	15–25	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
----------	100	95–100	80–100	30–45	15–25	0.6–2.0	0.20–0.22	6.6–7.8	Moderate.
----------	100	95–100	70–95	30–40	10–20	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
----------	100	95–100	70–95	30–40	10–25	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
----------	100	95–100	80–100	25–40	10–25	0.6–2.0	0.20–0.22	6.6–8.4	Moderate.
----------	----------	100	85–95	35–50	15–25	0.2–0.6	0.21–0.23	6.6–8.4	Moderate.
----------	----------	100	85–95	35–50	15–25	0.2–0.6	0.18–0.20	7.9–8.4	Moderate.
----------	100	95–100	55–80	25–40	11–20	0.2–0.6	0.18–0.20	7.4–8.4	Moderate.
----------	100	85–100	60–75	35–50	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
----------	100	80–100	50–60	25–40	15–25	0.2–0.6	0.16–0.18	7.9–8.4	Moderate.
----------	100	70–100	40–60	<35	5–20	0.2–2.0	0.15–0.17	6.6–8.4	Moderate.
----------	100	90–100	70–95	20–40	5–20	0.6–2.0	0.22–0.24	6.6–7.8	Moderate.
----------	100	90–100	70–95	20–40	5–20	0.6–2.0	0.20–0.22	7.4–8.4	Moderate.
----------	100	90–100	70–95	20–40	5–15	0.6–2.0	0.20–0.22	6.6–8.4	Moderate.
----------	100	85–95	60–75	20–40	5–25	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
----------	100	95–100	95–100	50–70	25–40	0.06–0.2	0.11–0.13	6.1–7.3	High.
----------	100	95–100	85–100	30–50	11–25	0.2–0.6	0.18–0.20	6.6–7.8	Moderate.
----------	100	95–100	95–100	50–65	25–35	0.06–0.2	0.12–0.14	5.6–6.5	High.
----------	100	95–100	95–100	50–70	25–40	0.06–0.2	0.11–0.13	6.1–7.3	High.
----------	100	95–100	85–100	30–50	11–25	0.2–0.6	0.18–0.20	6.6–7.8	Moderate.
----------	100	75–95	30–50	<25	<10	2.0–6.0	0.16–0.18	5.6–6.5	Low.
----------	100	90–100	75–95	30–45	11–25	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
----------	100	95–100	90–100	30–45	11–25	0.6–2.0	0.20–0.22	6.6–8.4	Moderate.
----------	100	85–95	60–85	20–40	5–20	0.6–2.0	0.20–0.23	5.6–7.3	Moderate.
----------	100	85–95	60–85	20–40	5–20	0.6–2.0	0.18–0.21	6.6–7.3	Moderate.
----------	100	85–95	60–85	20–40	5–20	0.6–2.0	0.18–0.21	6.6–8.4	Moderate.
----------	100	75–95	30–50	<25	<10	2.0–6.0	0.16–0.18	6.1–7.8	Low.
----------	100	70–95	12–35	NP	NP	6.0–20	0.09–0.11	6.6–7.8	Low.
----------	100	70–95	3–12	NP	NP	6.0–20	0.05–0.07	6.6–7.8	Low.
----------	----------	100	95–100	35–50	15–25	0.6–2.0	0.21–0.23	6.1–7.3	Moderate.
----------	----------	100	95–100	41–55	20–30	0.6–2.0	0.18–0.20	6.1–7.3	Moderate to high.
----------	100	95–100	95–100	30–45	15–25	0.6–2.0	0.20–0.22	7.4–8.4	Moderate.
----------	100	95–100	75–100	30–45	11–20	0.6–2.0	0.22–0.24	6.6–7.3	Moderate.
----------	100	95–100	90–100	35–45	15–25	0.6–2.0	0.20–0.22	6.6–8.4	Moderate.
----------	100	95–100	95–100	30–40	11–20	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
100	100	75–95	30–50	<25	<10	2.0–6.0	0.16–0.18	6.6–7.8	Low.
100	100	75–95	25–45	<25	<10	2.0–6.0	0.15–0.17	6.6–7.8	Low.
100	100	70–95	3–12	NP	NP	6.0–20	0.05–0.07	6.6–7.8	Low.
100	100	85–95	51–80	20–40	<10	0.6–2.0	0.20–0.22	6.6–7.8	Low.
100	100	75–95	25–45	<25	<10	2.0–6.0	0.15–0.17	6.6–8.4	Low.
100	100	70–95	3–12	NP	NP	6.0–20	0.05–0.07	6.6–7.8	Low

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Feet	*Inches*			
Ortello:					
OrA, OrC, OsA	>10; 5–10 un OsA.	0–19	Fine sandy loam	SM or SC	A–2 or A–4
		19–26	Fine sandy loam	SM	A–2 or A–4
		26–60	Loamy fine sand	SM or SP–SM	A–2
OtA	5–10	0–12	Loam	ML	A–4
		12–26	Fine sandy loam	SM	A–2 or A–4
		26–60	Loamy fine sand	SM or SP–SM	A–2
Orwet: Ou	[2]1–3	0–18	Loam or fine sandy loam	SM or ML	A–4 or A–6
		18–24	Loamy sand	SM or SP–SM	A–2
		24–60	Sand	SP, SP–SM, or SM	A–2 or A–3
Ovina:					
OvA, Ox	3–5	0–20	Fine sandy loam	SM or SC	A–2 or A–4
Slickspots part of Ox too variable to be rated.		20–27	Fine sandy loam	SM or SC	A–2 or A–4
		27–60	Loamy fine sand	SM or SP–SM	A–2 or A–3
OwA	3–5	0–12	Loam	ML	A–4
		12–27	Fine sandy loam	SM or SC	A–2 or A–4
		27–60	Loamy fine sand	SM or SP–SM	A–2 or A–3
Paka:					
PaD	>10	0–15	Sandy loam and loam	SM or SC	A–2 or A–4
		15–28	Clay loam	CL	A–6 or A–7
		28–60	Silty clay loam and silt loam.	CL	A–6 or A–7
PkD	>10	0–7	Sandy clay loam	SC or CL	A–6 or A–7
		7–35	Clay loam	CL	A–6 or A–7
		35–60	Silty clay loam and silt loam.	CL	A–6 or A–7
Sandy alluvial land: Sx Too variable to be rated.	(2)				
Silty alluvial land: Sy Too variable to be rated.	(2)				
Simeon: SzD	>10	0–9	Sandy loam	SM or SC	A–2 or A–4
		9–13	Loamy sand	SM or SP–SM	A–2 or A–3
		13–60	Medium and coarse sand	SP or SP–SM	A–3
Slickspots Mapped only in complexes with Clamo, Lawet, and Ovina soils. Too variable to be rated.	[2]2–5				
*Thurman: ThA, ThC, TmA, TnD, TvC For Valentine part of TvC, see Valentine series.	>10; 5–10 in TmA.	0–15	Loamy fine sand	SM or SP–SM	A–2 or A–3
		15–19	Loamy fine sand	SM or SP–SM	A–2 or A–3
		19–60	Fine sand	SP–SM or SP	A–3 or A–2
Trent: Tw	[2]5–10	0–21	Silty clay loam	CL	A–7 or A–6
		21–55	Silty clay loam	CL	A–7 or A–6
		55–60	Silt loam	CL	A–6
*Valentine: VaE, VtE For Thurman part of VtE, see Thurman series.	>10	0–5	Fine sand	SM or SP–SM	A–2 or A–3
		5–60	Fine sand	SP or SP–SM	A–3
Wet alluvial land: Wx Too variable to be rated.	[2]0–1				

[1] NP = Nonplastic.

significant to engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
100	100	75–95	25–45	<25	<10	2.0–6.0	0.16–0.18	6.1–6.5	Low.
100	100	75–95	25–45	<25	<10	2.0–6.0	0.15–0.17	6.1–7.3	Low.
100	100	70–95	10–30	NP	NP	6.0–20	0.08–0.10	6.1–7.3	Low.
100	100	85–95	51–80	20–40	<10	0.6–2.0	0.20–0.22	6.1–7.3	Low.
100	100	75–95	30–50	<25	<10	2.0–6.0	0.15–0.17	6.1–7.3	Low.
100	100	70–95	10–30	NP	NP	6.0–20	0.08–0.10	6.1–7.3	Low.
100	100	85–95	36–55	20–40	<15	0.6–6.0	0.16–0.22	7.9–8.4	Low.
100	100	70–95	10–30	NP	NP	6.0–20	0.09–0.11	6.6–7.8	Low.
100	100	70–95	3–15	NP	NP	6.0–20	0.05–0.07	6.6–7.8	Low.
100	100	75–95	30–50	<25	<10	2.0–6.0	0.16–0.18	6.1–7.3	Low.
100	100	75–95	30–50	<25	<10	2.0–6.0	0.15–0.17	6.6–7.3	Low.
100	100	70–95	8–20	NP	NP	6.0–20	0.08–0.10	6.6–7.8	Low.
100	100	85–95	51–80	20–40	<10	0.6–2.0	0.20–0.22	6.6–7.8	Low.
100	100	75–95	30–50	<25	<10	2.0–6.0	0.15–0.17	6.6–7.8	Low.
100	100	70–95	8–20	NP	NP	6.0–20	0.08–0.10	6.6–7.8	Low.
----------	100	60–85	30–50	<25	<10	2.0–6.0	0.13–0.15	6.1–6.5	Low.
----------	100	90–100	70–80	30–45	11–25	0.2–0.6	0.15–0.17	6.1–7.3	Moderate.
----------	100	95–100	85–100	30–45	11–25	0.2–2.0	0.18–0.20	7.4–8.4	Moderate.
----------	100	80–90	36–55	30–45	11–25	0.2–0.6	0.18–0.20	6.1–7.3	Moderate.
----------	100	90–100	70–80	30–45	11–25	0.2–0.6	0.15–0.17	6.1–7.3	Moderate.
----------	100	95–100	85–95	30–45	11–25	0.2–0.6	0.18–0.20	7.4–8.4	Moderate.
99–100	99–100	60–70	30–40	<25	<10	2.0–6.0	0.13–0.15	6.1–6.5	Low.
99–100	99–100	51–75	8–25	NP	NP	6.0–20	0.08–0.11	6.1–6.5	Low.
99–100	99–100	51–70	2–10	NP	NP	6.0–20	0.04–0.06	6.1–7.3	Low.
----------	100	80–95	5–20	NP	NP	6.0–20	0.10–0.12	5.6–6.5	Low.
----------	100	75–95	8–25	NP	NP	6.0–20	0.09–0.11	5.6–6.5	Low.
----------	100	75–90	3–12	NP	NP	6.0–20	0.05–0.07	5.6–7.3	Low.
----------	100	95–100	85–100	35–50	20–30	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
----------	100	95–100	85–100	30–45	11–25	0.6–2.0	0.18–0.20	6.1–7.3	Moderate.
----------	100	90–100	70–100	25–35	11–20	0.6–2.0	0.20–0.22	6.6–8.4	Low to moderate.
----------	100	75–95	5–20	NP	NP	6.0–20	0.07–0.09	5.6–6.5	Low.
----------	100	80–99	2–10	NP	NP	6.0–20	0.05–0.07	5.6–7.3	Low.

