SOIL SURVEY OF

Roberts County, South Dakota

United States Department of Agriculture
Soil Conservation Service
In cooperation with
United States Department of the Interior
Bureau of Indian Affairs
and
South Dakota Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1961–70. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Roberts Conservation 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 Roberts 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 woodland group and range site in which the soil has been placed.

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

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

Foresters and others can refer to the section "Use of the Soils for 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 "Use of the Soils for Wildlife Habitat."

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

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, schools, and recreation areas in the section "Town and Country Planning."

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

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

Newcomers in Roberts 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 at the beginning of the publication and in the section "Additional Facts About the County."

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SOIL SURVEY OF ROBERTS COUNTY, SOUTH DAKOTA

BY KENNETH F. MILLER, VERNON F. KOOPMAN, AND WILLIAM R. GLOVER, SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, IN COOPERATION WITH THE SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Roberts County is located in the northeastern corner of South Dakota (fig. 1). It is bounded on the north by North Dakota and on the east by Minnesota. Roberts County has a total area of 730,240 acres. Sisseton is the county seat. Other towns in the county are Claire City, Corona, Hammer, New Effington, Ortley, Peever, Rosholt, Summit, Victor, Whiterock, and Wilmot.

Roberts County has a continental type of climate characterized by hot summers and cold winters. The topography is nearly level to steeply sloping. Most of the soils formed in loamy to clayey glacial till, but the soils in the northeast part of the county formed in lacustrine silt and sand. The western part of the county lies on the Coteau De Prairies (*3*),[2] which is a plateau highland shaped like a flatiron and is the most conspicuous land feature in eastern South Dakota and in Roberts County. This plateau rises about 1,000 feet above the eastern part of the county. The northwest corner of the county is part of the Minnesota River-Red River lowland, and the northeast corner is on what is known as Glacial Lake Agassiz. Drainage runs north or south along the Continental Divide. The main drainage channels for the county consists of the Minnesota River and the North Fork of the Whetstone River, which drain south, and the Bois De Sioux River, which drains north from Lake Traverse.

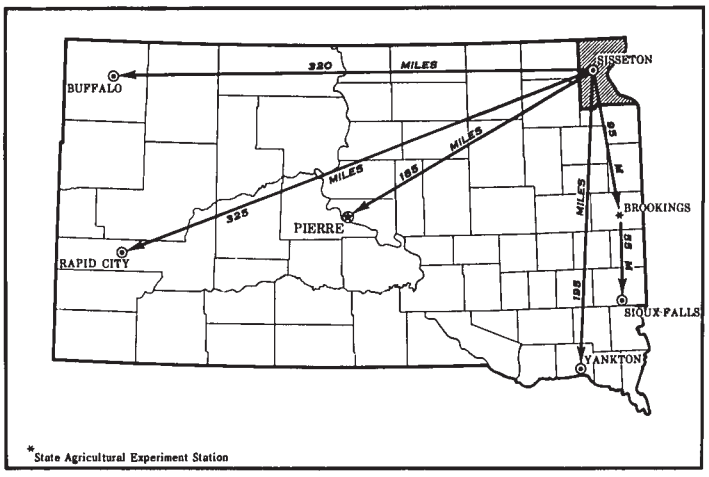

Figure 1—**Location of Roberts County in South Dakota.**

Farming is diversified in this county, and farm income from the sale of liverstock is slightly more than that received from the sale of crops. Corn, soybeans, wheat, rye, oats, flax, and alfalfa are the main crops. About 64 percent of the total land area in the county is used for crops, and 20 percent is used for range. The rest is used for tame pasture, wildlife habitat, recreation, and urban areas.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Roberts 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 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 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 soil 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. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Peever and Forman, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or 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, Peever clay loam, 0 to 2 percent slopes, is one of several phases within the Peever 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 photo-

[1] Others who contributed to the soil survey are MERLE M. KOST, HARRY R. JAMES, GEORGE W. ANDERSON, and FRED WILSON, Soil Conservation Service.

[2] Italic numbers in parentheses refer to Literature cited, p. 112.

graphs 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 Roberts County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Hamerly-Tonka complex, 0 to 3 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the 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. Antler and Hamerly soils, 0 to 2 percent slopes, is an undifferentiated group in this county.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that is 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. Marsh 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 estimated for all the soils.

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, 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 six general kinds of landscapes for broad interpretative purposes. Each of the broad groups and their soil associations in each group 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 association 2, the words, "silty and loamy" refer to the texture of the surface layer.

Well Drained and Moderately Well Drained Soils Formed in Glacial Drift and Lacustrine Silts; on Uplands

The soils in this group formed in loamy and silty glacial drift and in silty lacustrine sediment. They are dominantly loam and silt loam. The relief is mainly nearly level to sloping or undulating, but steeper soils are around sloughs and lakes and along the larger drainageways. Most areas of these associations are cultivated. Small areas of hilly or steep soils and some of the poorly drained, minor soils are used for pasture, hay, or wildlife habitat. Many of the nearly level soils have little or no limitations for crops, but in other areas soils are subject to water erosion and soil blowing.

1. Heimdal-Svea-Sisseton association

Well drained and moderately well drained, nearly level to steep, loamy soils formed in glacial drift

This association is an undulating ground moraine that consists of swells and swales. Differences in elevation range from 10 to 30 feet. This association is marked by many light-colored knolls and hilltops and by sloughs and potholes or depressions scattered throughout the association. Slopes are mostly short and irregular and nearly level to undulating. Rolling to steep slopes are around sloughs and potholes along the few creeks and large drainageways and in areas adjacent to Big Stone Lake. The drainage pattern is fairly

well defined on the edges of this association, but in other areas the swales and drainageways commonly terminate in sloughs, potholes, and small lakes.

This association makes up about 15 percent of the county. About 35 percent of it is Heimdal soils, about 15 percent is Svea soils, and about 12 percent is Sisseton soils (fig. 2). The rest is minor soils.

Heimdal soils are on slightly rounded swells, are mostly nearly level to undulating, and are well drained. They have a surface layer of dark-gray and dark grayish-brown loam and a subsoil of brown loam. The underlying material is calcareous, light-gray and pale-yellow loam and silt loam.

Svea soils are in swales, are mostly nearly level or gently sloping, and are moderately well drained. They have a surface layer of dark-gray loam and a subsoil of dark-gray and grayish-brown loam. The underlying material is calcareous loam.

Sisseton soils are gently undulating to steep and are well drained. They have a surface layer of calcareous, light brownish-gray and pale-yellow loam. The underlying material is calcareous, light-gray and pale-yellow loam and silt loam.

In most places in this association the Heimdal, Svea, and Sisseton soils occur together in intricate patterns on the landscape.

Minor soils in the association are Forman and Poinsett soils intermingled with Heimdal soils, Hamerly and Vallers soils in low areas rimming depressions, LaDelle soils on bottom lands and low terraces, Parnell and Tonka soils in depressions, and Waubay soils in some of the swales.

The Heimdal, Svea, and Sisseton soils take in water readily and have moderate or high available water capacity. Heimdal and Svea soils are medium or high in fertility, and Sisseton soils are low in fertility. The main concerns of management are control of water erosion and soil blowing and maintenance of fertility. Seasonal wetness and a high content of lime affect use and management of some of the minor soils.

Nearly all of the soils in this association are cultivated. Heimdal and Svea soils, especially, are well suited to all crops commonly grown in the county. Some of the steeper soils and some of the poorly drained, minor soils are used for grazing, for growing hay, and for wildlife habitat. The main farm enterprises are growing cash crops, dairy farming, and general livestock farming.

2. *Poinsett-Eckman-Heimdal association*

Well-drained, nearly level to sloping, silty and loamy soils formed in glacial drift and lacustrine silts

This association is a smooth ground moraine interspersed with large flats and large sloughs. The relatively smooth slopes are mostly nearly level and gently sloping. Steeper and more undulating areas are around sloughs and depressions and along drainageways. The drainage pattern is poorly defined. Swales and drainageways commonly terminate in sloughs, small lakes, and potholes or depressions.