[2] Subject to flooding.

TABLE 6.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in for referring to other series that

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
Bazile: BaA, BbA, BbC, BcA, BcC, BdA.	Slight if tile is placed at contact of sandy material.[2]	Severe: rapid permeability below depth of 27 inches.[2]	Severe: sand below depth of about 27 inches; vertical cuts subject to caving.	Slight	Severe: rapid permeability in sand below depth of about 27 inches.[2]	Slight: sand subject to blowing in cut areas.
Betts: BeD2	Moderate: moderate permeability.	Moderate where slopes are less than 7 percent. Severe where slopes are more than 7 percent: dikes needed on steeper slopes.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent: clay loam texture.	Moderate: moderate shrink-swell potential.	Moderate: fair cover soil; clay loam texture; moderate permeability.	Moderate: moderate shrink-swell potential; slopes of 3 to 11 percent.
Blown-out land: Bn.	Slight[2]	Severe: rapid permeability.[2]	Severe: sand texture; subject to caving.	Slight	Severe: rapid permeability; poor cover soil; fine sand texture.[2]	Moderate where slopes are less than 8 percent. Severe where slopes are more than 8 percent.
*Boelus: BoA, BoC. For Loretto part, see Loretto series.	Moderate: moderate permeability below depth of 2 feet.	Moderate: moderate permeability.	Slight	Moderate: moderate to low shrink-swell potential; hazard of frost action.	Slight	Slight: subject to water erosion and soil blowing; hazard of frost action.
Butler: Bt	Severe: slow permeability.	Slight	Severe: wet; subject to flooding.	Severe: subject to flooding; high shrink-swell potential; subject to frost action.	Moderate to severe: subject to flooding; wet in spring; poor cover soil.	Severe: subject to flooding; high shrink-swell potential; subject to frost action.
Cass: Ca, Cb	Severe: subject to flooding.[2]	Severe: moderately rapid permeability; subject to flooding.[2]	Severe: sand in lower part; vertical cuts subject to caving.	Severe: subject to flooding.	Severe: subject to flooding.[2]	Moderate: subject to flooding.

engineering properties of the soils

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

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Good: A-3 material below depth of 27 inches.	Fair: fine sand below depth of 27 inches has limited use because of poor gradation.	Fair: 8 to 16 inches of suitable material.	High seepage below depth of 27 inches.	Good compaction characteristics.	Well drained; all features favorable.	Moderate surface intake rate; sand at depth of about 27 inches; moderately slow permeability in subsoil; moderate available water capacity.	Nearly level to gently sloping.
Fair: moderate shrink-swell potential; needs compaction control.	Unsuited: sand not available.	Poor: suitable material too thin.	Low seepage; moderately sloping.	Low permeability when compacted; good compaction characteristics.	Well drained	Gently sloping to moderately sloping; moderately low surface intake rate; moderate permeability in subsoil; high available water capacity; hazard of water erosion.	Gently sloping to moderately sloping; hazard of water erosion.
Good to fair: compaction easily obtained; subject to soil blowing.	Poor: gradation provides very limited use.	Poor: low fertility; coarse texture.	High seepage because of rapid permeability.	High permeability when compacted.[3]	Excessively drained; all features favorable.	Rapid permeability; subject to severe soil blowing.[3]	([3]).
Fair to good: moderate shrink-swell potential.	Unsuited: sand not available.	Poor to a depth of 2 feet, fair below.	Moderate seepage.	Fair compaction characteristics; low permeability below depth of 2 feet when compacted.	Well drained; all features favorable.	Nearly level to gently sloping; high surface intake rate; moderate permeability in subsoil; high available water capacity; subject to water erosion and soil blowing.	Nearly level to gently undulating; subject to soil blowing.
Poor: high shrink-swell potential; subject to frost action; compaction control difficult.	Unsuited: sand not available.	Fair: silty clay loam surface layer 8 to 16 inches thick.	Low seepage; suited to dugouts with surface water supply.	Poor compaction characteristics; low permeability when compacted.	Slow permeability; subject to flooding.	Nearly level; very low surface intake rate; slow permeability in subsoil; moderate available water capacity; needs adequate surface drainage.	Nearly level.[3]
Good	Poor: limited use because of fines and gradation of sand; coarse material at depth of about 4 feet.	Good: subject to soil blowing at source.	Moderate to high seepage below depth of 20 inches.	Low permeability when compacted.	Well drained; subject to rare flooding.	Nearly level; moderate available water capacity; rapid surface intake rate; moderately rapid permeability in subsoil; rare flooding; subject to soil blowing.	Nearly level.[3]

TABLE 6.—*Interpretations of*

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
*Clamo: Cc, Cd. For Slickspots part of Cd, see Slickspots.	Severe: slow permeability; water table at depth of 3 to 8 feet.	Slight if lagoon is located above water table.	Severe: water table interferes, depending on depth of excavation.	Severe: subject to flooding; high shrink-swell potential; water table at depth of 3 to 8 feet.	Severe: water table at depth of 3 to 8 feet; poor cover soil; area method feasible in places.	Severe: subject to flooding; high shrink-swell potential; corrosion of metal pipe possible.
Clarno: CeC, CeD.	Moderate where slopes are less than 8 percent: moderate permeability. Severe where slopes are more than 8 percent.	Moderate where slopes are less than 7 percent: moderate permeability. Severe where slopes are more than 7 percent.	Slight	Moderate: moderate shrink-swell potential; slopes of more than 8 percent in CeD; subject to frost action.	Slight: fair cover soil.	Moderate: moderate shrink-swell potential; slopes of more than 8 percent in CeD.
Colo: Cf, Co	Severe: moderately slow permeability; subject to flooding; water table at depth of 3 to 8 feet.	Severe: location of water table determines depth of lagoon excavation; subject to flooding.	Moderate: water table at depth of 3 to 8 feet; subject to flooding.	Severe: subject to flooding; water table at depth of 3 to 8 feet; subject to frost action.	Severe: water table at depth of 3 to 8 feet.	Severe: subject to frost action and flooding.
*Crofton: CrC2, CrE2, CrF, CsC2, CsD2, CsE2. For Nora part of CsC2, CsD2, and CsE2, see Nora series.	Moderate where slopes are less than 15 percent: moderate permeability. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent: moderate permeability; needs sealing. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent: vertical cuts stable if soil is dry.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight: area type landfill suited to places where slopes are steepest; good cover soil.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.
Elsmere: EaA	Severe: water table at depth of 3 to 8 feet.[2]	Severe: water table at depth of 3 to 8 feet; rapid permeability.[2]	Severe: water table at depth of 3 to 8 feet; excavations subject to caving.	Severe: water table at depth of 3 to 8 feet; excavations subject to caving; hazard of seepage.	Severe: high water table.[2]	Moderate: subject to frost action; water table at depth of 3 to 8 feet.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: high shrink-swell potential; compaction control difficult; corrosion of metal pipe possible.	Unsuited: sand not available.	Poor: poor workability because of silty clay texture.	Low seepage; water table at depth of 3 to 8 feet; suited to dugouts.	Poor compaction characteristics; low permeability when compacted.	Slow permeability; water table at depth of 3 to 8 feet; subject to flooding.	Nearly level; very low surface intake rate; slow permeability in subsoil; moderate available water capacity; subject to flooding.	Nearly level.[3]
Fair: moderate shrink-swell potential; needs compaction control.	Unsuited: sand not available.	Fair: 8 to 16 inches of suitable soil material.	Low seepage	Low permeability when compacted; fair to good compaction characteristics.	Well drained; all features favorable.	Gently sloping to moderately sloping; moderate surface intake rate; moderate permeability in subsoil; high available water capacity; hazard of water erosion; few stones.	Gently sloping to moderately sloping; hazard of water erosion; few stones.
Fair to poor: subject to frost action and flooding; needs compaction control; moderate shrink-swell potential.	Unsuited: sand not available.	Good	Low to moderate seepage; water table at depth of 3 to 8 feet; suited to dugouts.	Low permeability when compacted; fair to good compaction characteristics.	Moderately slow permeability; water table at depth of 3 to 8 feet; subject to flooding.	Nearly level; moderately slow to moderate surface intake rate; moderately slow permeability in subsoil; high available water capacity; subject to soil blowing and flooding.	Nearly level.[3]
Fair: moderate shrink-swell potential; needs compaction control.	Unsuited: sand not available.	Poor: less than 8 inches of suitable material; low fertility.	Moderate seepage.	Good compaction characteristics; needs close control; subject to consolidation on wetting and loading; erodible slopes.	Well drained; all features favorable.	Moderate surface intake rate; moderate permeability in subsoil; high available water capacity; hazard of water erosion; not suited where slopes are more than 8 percent.	Severe hazard of water erosion; low fertility; not applicable on steepest slopes.
Fair to good: soil is easily compacted; borrow areas wet in spring.	Poor: fines; limited uses because of gradation.	Poor: erodible sandy soil; low fertility.	High seepage; water table at depth of 3 to 8 feet; suited to dugouts.	High permeability when compacted; foundations subject to seepage; fair to good compaction characteristics.	Rapid permeability; water table at depth of 3 to 8 feet.	Nearly level; low available water capacity; very high surface intake rate; rapid permeability in subsoil; subject to soil blowing; somewhat poorly drained.	Nearly level.[3]