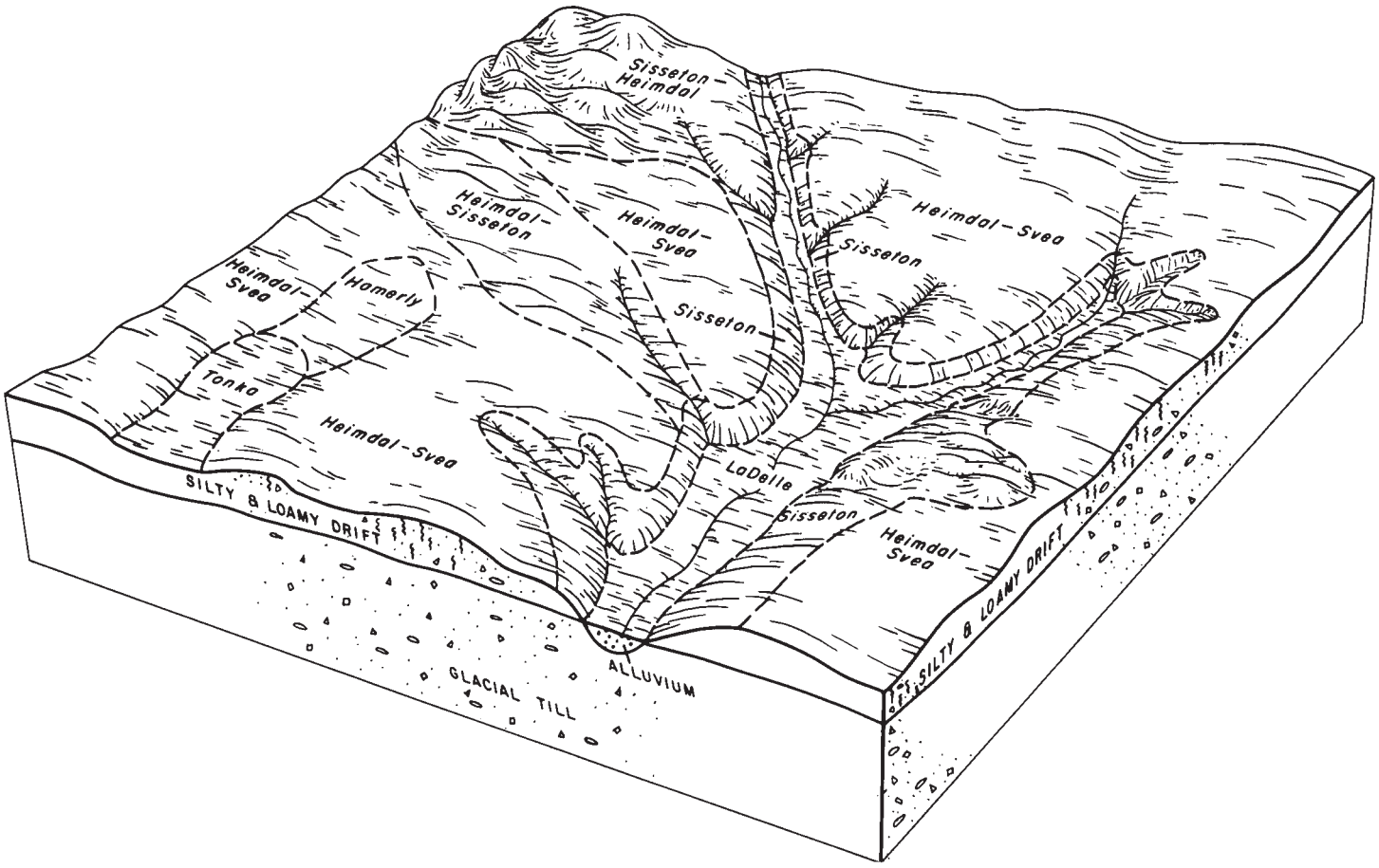

Figure 2.—**Pattern of topography, soils, and underlying material in the Heimdal-Svea-Sisseton association.**

Cottonwood Slough and Big Slough are prominent features in this association.

This association makes up about 10 percent of the county. About 23 percent is Poinsett soils, about 15 percent is Eckman soils, and about 15 percent is Heimdal soils (fig. 3). The remaining 47 percent consists of minor soils and small lakes.

Poinsett soils are on flats and slight rises and are nearly level and gently sloping. They have a surface layer of dark-gray silt loam. The subsoil is silty clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and light yellowish brown in the lower part. The lower part of it is calcareous and has spots and streaks of lime that extend into the underlying material. The underlying material is calcareous, pale-yellow and light-gray silt loam.

The landscape of Eckman soils is similar to that of Poinsett soils. Eckman soils have a surface layer of dark-gray loam and a silt loam subsoil that is grayish brown in the upper part, pale brown in the middle part, and light yellowish brown in the lower part. The underlying material is calcareous, light-gray and light yellowish-brown silt loam.

Heimdal soils are on rounded swells and are nearly level to undulating. They have a surface layer of dark-gray and dark grayish-brown loam and a subsoil of brown loam. The underlying material is calcareous, light-gray and pale-yellow loam and silt loam.

Minor soils in the association are Bearden and Glyndon soils on low flats rimming poorly drained soils; Borup and Gardena soils on broad flats; Buse and Zell soils on knolls and ridgetops; Embden, Hamar, Svea, and Waubay soils in swales; Parnell and Tonka soils in closed depressions; and Sverdrup soils on some of the flats and on rounded swells. Areas of Marsh are also in this association.

The Poinsett, Eckman, and Heimdal soils are medium or high in fertility, take in water readily, and have high available water capacity. Control of soil blowing and water erosion and maintenance of fertility are the main concerns of management. Wetness and the high content of lime are concerns in areas of some of the minor soils.

Nearly all of the soils in this association are cultivated. Poinsett, Eckman, and Heimdal soils are well suited to all the crops commonly grown in the county. Small areas of some of the steeper soils and some areas of the poorly drained soils are used for grazing, for growing hay, and for wildlife habitat. Growing cash crops, dairy farming, and general livestock farming are the main farm enterprises.

Well-Drained to Poorly Drained Soils Formed in Glacial Till; on Uplands

The soils in this group formed in loamy and clayey glacial till. Scattered throughout are poorly drained soils that

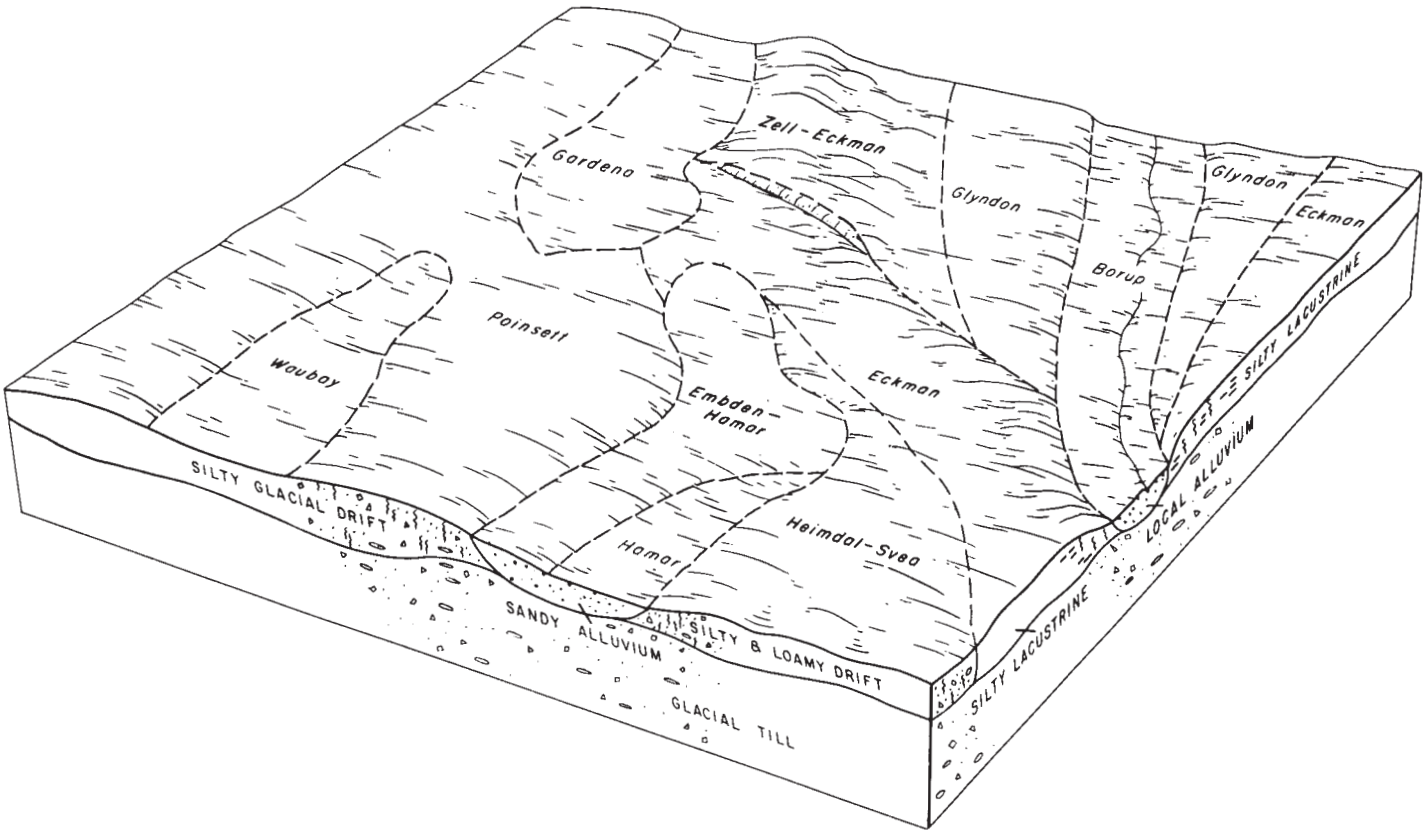

Figure 3—**Pattern of topography, soils, and underlying material in the Poinsett-Eckman-Heimdal association.**

formed in local alluvium and the under-lying glacial till. The soils in this group are dominantly loam and clay loam. Most of the nearly level to undulating and sloping soils are cultivated, but extensive areas of rolling to steep soils remain in native grass and are used for range, for growing hay, and for wildlife habitat. Control of water erosion and soil blowing and maintenance of fertility and tilth are the main concerns of management.

3. *Peever association*

Well-drained, nearly level to sloping, loamy soils formed in clayey glacial till

This association consists of two areas. The area north of the town of Sisseton is a ground moraine that has swells and swales. The other area, west and south of Sisseton, is dissected by many drainageways flowing northeasterly from the "Sisseton Hills" to the Little Minnesota River and the North Fork of the Whetstone River. Slopes are mostly nearly level and gently sloping or gently undulating. Steeper slopes are around sloughs, small lakes, and potholes in the northern area and along the many drainageways in the southern area. The drainage pattern is poorly defined in the northern area where slopes commonly are short and irregular, but it is well defined in the southern area.

This association makes up about 17 percent of the county. About 70 percent of it is Peever soils, and the rest is minor soils.

Peever soils have a surface layer of dark-gray clay loam. The subsoil is dark-gray and dark grayish-brown clay in the upper part and is calcareous, light brownish-gray clay and clay loam in the lower part. The underlying material is calcareous, light brownish-gray clay loam.

Minor soils in the association are Aastad and Cavour soils in low spots and swales, Forman soils on rounded swells, Hattie and Kloten soils on the sides of entrenched drainageways, Lamoure soils on bottom lands, Parnell and Tonka soils in depressions and low areas, and Rentill soils on rises.

Peever soils are medium or high in fertility, and they have moderate or high available water capacity . They take in water slowly. These soils lose tilth easily when cultivated. Control of water erosion and soil blowing, maintenance of fertility and tilth, and improvement of water intake are the main concerns of management.

Nearly all of this association is cultivated. Corn, small grain, flax, and alfalfa grow well in Peever soils. Some minor soils that are steep or poorly drained are used for pasture, for growing hay, and as wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

4. *Forman-Aastad association*

Well drained and moderately well drained, nearly level to rolling, loamy soils formed in loamy glacial till

This association is an undulating ground moraine consisting of swells and swales. Differences in elevation range from 10 to 25 feet. Slopes commonly are short and are mostly nearly level and gently undulating. Steeper areas are along the few drainageways in the association; around the many sloughs, small lakes, and potholes scattered throughout; and above flats along Lake Traverse. The drainage pattern is poorly defined, and the swales and drainageways terminate in sloughs, potholes, and small lakes.

This association makes up about 15 percent of the county. About 60 percent of it is Forman soils, and about 20 percent is Aastad soils. The rest is minor soils.

Forman soils are on slightly rounded swells, They are nearly level to rolling and are well drained. They have a surface layer of dark-gray loam and a clay loam subsoil that is dark brown and brown in the upper part and light brownish gray in the lower part. The underlying material is calcareous, light brownish-gray and light yellowish-brown clay loam and loam.

Aastad soils are in the lower parts of the landscapes and in swales, are nearly level or gently sloping, and are moderately well drained. They have a thick surface layer of dark-gray loam and a subsoil that is dark grayish-brown loam in the upper part, brown clay loam in the middle part, and light brownish-gray loam in the lower part. The underlying material is calcareous, light brownish-gray loam.

Minor soils in the association are Buse soils on the tops and upper sides of ridges and knolls, Hamerly and Vallers soils in low areas rimming closed depressions, Heimdal and Peever soils on some of the rounded swells intermingled with Forman soils, and Parnell and Tonka soils in closed depressions. Areas of Marsh are also in this association.

Forman and Aastad soils are easy to work, are medium or high in fertility, and have high available water capacity. Control of water erosion and soil blowing and maintenance of fertility and tilth are the main concerns of management.

Nearly all of this association is cultivated. The Forman and Aastad soils are well suited to all crops commonly grown in the county. Some steeper areas and some poorly drained minor soils are used for grazing, for growing hay, and for wildlife habitat. Growing cash crops, dairy farming, and general livestock farming are the main farm enterprises.

5. *Peever-Tonka association*

Well-drained and poorly drained, level to gently undulating, loamy and silty soils formed in clayey glacial till

This association is an undulating ground moraine consisting of swells, swales, and many closed depressions. Differences in elevation range from 2 to 10 feet in much of the association. Slopes are mostly nearly level. Gently undulating and steeper slopes are along the few drainageways and around the many potholes or depressions. The drainage pattern in much of the association is poorly defined.

This association makes up about 4 percent of the county. About 50 percent of it is Peever soils, and about 25 percent is Tonka soils. The rest is minor soils.

Peever soils are on slightly rounded swells and flats, are mostly nearly level and gently undulating, and are well drained. The surface layer is dark-gray clay loam. The subsoil is dark-gray and dark grayish-brown clay in the upper part and calcareous, light brownish-gray clay and clay loam in the lower part. The underlying material is calcareous, light brownish-gray clay loam.

Tonka soils are in depressions, are level, and are poorly drained. They have a surface layer of dark-gray silt loam, a subsurface layer of gray silt loam, and a subsoil of dark-gray and gray clay. The underlying material is gray clay loam.

Minor soils in the association are Aastad soils in swales, Forman soils on some of the swells, Hamerly and Vallers

soils in low areas rimming closed depressions, and Parnell soils in some of the closed depressions.

Peever and Tonka soils are medium or high in fertility, have high available water capacity, take in water slowly, and are slow to dry out in the spring. Wetness of the Tonka soils commonly delays farming in spring. Control of soil blowing and water erosion, maintenance of fertility and tilth, improvement of water intake in Peever soils, and improvement of drainage in Tonka soils are the main concerns of management.