TABLE 6.—*Interpretations of*

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
Fillmore: Fm	Severe: very slow permeability; subject to ponding.	Slight if protected from ponding. Severe if ponded.	Severe: subject to ponding; poorly drained; silty clay texture in subsoil.	Severe: subject to ponding; high shrink-swell potential; subject to frost action.	Severe: subject to ponding; fair to poor cover soil; water table is relatively deep in soils of very slow permeability.	Severe: subject to ponding; high shrink-swell potential; subject to frost action.
*Hadar: HaC, HaD. For Thurman part of HaD, see Thurman series.	Severe: moderately slow permeability below depth of 2 feet.	Moderate where slopes are less than 7 percent. Severe where slopes are more than 7 percent.	Moderate: clay loam texture.	Moderate: moderate shrink-swell potential below depth of 2 feet; subject to frost action.	Slight	Moderate where slopes are less than 8 percent: subject to frost action in upper 2 feet. Severe where slopes are more than 8 percent.
Hobbs: Hb, Hc, Hd.	Moderate: moderate permeability. Severe for Hd: subject to occasional flooding.	Moderate: moderate permeability. Severe where not protected.	Severe: subject to flooding and caving.	Severe: subject to flooding and frost action.	Severe: subject to flooding.	Severe: subject to flooding and frost action.
*Hord: He, HhC. For Hobbs part of HhC, see Hobbs series.	Moderate: moderate permeability.	Moderate: moderate permeability; HhC has slopes of 0 to 7 percent.	Slight	Moderate: moderate shrink-swell potential.	Slight: good cover soil.	Moderate: subject to frost action; HhC has slopes of 0 to 7 percent.
Lamo: Lb	Severe: moderately slow permeability; subject to flooding; water table at depth of 3 to 8 feet.	Severe: subject to flooding where not protected; water table at depth of 3 to 8 feet.	Severe: subject to caving; water table at depth of 3 to 8 feet.	Severe: subject to flooding; water table at depth of 3 to 8 feet; subject to frost action.	Severe: subject to flooding; water table at depth of 3 to 8 feet.	Severe: subject to frost action; moderate shrink-swell potential.
*Lawet: Lc, Ld. For Slickspots part of Ld, see Slickspots.	Severe: moderately slow permeability; water table at a depth of 1 foot to 5 feet.	Severe: water table at a depth of 1 foot to 5 feet.	Severe: water table at a depth of 1 foot to 5 feet; subject to caving and flooding.	Severe: water table at a depth of 1 foot to 5 feet; subject to flooding, caving, and frost action.	Severe: water table at a depth of 1 foot to 5 feet.	Severe: subject to flooding and frost action; hazard of corrosion to metal pipe.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Poor: high shrink-swell potential; borrow areas wet in spring; subject to frost action.	Unsuited: sand not available.	Fair to poor: poor workability to depth of 4 feet; wet in spring.	Low seepage; suited to dugouts with surface water supply.	Fair to poor compaction characteristics; low permeability when compacted.	Very slow permeability; subject to ponding; surface drainage outlets not available in most places.	Nearly level; slow surface intake rate; slow permeability in subsoil; moderate available water capacity; subject to ponding.	Nearly level.[3]
Fair: moderate shrink-swell potential; subject to frost action.	Fair: limited sand to a depth of 2 feet.	Poor: subject to soil blowing and water erosion; medium fertility.	Low seepage below depth of 2 feet.	Medium to low permeability when compacted; susceptible to seepage to depth of 24 inches; fair to good compaction characteristics.	Well drained; all features favorable.	Gently undulating to rolling; high surface intake rate; moderately slow permeability in subsoil; moderate available water capacity; subject to soil blowing; soil in HaD not suited.	Gently undulating to rolling; subject to soil blowing; hazard of water erosion.
Fair: moderate shrink-swell potential; subject to flooding.	Unsuited: sand not available.	Good: Hd wet after flooding.	Moderate seepage.	Fair compaction characteristics; subject to water erosion.	Well drained; Hd subject to occasional flooding.	Nearly level; moderate surface intake rate; moderate permeability in subsoil; high available water capacity; subject to flooding.	Nearly level.[3]
Good to fair: moderate shrink-swell potential; subject to frost action.	Unsuited: sand not available.	Good	Moderate seepage.	Good compaction characteristics; HhC susceptible to water erosion.	Well drained; all features favorable.	Nearly level to gently sloping; moderate surface intake rate; moderate permeability in subsoil; high available water capacity; hazard of water erosion in HhC.	Nearly level to gently sloping.
Poor: subject to frost action; borrow areas wet in spring; moderate shrink-swell potential.	Unsuited: sand not available.	Fair: silty clay loam texture.	Low to moderate seepage; water table at depth of 3 to 8 feet; suited to dugouts.	Fair to good compaction characteristics; low permeability when compacted.	Moderately slow permeability; water table at depth of 3 to 8 feet; subject to flooding.	Nearly level; low surface intake rate; moderately slow permeability in subsoil; high available water capacity; subject to flooding.	Nearly level.[3]
Poor: subject to frost action; borrow areas wet; hazard of corrosion to metal pipe.	Unsuited: sand not available.	Poor: high water table.	Water table at a depth of 1 foot to 5 feet; well suited to dugouts.	Fair to good compaction characteristics; borrow areas wet.	Moderately slow permeability; water table at a depth of 1 foot to 5 feet; subject to flooding; drainage outlets not available in most places.	(3)	Nearly level.[3]

TABLE 6.—*Interpretations of*

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
Leshara: Le	Severe: water table at a depth of 3 to 8 feet; moderate permeability; subject to flooding.	Moderate to severe: subject to flooding; water table at a depth of 3 to 8 feet.	Moderate to severe: subject to caving; water table at a depth of 3 to 8 feet.	Severe: subject to flooding, caving, and frost action; water table at a depth of 3 to 8 feet.	Severe: water table at a depth of 3 to 8 feet; subject to flooding.	Moderate to severe: subject to flooding and frost action.
Longford: LfC, LgD2.	Severe: slow permeability.	Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 7 percent. Severe where slopes are more than 7 percent.	Slight	Severe: high shrink-swell potential at a depth of 1 foot to 4 feet; slow permeability.	Slight to moderate: poor cover soil above a depth of 4 feet.	Severe: high shrink-swell potential.
Loretto: LhA, LkA, LkC.	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 1 to 7 percent in LkC.	Slight	Moderate: moderate shrink-swell potential; subject to frost action.	Slight	Slight: subject to frost action.
Loup: Lo, Lp	Severe: water table at a depth of 0 to 5 feet; subject to flooding.[2] [3]	Severe: water table at a depth of 0 to 5 feet; subject to flooding.[2]	Severe: water table at a depth of 0 to 5 feet; subject to caving; fine sand underlying material.	Severe: water table at a depth of 0 to 5 feet; subject to flooding.	Severe: high water table.[2]	Severe: subject to flooding and frost action; water table at a depth of 0 to 5 feet.
Marsh: Ma	Very severe: high water table.	Very severe: high water table; subject to flooding.	Very severe: high water table; subject to flooding.	Very severe: high water table; subject to flooding.	Very severe: high water table.	Very severe: high water table; subject to flooding; susceptible to frost action.
Moody: MoA, MoC.	Moderate: moderate permeability.	Moderate limitation if soil is compacted on bottom and side slopes of lagoon: moderate permeability.	Slight	Moderate: moderate to high shrink-swell potential at a depth of 1 foot to 3.5 feet.	Moderate: silty clay loam texture in subsoil: good cover soil below a depth of 1 foot to 3.5 feet.	Moderate: moderate to high shrink-swell potential; subject to frost action.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair to poor: subject to frost action; borrow areas wet in spring; moderate shrink-swell potential.	Unsuited: sand not available.	Good to fair: wet in spring.	Moderate seepage; water table at a depth of 3 to 8 feet; suited to dugouts.	Fair compaction characteristics; low permeability when compacted; needs foundation drains in places.	Moderate permeability; water table at a depth of 3 to 8 feet; subject to flooding.	Moderate permeability; water table at a depth of 3 to 8 feet; subject to flooding.	Nearly level.[3]
Fair to poor: high shrink-swell potential; difficult compaction control.	Unsuited: sand not available.	Poor: less than 8 inches of suitable soil material; poor workability.	Low seepage	Fair to poor compaction characteristics; low permeability when compacted.	Slow permeability.	Gently sloping to moderately sloping; low surface intake rate; slow permeability in subsoil; moderate available water capacity; hazard of water erosion; LgD2 not suited.	Gently sloping to moderately sloping; hazard of water erosion.
Good to fair: subject to frost action.	Unsuited: sand not available.	Good to fair: subject to soil blowing and water erosion; 8 to 16 inches of suitable soil material.	Moderate seepage.	Fair to good compaction characteristics; medium to low permeability when compacted; erodible slopes.	Well drained; all features favorable.	Nearly level to gently sloping; low to moderately low surface intake rate; moderate permeability in subsoil; high available water capacity; subject to soil blowing and water erosion.	Nearly level to gently sloping.
Poor: subject to frost action; high water table.	Poor: fine sand; limited gradation below a depth of 18 inches.	Poor: water table at a depth of 0 to 5 feet.	Water table at a depth of 0 to 5 feet; well suited to dugouts.	Moderate to high permeability when compacted; susceptible to seepage in foundations.	Water table at a depth of 0 to 5 feet; poor ditch stability in sandy underlying soil; drainage outlets not available in most places.	(3)	Nearly level.[3]
Very poor: very poorly drained.	Unsuited: sand not available.	Very poor: very poorly drained.	Water table over surface and rarely lower than 18 inches; well suited to dugouts.	(3)	Water table over surface and rarely lower than 18 inches; tile outlets not available.	(3)	(3).
Fair: moderate to high shrink-swell potential; needs compaction control.	Unsuited: sand not available.	Fair: about 8 inches of suitable soil material.	Low to moderate seepage, depending upon depth of excavation.	Fair compaction characteristics; subject to consolidation upon wetting and loading of foundation.	Well drained; all features favorable.	Nearly level to gently sloping; moderately low surface intake rate; slow to moderate permeability in subsoil; high available water capacity; subject to water erosion.	Nearly level to sloping.

TABLE 6.—*Interpretations of*

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
*Nora: NoC, NoD, NoE, NtD, NtE. For Thurman part of NtD and NtE, see Thurman series.	Moderate where slopes are less than 15 percent: moderate permeability. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent: moderate permeability. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate: moderate shrink-swell potential; subject to frost action; hazard of water erosion.	Slight: good cover soil.	Moderate where slopes are less than 8 percent: moderate shrink-swell potential; subject to frost action; hazard of water erosion. Severe where slopes are more than 8 percent.
Ord: Of, Om	Severe: water table at a depth of 3 to 8 feet; subject to flooding.[2]	Severe: water table at a depth of 3 to 8 feet; moderately rapid permeability to depth of about 2 feet and rapid permeability below; subject to occasional flooding.[2]	Severe: water table at a depth of 3 to 8 feet; subject to caving.	Severe: subject to flooding; water table at depth of 3 to 8 feet; subject to frost action.	Severe: water table at a depth of 3 to 8 feet.[2]	Severe: subject to flooding and frost action.
Ortello: OrA, OrC, OsA, OtA.	Slight[2]	Severe: moderately rapid permeability to depth of 2 feet and rapid permeability below.	Slight: subject to caving.	Slight	Severe: moderately rapid permeability; good where no ground-water pollution hazard.	Slight: subject to soil blowing.
Orwet: Ou	Severe: water table at a depth of 1 foot to 5 feet; subject to flooding.[2]	Severe: water table at a depth of 1 foot to 5 feet; rapid permeability.[2]	Severe: water table at a depth of 1 foot to 5 feet; subject to caving; sand below a depth of 18 inches.	Severe: water table at a depth of 1 foot to 5 feet; subject to flooding.	Severe: water table at a depth of 1 foot to 5 feet.[2]	Severe: subject to flooding and frost action; water table at a depth of 1 foot to 5 feet.
*Ovina: OvA, OwA, Ox. For Slickspots part of Ox, see Slickspots.	Severe: water table at a depth of 3 to 8 feet.[2]	Severe: water table at a depth of 3 to 8 feet; moderately rapid permeability.[2]	Severe: water table at a depth of 3 to 8 feet; subject to caving.	Moderate: water table at a depth of 3 to 8 feet; subject to caving and wall seepage; subject to frost action.	Severe: water table at a depth of 3 to 8 feet; moderately rapid permeability.[2]	Severe: subject to frost action; hazard of corrosion to metal pipe.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential; subject to frost action; hazard of water erosion for borrow and fill slopes; foundations subject to large consolidation when wetted and loaded.	Unsuited: sand not available.	Fair to poor: 8 to 16 inches of suitable material on gently sloping areas; limited soil and hazard of water erosion on strongly sloping areas.	Moderate seepage.	Fair compaction characteristics; subject to consolidation upon wetting and loading; erodible slopes.	Well drained; all features favorable.	Gently sloping to strongly sloping; moderate surface intake rate; moderate permeability in subsoil; high available water capacity; hazard of water erosion; not suitable for NoE and NtE.	Gently sloping to strongly sloping; hazard of water erosion.
Poor: subject to frost action; borrow areas wet in spring.	Poor: limited uses because of gradation; sand below depth of 2 feet in most places.	Fair: 8 to 16 inches of suitable soil material; borrow areas wet in spring.	Moderate to high seepage; water table at a depth of 3 to 8 feet; suited to dugouts.	Moderate to high permeability when compacted; embankments and foundation areas subject to seepage.	Moderately rapid permeability; water table at a depth of 3 to 8 feet; subject to flooding.	Nearly level; moderately high surface intake rate; moderately rapid permeability in subsoil; moderate available water capacity; subject to soil blowing and flooding.	Nearly level.[3]
Good: needs confinement for stable slopes.	Poor: limited uses because of gradation.	Good to fair: sandy and subject to soil blowing in places.	High seepage below a depth of 2 feet.	Medium permeability when compacted; good workability; erodible slopes.	Well drained; all features favorable.	Nearly level to gently undulating; moderately high surface intake rate; rapid permeability in subsoil; moderate available water capacity; subject to water erosion and soil blowing.	Nearly level to gently undulating; subject to soil blowing and water erosion.
Poor: subject to frost action and flooding; borrow areas wet in spring.	Poor: limited use because of poor gradation.	Poor: water table at a depth of 1 foot to 5 feet.	Moderate seepage; water table at a depth of 1 foot to 5 feet; well suited to dugouts.	Moderate to high permeability when compacted; subject to seepage in both embankment and foundation areas.	Water table at a depth of 1 foot to 5 feet; poor ditch stability in sand; drainage outlets not available in most places.	Water table at a depth of 1 foot to 5 feet.[3]	Nearly level.[3]
Poor: subject to frost action; borrow areas wet in spring; hazard of corrosion to metal.	Poor: limited use because of poor gradation.	Fair: 12 inches of suitable soil material; sandy; subject to soil blowing.	Moderate to high seepage; water table at a depth of 3 to 8 feet; suited to dugouts.	Low to medium permeability when compacted; subject to seepage in fills and foundations.	Moderately rapid permeability; water table at a depth of 3 to 8 feet.	Nearly level; moderately rapid surface intake rate; moderately rapid permeability in subsoil; moderate available water capacity; subject to soil blowing.	Nearly level.[3]