Most areas of this association are cultivated. Corn, flax, small grain, and alfalfa grow well in Peever soils and are suited, where drainage is adequate, to Tonka soils. Some areas of Tonka soils are used for grazing, for growing hay, and for wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

6. Forman-Aastad-Buse association

Well drained and moderately well drained, gently undulating to steep, loamy soils formed in loamy glacial till

This association is a glacial moraine that consists of hills, swales, and numerous depressions or potholes. Slopes are short and irregular and are mostly undulating and rolling (fig. 4). Slopes are hilly to steep, however, around some lakes and sloughs and along wooded coulees or drainageways that dissect the eastern side of the association, the soils in some hilly areas are stony. The drainage pattern is well defined in parts of this association, but in other areas swales and small drainageways terminate in sloughs, small lakes, and depressions.

This association makes up about 15 percent of the county. About 40 percent of it is Forman soils, about 20 percent is Aastad soils, and about 15 percent is Buse soils (fig. 5). The rest is minor soils.

Forman soils are on the sides of rounded hills, are gently undulating to steep, and are well drained. They have a surface layer of dark-gray loam. The subsoil is clay loam that is dark brown and brown in the upper part and light brownish gray in the lower part. The underlying material is calcareous, light brownish-gray clay loam and light yellowish-brown loam.

Aastad soils are in swales and are moderately well drained. They have a thick surface layer of dark-gray loam. The subsoil is dark grayish-brown loam in the upper part; brown clay loam in the middle part; and calcareous, light brownish-gray loam in the lower part. The underlying material is calcareous, light brownish-gray loam.

Buse soils are in the higher parts of the landscape, are undulating to steep, and are well drained. They have a

Figure 4.—**Typical area of Forman-Aastad-Buse association. Parnell soils are in the small pothole in the foreground where grass is taller.**

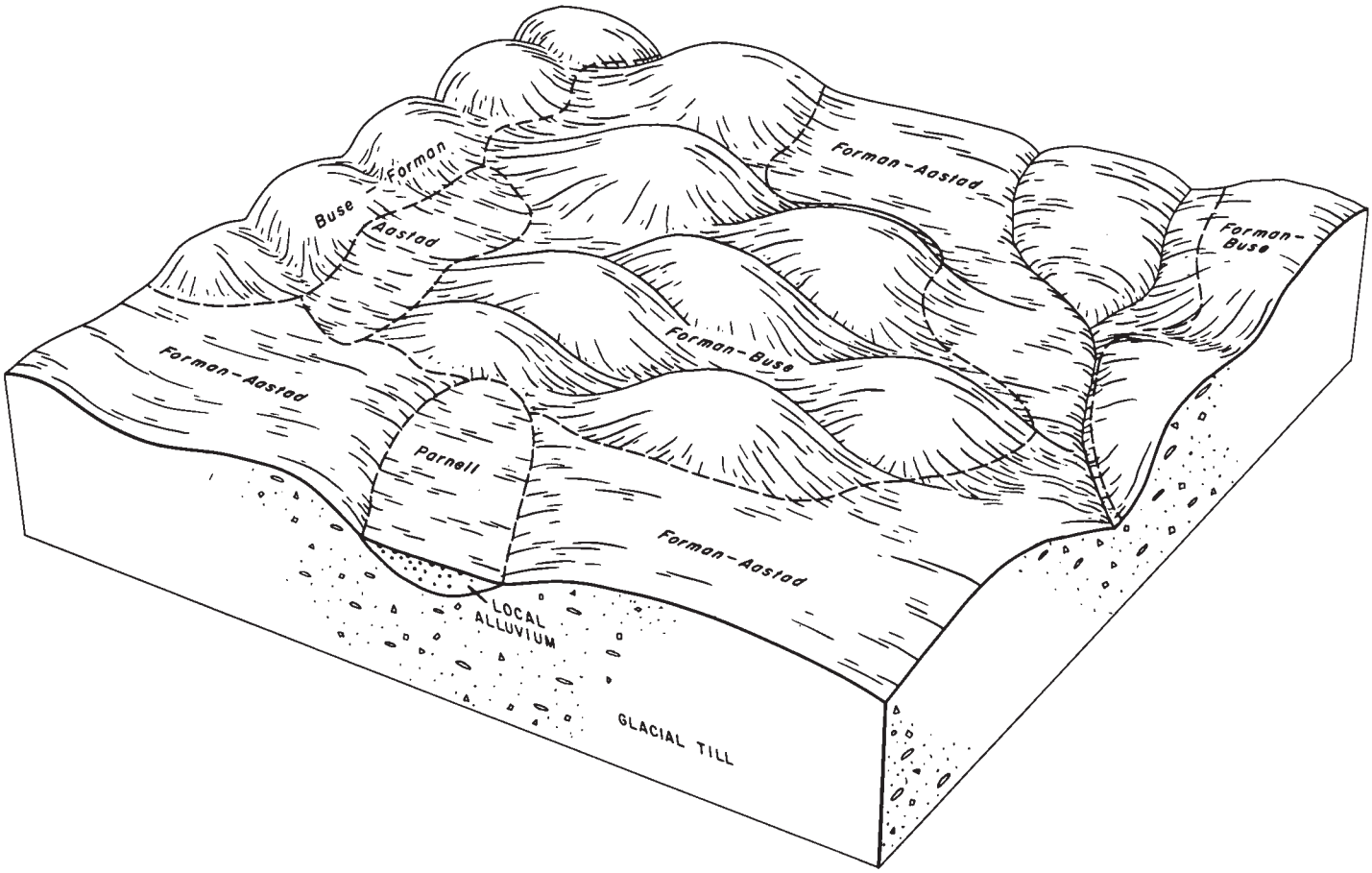

Figure 5.—**Pattern of topography, soils, and underlying material in the Forman-Aastad-Buse association.**

surface layer of calcareous, dark-gray loam. The underlying material is calcareous, light brownish-gray and pale-yellow loam.

In most places in this association, the Forman, Aastad, and Buse soils occur together in intricate patterns on the landscape.

Minor soils in the association are Barnes intermingled with Forman soils; Fordville, Renshaw, and Sioux soils, which are underlain by sand and gravel and are on some of the knolls and hilltops; Hamerly and Vallers soils in low areas that rim some of the sloughs and depressions; Parnell and Tonka soils in depressions; Sieche soils on the sides of wooded coulees; and Sinai soils on mesalike hilltops. Also in this association are small lakes and Marsh.

The Forman and Aastad soils are medium or high in fertility and have high available water capacity. Buse soils are low or medium in fertility and are stony in places. Stoniness, control of erosion, and maintenance of fertility are the main concerns of management.

In many areas of this association soils are too steep or too stony to be cultivated. Some of the less steep soils are in cultivation and are used mainly for feed crops. Extensive areas remain in native vegetation and are used for range. Livestock farming and ranching are the main farm enterprises.

7. *Hamerly-Vallers association*

Moderately well drained to poorly drained, nearly level and gently undulating, loamy soils formed in loamy glacial till

This association is a gently undulating ground moraine that consists of slight swells, swales, and many small potholes. Slopes are mostly nearly level and gently undulating. Steeper slopes are around sloughs.

This association makes up about 2 percent of the county. About 65 percent of it is Hamerly soils, and about 15 percent is Vallers soils. The rest is minor soils.

Hamerly soils are on slight swells and gentle rises and are nearly level and gently undulating. They are moderately well drained or somewhat poorly drained. The surface layer is calcareous, dark-gray loam. The underlying material is calcareous, light-gray and pale-yellow loam.

Vallers soils are in low areas between the swells and rises, are mostly nearly level, and are poorly drained. The surface layer is calcareous, gray loam. It is underlain by calcareous, gray, light olive-gray, and light-gray loam.

Minor soils in this association are Heimdal soils on the sides of low knolls, Parnell and Tonka soils in depressions, Sisseton soils on the tops of some low knolls, and Svea soils in swales.

The Hamerly and Vallers soils are medium in fertility and have high available water capacity. Their high content of lime causes them to blow easily and also affects the availability of plant nutrients. Wetness from a fluctuating water table commonly delays spring planting. Control of soil blow-

ing, improvement of fertility, and improvement of drainage are the main concerns of management.