TABLE 6.—*Interpretations of*

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
Paka: PaD, PkD	Severe: moderately slow permeability.	Slight	Slight	Moderate: moderate shrink-swell potential; subject to frost action.	Slight: good cover soil.	Slight: subject to frost action.
Sandy alluvial land: Sx. Properties too variable to rate. Severe limitations because of flooding for most uses.						
Silty alluvial land: Sy. Properties too variable to rate. Severe limitations because of flooding for most uses.						
Simeon: SzD	Slight if there is no hazard of pollution to ground-water.[2]	Severe: rapid permeability.[2]	Severe: medium sand below a depth of about 13 inches; hazard of caving.	Slight: subject to water erosion and soil blowing.	Severe: rapid permeability. Slight where leachate will not pollute underground water supply.[2]	Slight: subject to water erosion and soil blowing.
Slickspots Mapped only with Clamo, Lawet, and Ovina soils.	Severe: high water table; slow permeability.	Severe: high water table.	Severe: somewhat poorly drained and poorly drained; high water table.	Severe: occasional flooding; high water table.[3]	Severe: water table at a depth of 2 to 8 feet.	Severe: subject to flooding; highly susceptible to frost action; possible corrosion to metal pipe.
*Thurman: ThA, ThC, TmA, TnD, TvC. For Valentine part of TvC, see Valentine series.	Slight where slopes are less than 8 percent if there is no hazard of ground-water pollution. Moderate where slopes are more than 8 percent.	Severe: rapid permeability.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent: excavations need sloped banks; vertical excavations subject to caving.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent: subject to water erosion and soil blowing.	Severe: rapid permeability; fair to poor cover soil; subject to water erosion and soil blowing.[2]	Slight where slopes are less than 8 percent: subject to water erosion and soil blowing. Moderate where slopes are more than 8 percent.

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential; subject to frost action.	Unsuited: sand not available.	Fair: 8 to 16 inches of suitable material; subject to water erosion.	Low to moderate seepage; gently sloping to moderately sloping.	Low permeability when compacted; fair to good compaction characteristics.	Well drained; all features favorable.	Gently sloping to moderately sloping; moderate surface intake rate; moderately slow permeability in subsoil; high available water capacity; subject to water erosion and soil blowing.	Gently sloping to moderately sloping; subject to soil blowing and water erosion.
Good: cut and fill slopes are subject to water erosion and soil blowing.	Fair: limited use because of poor gradation.	Poor: borrow sites subject to water erosion and soil blowing; low fertility; droughty.	High seepage; gently sloping to moderately sloping.	Moderate to high permeability when compacted; highly erodible slopes; high permeability in foundation soils.	Excessively drained; all features favorable.	(3) ----------	(3).
Poor: highly susceptible to frost action.	Unsuited: sand not available.	Poor: saline-alkali soil; low fertility; toxic to many plants.[3]	Properties too variable to be rated.	Properties too variable to be rated.	Water table at a depth of 2 to 8 feet; occasional flooding; affected by salinity and alkalinity.	Saline-alkali soil [3]	Nearly level.[3]
Good: cut and fill slopes are subject to water erosion and soil blowing.	Poor: limited use because of gradation.	Poor: subject to soil blowing and water erosion; low fertility.	High seepage	High permeability when compacted; high vertical permeability in foundation soils.	Somewhat excessively drained; all features favorable.	Nearly level to gently rolling; low available water capacity; very high surface intake rate; rapid permeability in subsoil; subject to soil blowing; TnD and TvC not suited because of slope.	Nearly level to gently rolling; subject to water erosion and soil blowing.

TABLE 6.—*Interpretations of*

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
Trent: Tw	Moderate: moderate permeability; subject to flooding.	Moderate: moderate permeability.	Moderate: subject to flooding; vertical excavations subject to caving.	Severe: subject to flooding; seepage in basements; subject to frost action.	Moderate: subject to flooding; suited where no ground-water pollution hazard.	Moderate: subject to flooding and frost action.
*Valentine: VaE, VtE. For Thurman part of VtE, see Thurman series.	Slight where slope is less than 8 percent. Moderate where slope is more than 8 percent.[2]	Severe: rapid permeability.[2]	Slight where slope is less than 8 percent. Moderate where slope is more than 8 percent: vertical excavations subject to caving; excavations need sloped banks.	Slight where slope is less than 8 percent. Moderate where slope is more than 8 percent.	Severe: rapid permeability; poor cover soil; subject to soil blowing.[2]	Slight where slope is less than 8 percent. Moderate where slope is more than 8 percent.
Wet alluvial land: Wx.	Severe: high water table; subject to occasional flooding.	Severe: high water table; subject to flooding.	Severe: very poorly drained; water table above depth of 30 inches.	Severe: water table above depth of 30 inches.	Severe: water table above depth of 30 inches; subject to occasional flooding.	Severe: very poorly drained; highly susceptible to frost action.

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

TABLE 7.—*Engineering*

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

Soil name and location	Parent material	Report No S-67-	Depth
			Inches
Betts loam: 0.4 mile W. and 300 feet N. of SE. corner sec. 8, T. 27 N., R. 2 W. (Modal)	Glacial till.	1816 1817 1818	0–6 6–18 18–40
Boelus loamy fine sand: 0.25 mile E. and 0.1 mile N. of SW. corner sec. 27, T. 26 N., R. 3 W. (Less depth to subsoil than modal)	Eolian sand over Peoria Loess.	1813 1814 1815	0–7 18–33 47–60
Crofton silt loam: 250 feet E. and 140 feet S. of NW. corner sec. 7, T. 27 N., R. 1 W. (Modal)	Peoria Loess.	1786 1787 1788	0–6 6–21 21–60

engineering properties of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Roadfill	Sand	Topsoil	Pond reservoir areas	**Embankments, dikes, and levees**	**Drainage for crops and pasture**	**Irrigation**	**Terraces and diversions**
Fair: moderate shrink-swell potential; subject to frost action; borrow areas wet in spring.	Unsuited: sand not available.	Fair: silty clay loam surface layer; high fertility.	Low to moderate seepage.	Fair compaction characteristics; low permeability when compacted; needs foundation drainage in places.	Moderately well drained; subject to flooding.	Nearly level; moderately low surface intake rate; moderate permeability in subsoil; high available water capacity; subject to flooding.	Nearly level.[3]
Good: cut and fill slopes subject to severe soil blowing.	Poor: limited use because of gradation.	Poor: fine sand texture; low fertility.	High seepage.	High permeability when compacted; erodible slopes.	Excessively drained; fine sand texture; rapid permeability; all features favorable.	([3]) ----------	Gently undulating to rolling; subject to soil blowing; fine sand texture.
Poor: very poorly drained; highly susceptible to frost action.	Unsuited: sand not available.	Poor: very poorly drained.	Low to moderate seepage; water table within depth of 30 inches; well suited to dugouts.	Medium to low shear strength; medium to high compressibility; fair to poor compaction characteristics.	Water table within depth of 30 inches; tile outlets not available in most places; subject to occasional flooding.	Water table within depth of 30 inches.[3]	Nearly level.[3]

[2] Pollution to ground water may be a hazard because of moderately rapid or rapid permeability.
[3] This practice or structure generally not suited on this soil because of topography, position, or soil characteristics.

test data

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

Mechanical analysis[1]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHTO[2]	Unified[3]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
									Percent			
[4]97	95	88	80	65	59	44	31	24	35	17	A-6(9)	CL
100	99	93	88	76	71	60	39	31	42	24	A-7-6(14)	CL
[4]97	96	90	85	73	67	53	37	30	42	25	A-7-6(14)	CL
----------	100	93	71	22	17	11	6	5	[5]NP	[5]NP	A-2-4(0)	SM
----------	100	99	94	83	74	43	31	27	37	18	A-6(11)	CL
----------	----------	----------	100	99	90	48	32	25	41	22	A-7-6(13)	CL
----------	100	98	98	95	84	44	30	24	35	13	A-6(9)	CL
----------	100	99	99	97	86	45	30	24	36	15	A-6(10)	CL
----------	----------	----------	100	98	87	46	29	20	35	14	A-6(10)	CL