Most areas of this association are cultivated. Hamerly and Vallers soils are suited to most crops commonly grown in the county. The more poorly drained areas remain in native vegetation and are used for pasture, for growing hay, and for wildlife habitat. Growing cash crops, dairy farms, and general livestock farms are the main enterprises.

Somewhat Excessively Drained and Well-Drained Soils Formed in Outwash Sediment; on Uplands and Terraces

The soils in this group formed in loamy sediment underlain by sand and gravel. They are dominantly loam. Many of the nearly level to sloping or undulating areas are cultivated, but most of the rolling to steep areas remain in native grass and are used for range. The major soils are subject to erosion and soil blowing and also are droughty.

8. *Renshaw-Fordville association*

Somewhat excessively drained and well-drained, nearly level to steep, loamy soils that are shallow and moderately deep over outwash sand and gravel

Small areas of this association are scattered throughout the county. They consist mainly of glacial outwash moraines and glacial outwash plains. Slopes are mostly nearly level and gently sloping on the outwash plains and stream terraces, but they range from nearly level to steep in areas of outwash moraines. A few sloughs, small lakes, and potholes are scattered throughout the areas.

This association makes up about 6 percent of the county. About 45 percent of it is Renshaw soils, and about 30 percent is Fordville soils (fig. 6). The rest is minor soils.

Renshaw soils are nearly level to steep and are somewhat excessively drained. The surface layer is dark-gray loam, and the subsoil is dark-gray and dark grayish-brown loam. Sand and gravel are at a depth of 15 inches.

Fordville soils are nearly level and gently sloping and are well drained. They have a surface layer of dark-gray loam. The subsoil is dark-gray and dark grayish-brown loam. Sand and gravel are at a depth of 22 inches.

In some parts of this association, the Renshaw and Fordville soils occur together in intricate patterns on the landscape.

Minor soils in this association are Buse and Forman soils in areas where the sand and gravel thins out or is absent, Divide and Marysland soils in low, wet areas, and Sioux soils on ridges. Areas of Marsh are in some low areas.

Fordville soils are medium in fertility, and Renshaw soils are low in fertility. These soils are droughty. Conservation of moisture, control of water erosion and soil blowing, and maintenance or improvement of fertility are the main concerns of management.

About 50 percent of this association is cultivated. Corn, flax, wheat, oats, rye, and alfalfa are the crops grown, but corn is not so well suited as small grains and flax. Areas of

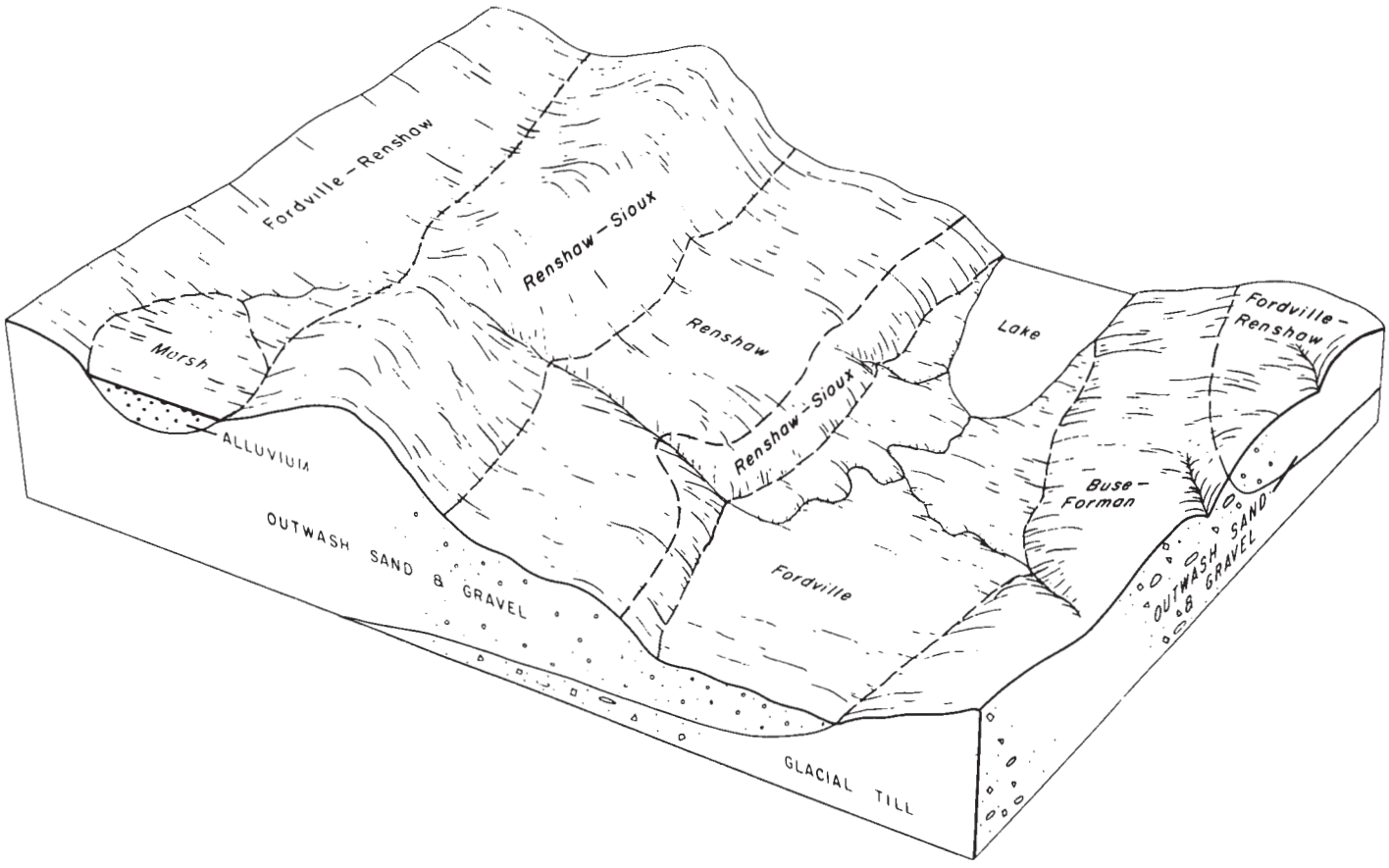

Figure 6.—**Pattern of topography, soils, and underlying material in the Renshaw-Fordville association.**

steeper soils and undrained areas of poorly drained minor soils remain in native vegetation and are used for range, for growing hay, and for wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

Well-Drained Soils Formed in Loess and Glacial Till; on Uplands

The soils in this group formed in a thin mantle of loess and glacial till. They are dominantly silt loam. Slopes are mostly nearly level to sloping. Most of the soils are cultivated and are subject to water erosion and soil blowing.

9. Vienna association

Well-drained, nearly level to sloping, silty soils formed in loess and glacial till

This soil association is in some of the higher elevations of the county where the glacial ground moraine is capped with a thin mantle of silty material. The swells or rises and swales have differences in elevation that range from 5 to 15 feet. The long, smooth slopes are mostly nearly level and gently sloping. Steeper slopes are around sloughs and along drainageways. The drainage pattern is well defined.

This association makes up about 3 percent of the county. About 80 percent of it is Vienna soils. The rest is minor soils.

Vienna soils have a surface layer of dark-gray silt loam. The subsoil is grayish-brown silt loam in the upper part; light olive-brown loam in the middle part; and calcareous, pale-yellow clay loam in the lower part. The underlying material is calcareous, pale-yellow clay loam.

Among the minor soils in this association are Buse and Forman soils on the sides of entrenched drainageways, Fordville and Renshaw soils in scattered areas where the underlying material is sand and gravel, and Lamoure soils on bottom lands along drainageways.

Vienna soils are medium or high in fertility and have high available water capacity. Control of erosion and maintenance of fertility are the main concerns of management.

Nearly all of this association is cultivated. The soils are well suited to corn, small grains, flax, and alfalfa. Small areas are used for pasture, for growing hay, and for wildlife habitat. Growing cash crops, dairy farming, and general livestock farming are the main farm enterprises.