TABLE 7.—*Engineering*

Soil name and location	Parent material	Report No S–67–	Depth
			Inches
Elsmere loamy fine sand: 0.3 mile W. and 100 feet N. of SE. corner sec. 36, T. 26N, R. 4 W. (Modal)	Eolian sand grading to alluvial sand.	1792	0–7
		1793	7–15
		1794	28–60
Hobbs silt loam: 0.2 mile E. and 25 feet N. of SW. corner sec. 7, T. 26 N., R. 1 W. (modal)	Silty alluvium.	1804	0–7
		1805	20–30
		1806	37–54
Lamo silty clay loam: 950 feet S. of NW. corner sec. 9, T. 26 N., R. 2 W. (Modal)	Silty alluvium.	1801	0–7
		1802	17–36
		1803	46–60
Lawet loam: 0.4 mile S. and 130 feet W. of NE. corner sec. 19, T. 27 N., R. 3 W. (Modal)	Loamy alluvium.	1798	0–10
		1799	18–25
		1800	31–55
Moody silty clay loam: 0.3 mile S. and 340 feet W. of NE. corner sec. 18, T. 28 N., R. 3 W. (subsoil finer textured than modal)	Peoria Loess.	1807	0–7
		1808	19–33
		1809	41–50
Nora silt loam: 0.25 mile E. and 435 feet N. of SW. corner sec. 4, T. 27 N., R. 1 W. (Modal)	Peoria Loess.	1810	0–7
		1811	7–16
		1812	35–48
Ortello fine sandy loam: 0.45 mile N. and 210 feet W. of SE. corner sec. 11, T. 27 N., R. 4 W. (Modal)	Eolian sand.	1789	0–7
		1790	7–19
		1791	26–60
Orwet loam: 570 feet W. and 240 feet S. of NE. corner sec. 30, T. 27 N., R. 3 W. (Coarser textured surface than modal)	Sandy alluvium.	1795	0–18
		1796	18–24
		1797	24–46
Thurman loamy fine sand: 0.4 mile S. and 150 feet W. of NE. corner sec. 12, T. 26 N., R. 4 W. (Modal)	Eolian sand.	1783	0–7
		1784	7–15
		1785	19–60
Valentine fine sand: 725 feet W. and 125 feet N. of SE. corner sec. 6, T. 25 N., R. 3 W. (Modal)	Eolian sand.	1781	0–5
		1782	5–60

[1] Mechanical analyses according to the AASHTO Designation T 88–70 (*1*). Results by this procedure frequently may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*9*), used by the Soil Conservation Service, the Department of Defense, and other agencies; 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 or for the support of structures other than highways. Soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are divided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are divided on the basis of the plasticity index. Nonplastic classes are

test data—Continued

Mechanical analysis[1]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHTO[2]	Unified[3]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
									Percent			
	100	88	65	14	11	9	6	4	NP	NP	A-2-4(0)	SM
	100	88	66	16	12	8	6	4	NP	NP	A-2-4(0)	SM
	100	89	65	7	5	5	4	4	NP	NP	A-3(0)	SP-SM
	100	98	90	75	68	40	26	20	34	15	A-6(10)	CL
	100	97	90	77	70	52	31	22	39	18	A-6(11)	CL
		100	99	96	91	45	28	24	38	20	A-6(12)	CL
		100	98	92	84	52	31	27	44	21	A-7-6(13)	CL
		100	98	90	83	52	33	26	43	24	A-7-6(14)	CL
	100	99	92	66	56	35	22	18	31	15	A-6(8)	CL
	100	97	88	70	61	43	31	22	46	20	A-7-6(12)	CL
	100	95	81	56	51	43	33	27	33	18	A-6(7)	CL
	100	93	80	54	50	41	32	25	22	10	A-4(4)	CL
			100	98	92	62	43	34	47	21	A-7-6(14)	CL
			100	98	93	61	44	37	51	29	A-7-6(18)	CH
	100	99	99	99	95	52	31	24	41	22	A-7-6(13)	CL
	100	97	91	83	76	45	31	26	37	14	A-6(10)	CL
	100	99	97	93	86	38	27	23	41	18	A-7-6(11)	CL
	100	99	99	98	93	49	30	24	36	15	A-6(10)	CL
	100	91	71	31	26	16	10	7	NP	NP	A-2-4(0)	SM
	100	91	72	32	26	17	9	6	NP	NP	A-2-4(0)	SM
	100	92	68	15	13	9	8	7	NP	NP	A-2-4(0)	SM
	100	91	70	40	34	24	16	12	33	9	A-4(1)	SM
	100	82	58	19	15	11	8	7	NP	NP	A-2-(0)	SM
	100	85	56	11	9	7	5	5	NP	NP	A-2-4(0)	SP-SM
	100	91	63	10	8	5	4	3	NP	NP	A-3(0)	SP-SM
	100	83	53	15	13	8	5	4	NP	NP	A-2-4(0)	SM
	100	81	52	9	8	6	5	4	NP	NP	A-3(0)	SP-SM
	100	86	65	15	11	7	5	4	NP	NP	A-2-4(0)	SM
	100	96	79	5	5	5	5	4	NP	NP	A-3(0)	SP-SM

[2]Based on AASHTO Designation M 145-66 (*1*).
[3]Based on Unified soil classification system (*9*).
[4]Mechanical analysis was also made using 1-inch, 3/4-inch, and 3/8-inch sieves. Percentage passing sieve was 100, 99, and 98, respectively.
[5]NP means nonplastic.

ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups that range from A-1 to A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b; A-2-4, A-2-5, A-2-6, A-2-7; and 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, is shown in table 5 for all soils mapped in the county.

Soil properties significant to engineering

Several estimated soil properties significant to engineering are shown in table 5. These estimates are made by layers of soil 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 seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 5 in the standard terms used by the U.S. Department of Agriculture. These terms are based on the percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary at the back of this survey.

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 state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5 but in table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

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

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

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

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils that have *high* shrink-swell potential are the most hazardous. Shrink-swell potential is not indicated for organic soils or for certain soils that shrink markedly on drying but do not swell quickly when rewetted.

Depth to bedrock is not shown, because bedrock in Pierce County is below a depth of 60 inches.

Engineering interpretations of the soils

The interpretations in table 6 are based on the estimated engineering properties of soils shown in table 5, on test data for soils in this county and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Pierce County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for ponds and reservoirs, embankments, drainage for crops and pasture, irrigation, and terraces and diversions. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use or, in other words, that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special design, or intensive maintenance. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *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 natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that

the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope; and if the floor needs to be leveled, depth to bedrock is also important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 6, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. 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 refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 6 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* and *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

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 of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

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

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

Sand is used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand 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 material, 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 ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and the content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

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

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

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

Irrigation of a soil (*8*) is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; texture; content of stones; accumulation of salts and alkali; depth of rooting zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in a fragipan or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table.

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

Soil test data

Table 7 contains engineering test data for some of the major soils in Pierce County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the formation of soils in Pierce County. The second explains the system of soil classification and places each soil series in some of the categories of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that 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, but some time is always required for differentation of soil horizons. Usually, a long time is required for the development of distinct horizons.

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

Parent material

Parent material is the unconsolidated mineral material from which a soil forms. It determines the chemical and mineralogical composition of the soil. In Pierce County the soils formed in eight kinds of parent material. In age of deposition from the oldest to the youngest, they are glacial till, glacial outwash, Pleistocene silt, Loveland Loess, Peoria Loess, eolian sand, colluvium, and alluvium.

Glacial till is part of the upland landscape for the first few miles east of the North Fork Elkhorn River. Small areas of this parent material are exposed on lower slopes adjacent to the west side of the North Fork Elkhorn River between Breslau and Pierce. Glacial till is firm, massive, light-gray loamy material that has many yellowish-brown and strong-brown relict mottles. It is calcareous and contains seams and masses of soft lime. A few stones and pebbles occur throughout the glacial till deposit. Betts, Clarno, and the lower part of the profile of Hadar soils formed in this material.

Glacial outwash is exposed as small areas on hillsides or ridgetops, above the glacial till deposits, and near Plainview. It is loose, single grained, pale-brown medium and coarse sand. A few small pebbles occur throughout this deposit. Simeon soils formed in this parent material.

Pleistocene silt is of minor occurrence and is at the surface only in the northwestern part of Pierce County. It is exposed mainly on northwest-facing slopes. It is friable, massive, light olive-gray or light-gray silty material. Paka soils formed in this parent material.

Loveland Loess is brownish, reddish, or pinkish silty to clayey material. Longford soils formed in this parent material. Small areas of this soil are near Plainview and are associated with the soils that formed in glacial till.

Peoria Loess is the parent material in which most silty soils formed in the uplands. The loess is friable, massive, very pale brown silty material. It is calcareous and contains a few lime concretions. The Butler, Crofton, Fillmore, Moody, and Nora soils formed in this parent material. The upper part of Bazile silt loam and the lower part of Loretto and Boelus soils also formed in this loess. Hord and Trent soils formed in Peoria Loess. They are in swales, on high stream terraces, and on uplands.

Eolian sand is the most recently deposited parent material of upland soils. It is also the most extensive parent material in Pierce County. This material was deposited by wind and is on low hummocks and dunes. It is loose, single grained, pale-brown or very pale brown fine sandy loam, loamy fine sand, or fine sand. Ortello, Thurman, and Valentine soils formed in deep deposits of this parent material. The upper part of Boelus and Hadar soils and the surface layer of Bazile soils, Loretto fine sandy loam, and Paka sandy loam also formed in eolian sand. Elsmere and Ovina soils formed in eolian sand on stream terraces.

Colluvium is material that accumulates as a result of the combined forces of gravity and water. This parent material is on foot slopes at the base of hills in the silty uplands. The gently sloping Hord soils and some areas of Trent soils formed in this friable, very dark brown silty material.

Alluvium is the parent material of the soils on bottom lands and stream terraces. This sandy to clayey material has been deposited by streams. The bottom lands continue to receive sediments from floodwaters. Cass, Clamo, Colo, Hobbs, Lamo, Lawet, Leshara, Loup, Ord, and Orwet soils formed in alluvium on bottom lands. The oldest alluvium is on the stream terraces that are above the present flood

plain and are not subject to flooding. Elsmere, Hord, Ovina, and Trent soils formed in this material.

Climate

Climate is fairly uniform throughout Pierce County. Precipitation, temperature, and wind have been important in the formation of the soils in the county.

The average annual precipitation is 25 inches. This is sufficient moisture to influence the development of zonal soils that have a very dark brown surface layer and contain a moderate amount of organic matter. In silty soils the surface layer and upper part of the subsoil have been leached of lime, and there is an accumulation of lime in the lower part of the subsoil or in the substratum. In a few mature silty soils, moisture has moved some clay from the surface layer downward into the subsoil. Sandy soils have been leached throughout the profile. Erosion caused by rain influences the thickness of the dark surface layer of most moderately sloping to steep soils. Excessive rain or rapid snowmelt results in flooding and some additional deposition on soils on bottom lands.

The warm summers and cold winters in Pierce County favor the development of soils that have a dark-colored surface layer. Average depth of frost penetration is 34 inches. This frost action aids in the formation of a granular surface layer and prismatic or blocky structure in the subsoil.

Northwest winds influenced the distribution of the eolian sand and loess parent materials and had a direct effect on the landscape in Pierce County. In winter these winds blow snow into drifts, resulting in additional moisture and deeper leaching on some southeast-facing slopes. Spring winds cause soil blowing of cultivated sandy soils. The upper part of hummocks commonly has a thin surface layer as the result of strong winds.

Plants and animals

Vegetation in Pierce County prior to settlement was mainly mid and tall grasses. These grasses have been an important factor in soil formation. The fibrous root system fills the surface layer with minute rootlets, which, upon decaying, contribute organic matter and promote the development of granular structure. Deeper roots improve the permeability of the subsoil and add a small amount of organic matter.

Micro-organisms, worms, insects, gophers, and other small animals are important in the development of the soils in Pierce County. Micro-organisms are important in transforming undecomposed organic matter into humus. Earthworms mix soil material, improve granulation, and increase the availability of plant nutrients. They are most abundant in the Hobbs, Hord, Leshara, Lamo, Colo, Orwet, and Lawet soils. Insects, gophers, and other small animals are also active in soil mixing and increase soil aeration and drainage.

Relief

Relief and position in the landscape are important factors in the formation of soils in Pierce County. Steepness, shape, and length of slope affect the rate of runoff and erosion and the amount of moisture available for soil formation. The soils on steep slopes have a thinner surface layer and less development in the subsoil than soils that are nearly level or gently sloping. Sandy soils on the upper part of hummocks have a thinner, darker colored surface layer than soils on the lower part of hummocks. This is mainly caused by soil blowing, which is more severe on the highest parts of the landscape than elsewhere.

Butler and Fillmore soils, because of their position in the landscape, receive extra moisture and have formed a claypan. Soils on bottom lands receive additional sediments because of their location on the flood plain. Some soils on bottom lands lack adequate drainage. Soils that have poor drainage have formed a dark-colored surface layer, which is high in content of organic matter, and a gray, mottled subsoil.

Time

Time is required for soils to form in parent material. In Pierce County soils formed entirely in transported, unconsolidated materials. Soil formation began as soon as the land surface was stabilized.

The youngest soils formed in alluvium on bottom lands. These soils continue to receive additional sediment from floodwater. Soil formation is interrupted by frequent additions to the surface layer, and the soils have minimal development. Cass and Hobbs soils are young soils in Pierce County.

The soils on stream terraces and uplands represent a wide range in time and degree of development. On moderately sloping to steep slopes, water and wind constantly erode the surface layer and slow the processes of soil formation. Crofton and Valentine soils are examples of upland soils that have a thin surface layer because erosion nearly keeps pace with development. The more mature soils have been in place for a long time and are approaching equilibrium with their environment. Soils of the Moody series are mature and formed on stable land surfaces. Their surface layer is dark colored and granular, and the subsoil is well developed. Lime has been leached to a depth of about 40 inches.

Classification of the Soils

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

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 the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of a property may be used in several different categories. In table 8, the soil series of Pierce County are placed in three categories of the current system. This classification is current as of December, 1973. 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 tend to give broad climatic groupings of soils. The exceptions to this are Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables, ending in *sol* (Moll-i-sol).

Suborder.—Each order is divided into suborders using those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; 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. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu*, meaning water or wet, and *oll*, from Mollisol).

Great group.—Soil suborders are separated into great groups on the basis of uniformity in the kind 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 growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl*, meaning simple horizons; *aqu*, for wetness or water; and *oll*, from Mollisols).

Subgroup.—Great groups are divided into subgroups, one that represents the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives in front of the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

Family.—Soil families are established within a subgroup mainly on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae (see table 8). An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

Additional Facts About the County

According to the U.S. Census of Agriculture, farms in Pierce County are decreasing in number and increasing in size. In 1964 there were 1,249 farms, and their average size was 283 acres. In 1969 there were 1,061 farms, and their average size was 324 acres. The percentage of tenant-operated farms decreased from 36 percent in 1964 to 28 percent in 1969.

The acreage of land under irrigation is increasing rapidly. In 1964 there were 68 farms with irrigation on 5,479 acres; in 1969 the numbers increased to 96 farms and 10,797 acres. Factors are favorable for increased irrigation, mainly in the area west of the North Fork Elkhorn River. Center-pivot, self-propelled irrigation systems are well suited to the gently undulating sandy soils. Some areas of range on gently undulating sandhills are being converted to irrigated cropland. Irrigation is also increasing on the nearly level to gently sloping silty soils in the vicinity of Plainview and Osmond. Some moderately sloping to strongly sloping silty soils are irrigated, but their irrigation is limited by the hazard of erosion.

The acreage of poorly drained soils being tiled is increasing, but it is restricted somewhat by lack of suitable tile outlets.

A small acreage of steep silty soils and severely eroded sandy soils is being seeded to native grass. Near the southeastern corner of the county, along U.S. Highway 81, some areas are being converted from cropland or pasture to business sites.

Ground water of suitable quality for livestock and domestic uses is available in most parts of Pierce County. In some local areas, especially near McLean, water supplies from deep wells cannot be obtained and water is piped from shallow wells on the bottom lands to farmsteads in the uplands. In the glacial till area, some wells yield water that is very hard and not satisfactory for all domestic and industrial uses.

Irrigation wells that yield 750 to 1,000 gallons per minute can be obtained southwest of a line along the Dry Creek-North Fork Elkhorn River stream system. Wells that produce similar yields can also be obtained in most areas in the southeast and northwest corners of the county. The depth of the wells ranges from 120 to 300 feet. Northeast of this line, in the glacial till area, the sand and gravel deposits that furnish water to irrigation wells in the county are not uniformly present, so irrigation wells can be obtained in some places and not in others. Where irrigation wells can be developed, their depth ranges from 200 to 400 feet and their yield generally ranges from 250 to 750 gallons per minute. The quality of water in all parts of the county is suitable for irrigating crops.

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Bazile	Fine-silty over sandy or sandy-skeletal, mixed, mesic.	Udic Haplustolls	Mollisols.
Betts	Fine-loamy, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Boelus	Sandy over loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Butler	Fine, montmorillonitic, mesic	Abruptic Argiaquolls	Mollisols.
Cass	Coarse-loamy, mixed, mesic	Fluventic Haplustolls	Mollisols.
Clamo	Fine, montmorillonitic, mesic	Cumulic Haplaquolls	Mollisols.
Clarno	Fine-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Colo	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Crofton	Fine-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Elsmere	Sandy, mixed, mesic	Aquic Haplustolls	Mollisols.
Fillmore	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Hadar	Sandy over loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Hobbs	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Hord	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Lamo	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Lawet	Fine-loamy, mesic	Typic Calciaquolls	Mollisols.
Leshara	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Longford	Fine, montmorillonitic, mesic	Udic Argiustolls	Mollisols.
Loretto	Fine-loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Loup	Sandy, mixed, mesic	Typic Haplaquolls	Mollisols.
Moody	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Nora	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Ord	Coarse-loamy, mixed, mesic	Fluvaquentic Haplustolls	Mollisols.
Ortello	Coarse-loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Orwet	Sandy, mesic	Typic Calciaquolls	Mollisols.
Ovina	Coarse-loamy, mixed, mesic	Aquic Haplustolls	Mollisols.
Paka	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Simeon	Mixed, mesic	Typic Ustipsamments	Entisols.
Thurman[1]	Sandy, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Trent	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Valentine	Mixed, mesic	Typic Ustipsamments	Entisols.

[1] The Thurman series was sampled in Pierce County, and the data are published in Soil Survey Investigations Report Number 5 (7). Also in this report are data on the Cass, Crofton, Hord, Leshara, Moody, Nora, and Valentine series, which were sampled in locations outside the county.

Mid and tall grasses were the native vegetation of Pierce County. In the silty uplands big bluestem, little bluestem, switchgrass, and grama grasses were the dominant species. Vegetation on the sandy uplands included a higher percentage of bunchgrasses. The most important species were little bluestem, sand bluestem, prairie sandreed, needle-and-thread, and blue grass. Prairie cordgrass, commonly called slough grass, was dominant on the bottom lands that were marshy, and cattails grew in the wettest areas. Big bluestem, switchgrass, and indiangrass were the main species on the somewhat poorly drained to well-drained bottom lands.

A few trees grew along the lower part of the North Fork Elkhorn River. Cottonwood, willow, elm, and box elder were the species observed by the original surveyor in 1858. Sand cherries, wild strawberries, and wild plums provided fruit for the early settlers (2).

The main natural resources in the county, in addition to the soils and water supply, are the sand and gravel deposits, which are close enough to the surface in some places to be mined from pits; and the meadows and rangelands, which support a variety of birds and wildlife. The depth to water beneath some of the meadows is shallow enough that dugouts can be constructed for ponds, which support some fish.

Most grain, livestock, and other freight are transported by truck. U.S. Highway 20 crosses the county from east to west, and U.S. Highway 81 from north to south. State Highway 13 runs southeast to northwest. Most of the main county roads and rural mail routes are gravelled, and a few are hard surfaced. Graded roads are on many section lines, except in the sandhills.

Creameries, dairies, and cheese plants operate truck routes to collect milk, cream, and eggs. Grain not used or stored on the farm is hauled by truck and sold to local elevators. Livestock is shipped by truck to markets in Plainview, Norfolk, Sioux City, and Omaha. Large trucking companies transport most merchandise received by local merchants.

A railroad provides freight service to Hadar, Pierce, Foster, and Plainview, and another serves McLean, Osmond, Breslau, and Plainview. Railroads haul some grain from local elevators to large terminal markets. Some freight, such as machinery, lumber, cement, and fertilizer, is transported by rail to towns in the county.

Buslines provide daily passenger service to most towns in the county. The nearest commercial airline is at Norfolk in neighboring Madison County.

Geology

The Ogallala Formation, composed mostly of stream-deposited and partly consolidated sand, silt, and clay, is the uppermost bedrock unit in Pierce County. This formation overlies the Niobrara Chalk and the Pierce Shale of Cretaceous age and underlies the mantlerrock, or unconsolidated deposits, of Quarternary age.

The mantlerock in Pierce County is an extremely complex assortment of stream-deposited silt, clay,

sand, and gravel; two or more glacial tills and associated melt-water deposits; and wind-deposited silt and sand. Stream-deposited beds of sand and gravel and of silt and clay in various arrangements overlie the bedrock in Pierce County. West of the North Fork Elkhorn River, these beds range from 30 to 260 feet in thickness; east of the river they are 1 foot to 100 feet thick. Glacial till overlies these beds east of the North Fork Elkhorn River and, in a few places, immediately west of it. The till reaches a maximum thickness of 250 feet in the northeastern part of the county.

Water-deposited sand overlies the till in some areas. Beds of wind-deposited silt, called loess, overlie the till and, in parts of the county, the older stream-deposited material. The lower and older loess is the Loveland, and the uppermost loess is the Peoria. The loess beds reach a maximum thickness of 75 feet. Wind-deposited sand blankets much of the county and has a maximum thickness of 50 feet in the sandhills in the southwestern part of the county. The most recent deposits are the alluvial materials along the present streams.

Relief and Drainage

Local relief in Pierce County is measured in tens of feet, and the maximum relief within the county is 350 feet. The elevation ranges from 1,872 feet above mean sea level in the northeastern part of the county at the southwest corner of sec. 1, T. 27, R. 1 to 1,522 feet on the North Fork Elkhorn River at the Pierce-Madison County line near the southeast corner of Pierce County.

Most of Pierce County is drained by the North Fork Elkhorn River. About 4 square miles in the southwest corner drains to the Elkhorn River, about 15 square miles in the northeastern part of the county is drained by Middle Logan Creek, and about 8 square miles in the northwest corner is drained by Brazile Creek.

About 10 percent of the county is an undulating sandhill landscape. The sandhills are mainly in the southwestern part of the county. They vary in size from low hummocks to higher, round-topped dunes, and the valleys consist of the gently sloping lower slopes of the hills and the swales between the hills. The sandy soils absorb most of the precipitation; thus, runoff is low and there are very few well-defined drainage channels.