Moderately Well Drained to Poorly Drained Soils Formed in Lacustrine Sediment, Glacial Melt-water Deposits, and Glacial Till; on Uplands

The soils in this group formed mainly in lacustrine sediment and glacial till. They are dominantly silt loam, loam, fine sandy loam, and loamy fine sand. Slopes are mostly nearly level. Many of the soils have a water table within a depth of 5 feet. Many areas are cultivated, but the more poorly drained areas are used for pasture, for growing hay, and for wildlife habitat. Improvement of drainage and control of soil blowing are main concerns of management.

10. Marsh-Antler-Hamerly association

Marsh and moderately well drained to poorly drained, nearly level, calcareous, silty and loamy soils formed in lacustrine sediment and glacial till

This association is a broad, slightly depressed, glacial lake plain that consists of sloughs, open water, potholes, flats, and slight rises. Differences in elevation range from 2 to 5 feet. Slopes are mostly nearly level.

This association makes up about 2 percent of the county. About 50 percent of it is Marsh, about 20 percent is Antler soils, and about 10 percent is Hamerly soils. The rest is minor soils.

The areas of Marsh are in the lowest parts of the association and commonly contain small bodies of open water. Water is near or on the surface during much of the growing season.

Antler soils are on flats adjacent to Marsh. They are nearly level, and are somewhat poorly drained or poorly drained. They have a surface layer of calcareous, dark-gray and gray silt loam. Below the surface layer are layers of silt loam and loam that are dominantly gray. Below a depth of 29 inches the underlying material is calcareous, mottled loam.

Hamerly soils are on very slight rises and are moderately well drained or somewhat poorly drained. They have a surface layer of calcareous, dark-gray loam. Below this is calcareous, light-gray loam. The rest of the soils is calcareous loam that is light olive brown when moist and is mottled in the lower part.

Minor soils in the association are Colvin and Tonka soils in depressions; Glyndon soils intermingled with Antler and Hamerly soils; Playmoor soils in low areas along ill-defined, sluggish drainageways; and Vallers soils in low areas adjacent to depressions.

Marsh is too wet to be suited to pasture plants. Vegetation is cattail, rushes, and sedges. Wetness from a high water table delays farming in some years on the Antler and Hamerly soils. The high content of lime in these soils causes them to blow easily when they are dry and also affects the availability of plant nutrients. Control of soil blowing, maintenance or improvement of fertility, and improvement of drainage are the main concerns of management.

Much of this association serves as wildlife habitat. Parts of the better drained areas are cultivated. Corn, small grains, flax, and alfalfa are the main crops. Other areas remain in native vegetation and are used for grazing, for growing hay, and for wildlife habitat. If adequately drained and fertilized, many of the soils in this association have a potential for many of the crops commonly grown in the county.

11. Towner-Hecla-Hamar association

Moderately well drained to poorly drained, nearly level, loamy and sandy soils formed in glacial melt water deposits and lacustrine sands

This association is a glacial lake plain consisting of slight swells, swales, and low flats. Slopes are nearly level. Sluggish drainageways commonly terminate in sloughs and depressions or potholes, and the drainage pattern is poorly defined.

This association makes up less than 1 percent of the county. About 25 percent of it is Towner soils, about 25 percent is Hecla soils, and about 15 percent is Hamar soils. The rest is minor soils.

Towner soils are on slightly depressed flats and are moderately well drained. They have a surface layer of dark-gray fine sandy loam and loamy fine sand. The underlying material is grayish-brown loamy fine sand to a depth of 25 inches and is loam below this depth.

Hecla soils are on slight swells and are moderately well drained. They have a thick surface layer of dark-gray loamy fine sand and a transition layer of grayish-brown loamy fine sand. The underlying material is pale-brown and light-gray loamy fine sand and fine sand.

Hamar soils are in swales and depressions and are somewhat poorly drained or poorly drained. They have a thick surface layer of dark-gray fine sandy loam and grayish-brown loamy fine sand and a transition layer of light brownish-gray loamy fine sand. The underlying material is loamy fine sand that is olive and olive gray when moist. These soils have prominent mottles below a depth of 16 inches.

Minor soils in the association are mainly Borup soils in some of the low wet areas, Embden soils in swales along with Hecla soils, and Glyndon and Ulen soils on some of the flats. Also in this association are small areas of Marsh.

Towner, Hecla, and Hamar soils are medium in fertility but are susceptible to soil blowing. Wetness from a high water table commonly delays spring planting. Control of soil blowing, improvement of drainage, and maintenance of fertility are the main concerns of management.

Nearly all of this association is cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops. Sunflowers also grow well on these soils. A few undrained, wet areas remain in native vegetation and are used for grazing, for growing hay, or for wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

12. Doran association

Somewhat poorly drained, nearly level, loamy soils formed in glacial melt-water deposits and glacial till

This association is a flat-appearing glacial lake plain just above the adjacent Marsh-Antler-Hamerly association. Slopes are mostly nearly level. Areas of sloping to hilly soils are on the sides of large drainageways and along the east side of the main area of Doran soils.

This association makes up about 1 percent of the county. About 60 percent of it is Doran soils. The rest is minor soils.

Doran soils have a surface layer of dark-gray loam and a subsoil of grayish-brown clay loam. The underlying material is calcareous, light-gray and light grayish-brown clay loam.

Minor soils in the association are mainly Borup soils in low areas along sluggish drainageways; Eckman, Forman, and Zell soils on low knolls and ridges; Glyndon, Hamerly, and Vallers soils in low areas adjacent to closed depressions; Renshaw and Sverdrup soils in areas underlain by stringers of sandy to gravelly material; and Tonka soils in small depressions.

Doran soils are medium or high in fertility and have high available water capacity. These soils take in water slowly, and spring planting commonly is delayed by wetness. Conservation of moisture, maintenance of tilth, and improvement of water intake into the subsoil are the main concerns of management.

Nearly all of this association is cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops grown, and they are well suited to the Doran soils. Some of the areas of sloping soils and many of the undrained, wet areas remain in native vegetation. These areas are used for grazing, for growing hay, or for wildlife habitat. Growing cash crops, dairy farming, and general livestock farming are the main farm enterprises.

13. Glyndon-Gardena association

Moderately well drained and somewhat poorly drained, nearly level, silty soils formed in lacustrine silts

This association is a broad, glacial lake basin that has only slight differences in elevation. Slopes are mostly nearly level, but areas of gently sloping soils are around some of the depressions scattered throughout the association.

This association makes up about 1 percent of the county. About 85 percent of it is Glyndon soils, and about 10 percent is Gardena soils. The rest is minor soils.

Glyndon soils are moderately well drained or somewhat poorly drained. They have a thick surface layer of calcareous, dark-gray and gray silt loam. The underlying material is calcareous, gray, light yellowish-brown, and pale-yellow silt loam.

Gardena soils are moderately well drained. They have a surface layer of dark-gray silt loam. The subsoil is gray and light brownish-gray silt loam. The underlying material is calcareous, white, light-gray, and pale-yellow silt loam.

Minor soils in this association are mainly Borup soils in low areas and closed depressions, Eckman soils on slight rises, and Embden and Hamar soils in some of the swales and low areas.

Glyndon and Gardena soils are medium or high in fertility, and they have high available water capacity. Wetness from the rise of the water table delays farming in some years. The high content of lime in the Glyndon soil causes it to blow easily and affects the availability of plant nutrients. Control of soil blowing, maintenance of fertility, and seasonal wetness are the main concerns of management.

Nearly all of this association is cultivated. Corn, soybeans, flax, small grains, and alfalfa are the main crops. Some undrained, wet areas remain in native grass. They are used for grazing, for growing hay, or for wildlife habitat. Growing cash crops, dairy farming, and general livestock farming are the main farm enterprises.

Moderately Well Drained and Poorly Drained Soils Formed in Alluvium; on Bottom Lands, Low Terraces, and Upland Flats

The soils in this group formed in alluvium. They are dominantly silt loam, silty clay loam, and clay. Many areas of the better drained soils are cultivated, but many areas of the poorly drained soils are used for pasture, for growing hay, and for wildlife habitat. Wetness from flooding or from a high water table and maintenance of tilth are management concerns, and some of the soils also are subject to soil blowing.