About 30 percent of the county is gently undulating, predominantly sandy and loamy uplands. The landscape is a series of low, round-topped hummocks that have short side slopes and an occasional long gentle slope. This landscape occurs across the center of the county diagonally from northwest to southeast. Most of the precipitation is absorbed by the sandy soil, and a small part of the precipitation is lost through runoff.

Silty uplands make up about 30 percent of the county. The area northwest of Osmond is mainly gently sloping, but several small areas are nearly level and a few small to large depressions occur. The northeastern part, the extreme southwest corner, and small areas west and south of Pierce are moderately sloping. The landscape consists of gently sloping, narrow, convex ridgetops and long, moderately sloping hillsides. Most slopes are long and smooth, and a few side slopes are strongly sloping or steep. A moderate amount of the precipitation enters the soil, and a considerable part is lost through runoff. Well-defined drainageways have developed.

About 30 percent of the county is nearly level bottom lands and stream terraces. Bottom lands along Breslau Creek, Dry Creek, and Willow Creek are mostly poorly drained and have a high water table. The bottom lands along Yankton Slough, Hadar Creek, and other minor drainageways are somewhat poorly drained to well drained. The silty stream terraces are well drained or somewhat poorly drained.

Surface drainage is very slow on the bottom lands and stream terraces. The lowest level along the stream channels is flooded one or more times each year. The stream terraces are topographically above the present-day flood level.

Climate[7]

The climate of Pierce County is typical of climates found in the interiors of large continents. Summers are rather warm, winters are cold, and precipitation is moderate. Large daily and annual variations in temperatures and precipitation are common. The distribution of temperature and precipitation is largely determined by the location, movement, and interaction of large-scale weather systems.

The climatic data available from Osmond, situated in the northern part of Pierce County, and Winside, in neighboring Wayne County, are representative of local conditions. However, the variability in rainfall produced by warm-season showers over a short distance is often noticeable.

Approximately three-quarters of the annual precipitation falls during the warm half of the year, April to September (table 9). During an average year, precipitation amounting to 0.01 inch or more occurs on 93 days, and amounts of 0.1 inch or greater are recorded on 50 days. Heavy precipitation, amounting to 0.5 inch or more, falls an average of 17 days per year, 13 of which are in the warm part of the year, when the potential for soil erosion is high. Once a year, rainfall equalling or exceeding 1.0 inch in 30 minutes, 1.3 inches in an hour, 1.5 inches in 3 hours, 1.9 inches in 12 hours, and 2.2 inches in 24 hours should be expected.

At the beginning of spring and during fall, precipitation is usually well distributed and is light but steady. However, by the end of spring and on into summer, most of the rainfall results from erratic shower and thunderstorm activity. A few of the thunderstorms become severe at times and may be accompanied by torrential rain, hail, damaging wind, and, on rare occasions, a tornado.

Average snowfall totals about 29 inches per year and accounts for approximately 10 percent of the annual precipitation. The first snowfall of 1 inch or more usually falls late in November, and the ground

[7] By MORRIS S. WEBB, climatologist for Nebraska, National Weather Service, U.S. Department of Commerce.

is commonly covered by snow from December to the middle of March. Snowfall is often accompanied by brisk north winds, which can whip the snow into sizable drifts.

A dry surface layer and ample moisture in the subsoil are the ideal combination during crop planting. However, variations from this optimum are frequent. It is difficult to provide the desired 1 inch of moisture per week for growing corn if moisture is lacking in the subsoil at the beginning of the growing season. The chances are 2 in 5 of receiving a weekly rainfall 1 inch in June and only 1 in 4 late in July and in August.

Temperature extremes at Osmond, since temperature records were begun in 1941, are from 110° F., measured on July 11, 1954, to −32°, on January 19, 1970. In an average year, the temperature reaches −22° or lower and 101° or higher.

Temperatures of 90° or higher, too high for optimum corn growth, occur an average of 37 days per year, and freezing temperatures occur an average of 166 days per year. The growing season usually lasts 145 days. The probabilities of the last freezing temperature in spring and the first in fall are shown in table 10.

Literature Cited

(1) American Association of State Highway [and Transportation] Officials. 1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 vol., illus.

(2) Hansen, Esther Kolterman. 1967. Echoes of the past and along pioneer trails in Pierce County, Nebraska. Ed. 3, 114 pp., illus.

(3) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027–1034, illus.

(4) United States Department of Agriculture. 1932. Soil survey of Pierce County, Nebraska. Series 1928, No. 9, 26 pp., illus., maps.

(5) ———. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus [Supplement issued in May 1962]

(6) ———. 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplements issued in March 1967 and in September 1968]

(7) ———. 1966. Soil laboratory data and descriptions for some soils of Nebraska. Soil Surv. Invest. 5, in cooperation with Univ. of Nebr. Conserv. and Surv. Div. 233 pp.

(8) ———. Soil Conservation Service. 1971. Irrigation guide for Nebraska. Looseleaf.

(9) United States Department of Defense. 1968. Unified soil classification system for roads, airfields, embankments and foundations. MIL-STD-619B, 30 pp., illus.

Glossary

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

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

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

Available water capacity. The ability to hold water available for use by plants, usually expressed in linear depth of water per unit of soil depth. Commonly defined as the difference between the percentage of water in soil at field capacity and the percentage at the wilting point of most plants. This difference in percentage multiplied by the bulk density and divided by 100 gives a value in surface inches of water per inch of soil depth. In this survey, the classes of available water capacity are defined by the depth of surface water available above a depth of 60 inches or above a limiting layer. The classes are: *very low*, 0 to 3 inches; *low*, 3 to 6 inches; *moderate*, 6 to 9 inches; and *high*, more than 9 inches.

Bottom land. Low land formed by alluvial deposit along a stream or in a lake basin; a flood plain.

TABLE 9.—*Temperature and precipitation data*

[Data in columns 1–7 from Osmond, Pierce County, Nebr.; data in columns 8 and 9 from Winside, Wayne County, Nebr.]

Month	Temperature				Precipitation				
	Average daily maximum[1]	Average daily minimum[1]	Two years in 10 have at least 4 days with[2]: Maximum temperature equal to or higher than—	Two years in 10 have at least 4 days with[2]: Minimum temperature equal to or lower than—	Average monthly total[1]	One year in 10 has precipitation[1]: Equal to or less than—	One year in 10 has precipitation[1]: Equal to or more than—	Number of days that have 1 inch or more of snow cover[3]	Average depth of snow on days that have snow cover[3]
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	31	7	51	−15	0.6	0.2	1.5	16	4
February	36	13	58	−10	1.0	.1	2.0	15	5
March	45	22	68	1	1.6	.5	3.3	9	6
April	63	36	81	21	2.4	.9	4.3	1	3
May	73	47	88	34	4.0	1.2	6.7	(4)	4
June	83	58	96	46	4.3	1.9	7.4		
July	88	62	100	52	3.1	1.3	6.2		
August	87	61	98	50	3.0	.9	5.2		
September	77	50	94	36	2.5	.9	4.9		
October	67	39	85	25	1.6	.1	3.2	(4)	3
November	49	24	69	6	.9	.2	2.2	3	3
December	36	13	56	−8	.8	.2	1.5	10	3
Year	61	36	[5]101	[6]−22	25.8	18.9	33.8	54	4

[1] Data for period 1942–71.
[2] Data for period 1893–1963.
[3] Data for period 1941–70.
[4] Less than one-half day.
[5] Average annual highest temperature.
[6] Average annual lowest temperature.

TABLE 10.—*Probabilities of last freezing temperature in spring and first in fall*

[Based on interpolation of data from Hartington, Niobrara, Norfolk, and Oakdale, Neb.]

Probability	Dates for given probability and temperature[1]				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
One year in 10 later than	April 11	April 15	April 28	May 13	May 22
Two years in 10 later than	April 3	April 12	April 21	May 5	May 15
Five years in 10 later than	March 26	April 2	April 12	April 23	May 5
Fall:					
One year in 10 earlier than	October 24	October 18	October 9	September 26	September 19
Two years in 10 earlier than	October 31	October 23	October 15	September 30	September 25
Five years in 10 earlier than	November 8	November 2	October 25	October 14	October 3

[1] All freeze data are based on temperatures in a standard National Weather Service thermometer shelter at a height of approximately 5 feet above the ground and in a representative exposure. Lower temperatures exist at times nearer the ground and in local areas that are subject to extreme air drainage. The dates in this table are based on the period 1921–65.

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

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. In some soils much of the clay fraction is carbonates.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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

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

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

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

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

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

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

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

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

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

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Depth, soil. The total thickness of weathered soil material over mixed sand and gravel or bedrock. In this survey the classes of soil depth are *very shallow*, 0 to 10 inches; *shallow*, 10 to 20 inches; *moderately deep*, 20 to 40 inches; and *deep*, more than 40 inches.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

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

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

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

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

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

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

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

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

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 land surface by wind (sandblast), running water, and other geological agents.

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

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

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

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

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

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

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like

that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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

Intake rate. The average rate of water entrance into the soil, under irrigation. Most soils have a faster initial rate, which decreases with time. Therefore, intake rate for design purposes is not constant, but varies, depending on the net amount of irrigation water to be applied.

Leaching. The removal of soluble material from soils or other material by percolating water.

Lime. Chemically, lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived material applied to neutralize acid soil. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

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

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

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

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10 YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

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.

Organic-matter content. The amount of organic matter in soil material. The classes used in this survey are *very low,* less than 0.5 percent organic matter present; *low,* 0.5 to 1.0 percent; *moderately low,* 1.0 to 2.0 percent; *moderate,* 2.0 to 4.0 percent; and *high,* 4.0 to 8.0 percent.

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

Permeability, soil. The quality of a saturated soil that enables water or air to move through it. In this survey, permeability applies to that part of the soil below the Ap horizon or equivalent layer and above a depth of 60 inches or above bedrock that is at a depth of less than 60 inches. If there is a change of two or more permeability classes within a short vertical distance, the classes and depth are stated. Classes of soil permeability are *very slow,* less than 0.06 inches of water per hour; *slow,* 0.06 to 0.20 inches; *moderately slow,* 0.20 to 0.6 inches; *moderate,* 0.5 to 2.00 inches; *moderately rapid,* 2.00 to 6.00 inches; *rapid,* 6.00 to 20.00 inches; and *very rapid,* more than 20.00 inches.

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

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

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

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

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

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

Slope. The degree of deviation of a surface from the horizontal, usually expressed in percent or degrees. In this survey, the classes of slopes are *nearly level,* 0 to 1 percent; *very gently sloping,* 1 to 2 percent; *gently sloping or gently undulating,* 2 to 7 percent; *moderately sloping or gently rolling,* 7 to 11 percent; *strongly sloping or rolling,* 11 to 17 percent; and *steep,* 17 to 30 percent.

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

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

Stratified. Composed of, or arranged in strata, or layers, such as stratified alluvium. The term is confined 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.

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

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

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Generally, the A 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 may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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

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

Underlying material. The part of the soil below the solum.

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

☆ U.S. GOVERNMENT PRINTING OFFICE: 1976—214-809/60

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. Windbreak suitability groups are described on pages 69 and 70. Other information is given in tables as follows:

Acreage and extent, table 1, page 11.
Predicted yields, table 2, page 63.
Potential of principal soils for wildlife habitat, table 4, page 70.
Engineering uses of the soils, tables 5, 6, and 7, pages 74 through 95.