14. LaDelle-Playmoor-Lamoure association

Moderately well drained and poorly drained, nearly level, silty soils formed in alluvium

This association consists of bottom lands and low terraces along the major streams in the county. Slopes are mostly nearly level.

This association makes up about 5 percent of the county.

About 35 percent of it is LaDelle soils, about 30 percent is Playmoor soils, and about 15 percent is Lamoure soils. The rest is minor soils.

LaDelle soils are on high bottoms and low terraces and are moderately well drained. They have a thick surface layer of calcareous, dark-gray silt loam. The underlying material is calcareous, gray and dark-gray silt loam.

Playmoor soils are on low bottoms and are poorly drained. They have a surface layer of calcareous, dark-gray silty clay loam. The underlying material is calcareous, gray and dark-gray silty clay loam. Spots and streaks of salts are in the upper part of the soils.

Lamoure soils are on bottom lands and are poorly drained. They have a surface layer of calcareous, dark-gray silty clay loam and a subsoil of calcareous, gray silty clay loam. The underlying material is calcareous, gray, dark-gray, and olive-gray silty clay loam.

Minor soils in this association are Dovray and Ludden soils in places where the alluvium is more clayey, Hamerly and Vallers soils on flats adjacent to the bottom lands, and Loamy Fluvaquents along some of the stream channels.

LaDelle, Playmoor, and Lamoure soils are medium or high in fertility and have high available water capacity. LaDelle soils have little or no limitations for crops, but wetness from flooding and from a high water table is a concern of management on the Playmoor and Lamoure soils. Salinity also is a concern on Playmoor soils.

The better drained areas of this association are cultivated. Corn, small grains, and alfalfa are the main crops grown, but some soybeans are grown on LaDelle soils. Many of the more poorly drained areas remain in native vegetation and are used for pasture, for growing hay, or for wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

15. Dovray-Ludden-Lamoure association

Poorly drained, nearly level, clayey and silty soils formed in alluvium

This association consists of bottom lands, low terraces, and broad, low flats on uplands. Stream channels meander through many of the areas. Slopes are mostly nearly level.

This association makes up about 3 percent of the county. About 25 percent of it is Dovray soils, about 13 percent is Ludden soils, and about 12 percent is Lamoure soils. The rest is minor soils.

Dovray soils have a thick surface layer of very dark-gray clay and a subsoil of calcareous, dark-gray and gray clay. The underlying material is calcareous, gray clay.

Ludden soils commonly are at a slightly lower level than Dovray soils. They have a thick surface layer of calcareous, dark-gray clay underlain by calcareous, gray clay and light-gray silty clay.

Lamoure soils are along tributary drainageways and on flood plains adjacent to stream channels. They have a surface layer of calcareous, dark-gray silty clay loam and a subsoil of calcareous, gray silty clay loam. The underlying material is calcareous, gray, dark-gray, and olive-gray silty clay loam.

Minor soils in this association are mainly Bearden and LaDelle soils on high bottoms and low terraces, Loamy Fluvaquents in some of the channeled areas, Parnell and Tonka soils in small depressions, Peever soils on islands of uplands, and Playmoor soils in some of the low, wet areas. Small areas of Marsh are in some low areas.

Dovray, Ludden, and Lamoure soils are medium or high in fertility. Dovray and Ludden soils take in water very slowly. Wetness from flooding and from the high water table is the main concern of management. Other concerns are mainly control of soil blowing, improvement of water intake, and maintenance of tilth and fertility.

The better drained areas of this association, mainly Dovray and Lamoure soils, are cultivated. Corn, small grains, flax, and alfalfa are the main crops. The more poorly drained areas remain in native vegetation and are used for grazing, for growing hay, and for wildlife habitat. Growing cash crops and general livestock farming are the main farm enterprises.

Descriptions of the Soils

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

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for dry soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Marsh and Sandy lake beaches, for example, do not belong to a soil series, but nevertheless, they are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. The page for the description of each capability unit 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 (*6*).

Aastad Series

The Aastad series consists of deep, moderately well drained, nearly level to rolling, loamy soils in swales and on toe slopes in uplands. These soils formed in glacial till. The native vegetation is mostly tall grasses.

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

Soil	Acres	Percent
Aastad loam, 0 to 2 percent slopes	3,400	0.5
Antler-Colvin silt loams	550	.1
Antler-Tonka silt loams	1,000	.1
Antler and Hamerly soils, 0 to 2 percent slopes	3,480	.5
Barnes-Buse stony complex, 9 to 40 percent slopes	5,660	.8
Bearden silty clay loam	2,700	.4
Borup silt loam	3,900	.5
Buse-Forman loams, 20 to 40 percent slopes	10,500	1.4
Colvin silt loam, saline	650	.1
Dickey fine sandy loam, 0 to 2 percent slopes	860	.1
Dickey fine sandy loam, 2 to 6 percent slopes	1,350	.2
Divide-Marysland loams	4,800	.7
Doran loam	5,250	.7
Dovray clay	5,900	.8
Eckman loam, 0 to 2 percent slopes	4,862	.7
Eckman loam, 2 to 6 percent slopes	5,400	.7
Eckman-Zell complex, 6 to 9 percent slopes	1,080	.1
Embden-Hamar fine sandy loams	2,750	.4
Fordville loam, 0 to 3 percent slopes	11,250	1.5
Fordville-Renshaw loams, 3 to 6 percent slopes	5,400	.7
Forman-Aastad loams, 0 to 2 percent slopes	23,500	3.2
Forman-Aastad loams, 2 to 6 percent slopes	72,550	10.0
Forman-Aastad loams, 6 to 9 percent slopes	17,350	2.4
Forman-Aastad loams, 9 to 15 percent slopes	25,200	3.5
Forman-Aastad stony complex, 0 to 9 percent slopes	3,000	.4
Forman-Buse loams, 6 to 9 percent slopes, eroded	16,100	2.2
Forman-Buse loams, 9 to 15 percent slopes, eroded	10,400	1.4
Forman-Buse loams, 15 to 25 percent slopes	12,600	1.7
Forman-Buse stony complex, 9 to 40 percent slopes	18,660	2.6
Gardena silt loam	1,100	.2
Glyndon silt loam, 0 to 3 percent slopes	9,360	1.3
Hamar fine sandy loam	420	.1
Hamerly-Tonka complex, 0 to 3 percent slopes	11,800	1.6
Hamerly-Vallers loams, 0 to 2 percent slopes	5,100	.7
Hamerly-Vallers loams, 2 to 4 percent slopes	12,650	1.7
Hattie clay loam, 9 to 15 percent slopes	2,250	.3
Hattie clay loam, 15 to 40 percent slopes	450	.1
Hattie and Kloten soils, 9 to 25 percent slopes	350	(1)
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	990	.1
Heimdal-Sisseton loams, 2 to 6 percent slopes	26,750	3.8
Heimdal-Sisseton loams, 6 to 9 percent slopes	10,200	1.4
Heimdal-Svea loams, 0 to 2 percent slopes	12,500	1.7
Heimdal-Svea loams, 2 to 6 percent slopes	32,500	4.5
LaDelle silt loam	13,500	1.8
Lamoure silty clay loam	8,200	1.1
Loamy Fluvaquents	8,400	1.2
Ludden clay	2,900	.4
Maddock loamy fine sand, 0 to 6 percent slopes	550	.1
Maddock loamy fine sand, 6 to 25 percent slopes	1,300	.2
Marsh	23,800	3.3
Marysland silt loam, wet	2,050	.3
Parnell silty clay loam	13,120	1.8
Peever clay loam, 0 to 2 percent slopes	34,000	4.7
Peever clay loam, 2 to 6 percent slopes	50,650	6.9
Peever clay loam, 6 to 9 percent slopes	4,400	.6
Peever-Cavour complex, 0 to 3 percent slopes	1,700	.2
Peever-Tonka complex	18,550	2.5
Playmoor silty clay loam	11,450	1.6
Poinsett silt loam, 0 to 2 percent slopes	10,860	1.5
Poinsett silt loam, 2 to 6 percent slopes	6,630	.9
Rauville mucky silt loam	2,120	.3
Renshaw loam, 0 to 3 percent slopes	5,750	.8
Renshaw loam, 3 to 9 percent slopes	9,800	1.3
Renshaw-Sioux loams, 3 to 9 percent slopes	3,500	.5
Renshaw-Sioux loams, 9 to 20 percent slopes	3,450	.5
Renshaw-Sioux stony loams, 9 to 40 percent slopes	1,800	.2
Rentill loam, 0 to 2 percent slopes	2,470	.3
Rentill loam, 2 to 6 percent slopes	740	.1
Sandy lake beaches	350	(1)
Sieche loam, 15 to 40 percent slopes	3,980	.5
Sinai silty clay, 0 to 2 percent slopes	2,460	.3
Sinai silty clay, 2 to 6 percent slopes	640	.1
Sisseton loam, 25 to 40 percent slopes	4,300	.6
Sisseton-Heimdal loams, 9 to 25 percent slopes	4,090	.6
Svea loam, 5 to 9 percent slopes	630	.1
Sverdrup sandy loam, 0 to 3 percent slopes	2,700	.4
Sverdrup sandy loam, 3 to 9 percent slopes	5,150	.7
Tonka silt loam	8,450	1.1
Towner fine sandy loam	1,070	.1
Ulen sandy loam	760	.1
Vallers-Hamerly loams, 0 to 2 percent slopes	4,100	.6
Vienna silt loam, 0 to 2 percent slopes	3,160	.4
Vienna silt loam, 2 to 6 percent slopes	12,755	1.7
Vienna silt loam, 6 to 9 percent slopes	2,360	.3
Waubay silty clay loam	1,450	.2
Zell-Eckman complex, 9 to 25 percent slopes	580	.1
Gravel pits	850	.1
Water, less than 40 acres	1,265	.2
Water, greater than 40 acres	20,928	2.8
Total	730,240	100.0