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Dryland Page	Capability unit Irrigated Symbol	Irrigated Page	Range site Name	Range site Page	Windbreak suitability group
BaA	Bazile loam, terrace, 0 to 1 percent slopes	11	IIs-5	45	I-7	55	Silty Lowland	66	4
BbA	Bazile silt loam, 0 to 1 percent slopes	12	IIs-5	45	I-7	55	Silty	67	4
BbC	Bazile silt loam, 1 to 7 percent slopes	12	IIIe-1	45	IIIe-7	59	Silty	67	4
BcA	Bazile soils, 0 to 1 percent slopes	12	IIe-6	44	IIe-9	56	Sandy	66	3
BcC	Bazile soils, 1 to 7 percent slopes	12	IIIe-6	46	IIIe-9	60	Sandy	66	3
BdA	Bazile soils, terrace, 0 to 1 percent slopes	12	IIe-6	44	IIe-9	56	Sandy	66	3
BeD2	Betts loam, 3 to 11 percent slopes, eroded	13	IVe-9	50	IVe-4	61	Limy Upland	67	5
Bn	Blown-out land	13	VIIe-5	53	------	--	Sands	66	10
BoA	Boelus-Loretto complex, 0 to 2 percent slopes	14	IIe-6	44	IIe-10	56	Sandy	66	3
BoC	Boelus-Loretto complex, 2 to 7 percent slopes	14	IIIe-6	46	IIIe-10	60	Sandy	66	3
Bt	Butler silty clay loam	15	IIw-2	44	IIw-1	56	Clayey Overflow	66	2
Ca	Cass fine sandy loam	15	IIs-6	45	IIs-8	58	Sandy Lowland	66	3
Cb	Cass loam	15	I-1	43	I-8	55	Sandy Lowland	66	1
Cc	Clamo silty clay	16	IIIw-1	47	IIIw-1	60	Subirrigated	65	2
Cd	Clamo-Slickspots complex	16	IVs-1	51	------	--	----------	--	--
	Clamo part	--	------	--	------	--	Subirrigated	65	2
	Slickspots part	--	------	--	------	--	Saline Subirrigated	65	10
CeC	Clarno loam, 2 to 7 percent slopes	17	IIe-1	44	IIIe-4	59	Silty	67	4
CeD	Clarno loam, 7 to 11 percent slopes	17	IIIe-1	45	IVe-4	61	Silty	67	4
Cf	Colo fine sandy loam, overblown	18	IIw-6	45	IIw-5	57	Subirrigated	65	2
Co	Colo silt loam	18	IIw-4	45	IIw-4	57	Subirrigated	65	2
CrC2	Crofton silt loam, 3 to 7 percent slopes, eroded	19	IIIe-9	46	IIIe-6	59	Limy Upland	67	5
CrE2	Crofton silt loam, 7 to 17 percent slopes, eroded	19	IVe-9	50	------	--	Limy Upland	67	5
CrF	Crofton silt loam, 17 to 30 percent slopes	19	VIe-9	51	------	--	Limy Upland	67	10
CsC2	Crofton-Nora silt loams, 1 to 7 percent slopes, eroded	19	IIIe-9	46	IIIe-6	59	----------	--	--
	Crofton part	--	------	--	------	--	Limy Upland	67	5
	Nora part	--	------	--	------	--	Silty	67	4
CsD2	Crofton-Nora silt loams, 7 to 11 percent slopes, eroded	19	IIIe-9	46	IVe-6	61	----------	--	--
	Crofton part	--	------	--	------	--	Limy Upland	67	5
	Nora part	--	------	--	------	--	Silty	67	4
CsE2	Crofton-Nora silt loams, 11 to 17 percent slopes, eroded	20	IVe-9	50	------	--	----------	--	--
	Crofton part	--	------	--	------	--	Limy Upland	67	5
	Nora part	--	------	--	------	--	Silty	67	4
EaA	Elsmere loamy fine sand, 0 to 2 percent slopes	20	IIIw-5	47	IIIw-11	61	Subirrigated	65	2
Fm	Fillmore complex	21	IIIw-2	47	IIIw-2	61	Clayey Overflow	66	6

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Dryland Page	Capability unit Irrigated Symbol	Irrigated Page	Range site Name	Range site Page	Windbreak suitability group
HaC	Hadar loamy fine sand, 2 to 7 percent slopes	22	IIIe-6	46	IIIe-10	60	Sandy	66	3
HaD	Hadar-Thurman complex, 7 to 11 percent slopes	22	IVe-6	50	------	--	Sands	66	3
Hb	Hobbs silt loam	23	I-1	43	I-6	54	Silty Lowland	66	1
Hc	Hobbs silt loam, calcareous	23	I-1	43	I-6	54	Silty Lowland	66	1
Hd	Hobbs silt loam, occasionally flooded	23	IIw-3	44	IIw-6	57	Silty Overflow	65	1
He	Hord silt loam	24	I-1	43	I-6	54	Silty Lowland	66	4
HhC	Hord-Hobbs silt loams, 0 to 7 percent slopes	24	IIe-1	44	IIe-6	56	Silty Lowland	66	--
	Hord part	--	------	--	------	--	----------	--	4
	Hobbs part	--	------	--	------	--	----------	--	1
Lb	Lamo silty clay loam	25	IIw-4	45	IIw-3	57	Subirrigated	65	2
Lc	Lawet loam	26	IVw-4	50	------	--	Subirrigated	65	6
Ld	Lawet-Slickspots complex	26	IVs-1	51	------	--	----------	--	--
	Lawet part	--	------	--	------	--	Subirrigated	65	6
	Slickspots part	--	------	--	------	--	Saline Subirrigated	65	10
Le	Leshara silt loam	27	IIw-4	45	IIw-6	57	Subirrigated	65	2
LfC	Longford loam, 1 to 5 percent slopes	27	IIIe-2	46	IIIe-2	58	Clayey	67	4
LgD2	Longford soils, 2 to 8 percent slopes, eroded	28	IVe-4	48	------	--	Clayey	67	4
LhA	Loretto fine sandy loam, terrace, 0 to 2 percent slopes	28	IIe-3	44	IIe-5	55	Sandy	66	3
LkA	Loretto loam, 0 to 1 percent slopes	28	I-1	43	I-4	54	Silty	67	4
LkC	Loretto loam, 1 to 7 percent slopes	29	IIe-1	44	IIIe-4	59	Silty	67	4
Lo	Loup fine sandy loam	29	IVw-6	50	------	--	Subirrigated	65	6
Lp	Loup soils	29	Vw-7	51	------	--	Wet Land	65	6
Ma	Marsh	30	VIIIw-7	53	------	--	----------	--	10
MoA	Moody silty clay loam, 0 to 1 percent slopes	30	I-1	43	I-3	54	Silty	67	4
MoC	Moody silty clay loam, 1 to 7 percent slopes	30	IIe-1	44	IIIe-3	58	Silty	67	4
NoC	Nora silt loam, 1 to 7 percent slopes	31	IIe-1	44	IIIe-6	59	Silty	67	4
NoD	Nora silt loam, 7 to 11 percent slopes	31	IIIe-1	45	IVe-6	61	Silty	67	4
NoE	Nora silt loam, 11 to 17 percent slopes	32	IVe-1	48	------	--	Silty	67	4
NtD	Nora-Thurman complex, 7 to 11 percent slopes	32	IVe-3	48	IVe-8	62	----------	--	--
	Nora part	--	------	--	------	--	Silty	67	4
	Thurman part	--	------	--	------	--	Sandy	66	3
NtE	Nora-Thurman complex, 11 to 17 percent slopes	32	VIe-3	51	------	--	----------	--	--
	Nora part	--	------	--	------	--	Silty	67	4
	Thurman part	--	------	--	------	--	Sandy	66	3
Of	Ord fine sandy loam	33	IIw-6	45	IIw-8	57	Subirrigated	65	2
Om	Ord loam	33	IIw-4	45	IIw-8	57	Subirrigated	65	2
OrA	Ortello fine sandy loam, 0 to 2 percent slopes	33	IIe-3	44	IIe-8	56	Sandy	66	3
OrC	Ortello fine sandy loam, 2 to 7 percent slopes	34	IIIe-3	46	IIIe-8	59	Sandy	66	3
OsA	Ortello fine sandy loam, terrace, 0 to 2 percent slopes	34	IIe-3	44	IIe-8	56	Sandy	66	3
OtA	Ortello loam, terrace, 0 to 1 percent slopes	34	I-1	43	I-8	55	Sandy	66	4
Ou	Orwet loam	35	IVw-4	50	------	--	Subirrigated	65	6
OvA	Ovina fine sandy loam, 0 to 2 percent slopes	35	IIw-6	45	IIw-8	57	Subirrigated	65	2

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Page	Capability unit Irrigated Symbol	Page	Range site Name	Page	Windbreak suitability group
OwA	Ovina loam, 0 to 1 percent slopes-------	35	IIw-4	45	IIw-8	57	Subirrigated	65	2
Ox	Ovina-Slickspots complex----------	36	IIIs-1	48	IIIs-8	61	----------	--	--
	Ovina part----------	--	------	--	------	--	Subirrigated	65	2
	Slickspots part----------	--	------	--	------	--	Saline Subirrigated	65	10
PaD	Paka sandy loam, 3 to 8 percent slopes--	36	IIIe-3	46	IIIe-5	59	Sandy	66	3
PkD	Paka sandy clay loam, 3 to 8 percent slopes----------	37	IIIe-3	46	IIIe-5	59	Silty	67	4
Sx	Sandy alluvial land----------	37	VIw-7	52	------	--	Sandy Lowland	66	10
Sy	Silty alluvial land----------	37	VIw-7	52	------	--	Silty Overflow	65	10
SzD	Simeon sandy loam, 3 to 9 percent slopes----------	38	VIs-4	52	------	--	Shallow to Gravel	67	10
ThA	Thurman loamy fine sand, 0 to 2 percent slopes----------	39	IIIe-5	46	IIIe-11	60	Sandy	66	3
ThC	Thurman loamy fine sand, 2 to 7 percent slopes----------	39	IVe-5	49	IVe-11	62	Sandy	66	3
TmA	Thurman loamy fine sand, terrace, 0 to 2 percent slopes----------	39	IIIe-5	46	IIIe-11	60	Sandy	66	3
TnD	Thurman fine sandy loam, 7 to 11 percent slopes----------	40	IVe-3	48	------	--	Sandy	66	3
TvC	Thurman and Valentine soils, 1 to 7 percent slopes----------	40	IVe-5	49	IVe-11	62	Sandy	66	--
	Thurman part----------	--	------	--	------	--	----------	--	3
	Valentine part----------	--	------	--	------	--	----------	--	7
Tw	Trent silty clay loam----------	40	I-1	43	I-3	54	Silty Lowland	66	4
VaE	Valentine fine sand, rolling----------	41	VIe-5	51	------	--	Sands	66	7
VtE	Valentine and Thurman soils, rolling----	41	VIe-5	51	------	--	Sands	66	7
Wx	Wet alluvial land----------	41	Vw-7	51	------	--	Wet Land	65	10

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.