[1] Less than 0.05 percent.

In a representative profile the surface layer is dark-gray loam about 12 inches thick. The subsoil, about 24 inches thick, is dark grayish-brown loam in the upper part; brown clay loam in the middle part; and light brownish-gray, calcareous loam in the lower part. It is slightly hard or hard when dry, and it is friable when moist. The underlying material is light brownish-gray, calcareous loam.

Fertility and content of organic-matter are high in Aastad soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is slow or medium, and most areas receive runoff from adjacent soils.

Many areas of these soils are cultivated and are used for growing corn, soybeans, flax, small grain, alfalfa, and tame grasses. In places areas remain in native grass and are used for grazing and for growing hay.

Representative profile of Aastad loam in a cultivated area of Forman-Aastad loams, 2 to 6 percent slopes; 1,017 feet north and 129 feet east of the southwest corner of sec. 28, T. 126 N., R. 52 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, friable; neutral; abrupt, smooth boundary.

A12—8 to 12 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine and medium, granular; soft, friable; neutral: clear, wavy boundary.

B1—12 to 18 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

B2—18 to 30 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; common, fine and medium, distinct mottles and stains that are yellowish red (5YR 4/6) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, blocky and subangular blocky; hard, friable; thin continuous clay films; neutral; abrupt, wavy boundary.

B3ca—30 to 36 inches, light brownish-gray (2.5Y 6/2) loam, olive brown (2.5Y 4/4) moist; common, fine and medium, prominent mottles and stains that are strong brown (7.5YR 5/8) moist; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, friable; few fine threads and coats of segregated lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1—36 to 49 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong

brown (7.5YR 5/8) and yellowish red (5YR 4/8) moist; massive; hard, friable; few fine threads and segregations of lime; strong effervescence moderately alkaline; gradual, wavy boundary.

C2—49 to 60 inches, light brownish-gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 4/8) moist; massive; hard, friable; few fine threads and segregations of lime; strong effervescence; moderately alkaline.

The A horizon is dark-gray or very dark gray loam or clay loam. It is neutral or slightly acid, and it ranges from 8 to 12 inches in thickness. The B1 horizon is very dark brown or very dark grayish brown when moist and has a hue of 10YR or 2.5Y. It ranges from 2 to 6 inches in thickness. The B2 horizon ranges from dark brown to very dark grayish brown when moist and has a hue of 10YR or 2.5Y. Clay content in the B2 horizon commonly ranges from 30 to 35 percent, but in places it is less than 30 percent. The B2 horizon ranges from 6 to 12 inches in thickness. The B1 and B2 horizons are neutral or mildly alkaline. The B3ca horizon is loam or clay loam and ranges from 2 to 6 inches in thickness. The C horizon is loam or clay loam.

Aastad soils are mapped with or are near Forman and Peever soils. Their position in the landscape is similar to that of Svea soils. Their horizons, when moist, are very dark grayish brown or are darker to a greater depth than Forman and Peever soils. Aastad soils have more clay in the B horizon than Svea soils.

Aastad loam, 0 to 2 percent slopes (AaA).—This soil is on uplands in concave-shaped swales and shallow drainageways. Areas commonly are long and narrow and range from 3 to 25 acres in size.

Included with this soil in mapping are small areas of Forman, Hamerly, Peever, and Tonka soils. Forman and Peever soils are on slight rises or on the edges of some areas. Hamerly soils are in low areas rimming small, closed depressions. Tonka soils are in closed depressions less than 2 acres in size, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is slow, and little or no erosion has occurred. Most areas receive additional runoff from adjacent soils. Farming is delayed for short periods during wet years. This soil has few limitations for crops.

Many areas are cultivated. This soil is well suited to all crops commonly grown in the county. Capability unit I–3; Overflow range site; windbreak suitability group 1.

Antler Series

The Antler series consists of deep, poorly drained and somewhat poorly drained, silty soils on uplands. They are nearly level and are calcareous. These soils formed in glacial lake sediment underlain by glacial till. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is dark-gray and gray, calcareous silt loam about 13 inches thick. It contains nests of gypsum crystals. The underlying material is gray, calcareous silt loam to a depth of about 18 inches. It is slightly hard when dry and friable when moist. Below this is a 4–inch layer of gray-and-white, calcareous loam that contains many cobbles and pebbles. This layer is underlain by light brownish-gray, calcareous silt loam to a depth of 29 inches. Below a depth of 29 inches is calcareous loam that is light olive brown and gray when moist and has yellowish-brown, strong-brown, and yellowish-red mottles.

Fertility is medium, and content of organic matter is moderate in Antler soils. Available water capacity is moderate or high. Permeability is moderately slow, and runoff is slow. The seasonal water table is at a depth ranging from 1 to 4 feet.

Some areas of these soils are cultivated and are used for growing corn, small grain, alfalfa, and tame grasses. Other areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Antler silt loam in an area of Antler and Hamerly soils, 0 to 2 percent slopes; 1,575 feet north and 186 feet east of the southwest corner of sec. 3, T. 129 N., R. 47 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable; few, fine, distinct nests of gypsum crystals; slight effervescence; moderately alkaline; abrupt, smooth boundary.

A12ca—8 to 13 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, coarse, subangular blocky structure parting to weak, fine granular; slightly hard, friable; few, fine, distinct nests of gypsum crystals; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—13 to 18 inches, gray (5Y 5/1) silt loam, dark gray (5Y 4/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; abrupt, wavy boundary.

IIC2ca—18 to 22 inches, gray (5Y 6/1) and white (5Y 8/1) loam, dark gray (5Y 4/1) and gray (5Y 5/1) moist; massive; slightly hard, friable; many cobbles, pebbles, and pieces of disintegrated rock; violent effervescence; moderately alkaline; clear, wavy boundary.

IIIC3—22 to 29 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; clear, wavy boundary.

IVC4—29 to 45 inches, light yellowish-brown (2.5Y 6/4) and light-gray (5Y 7/1) loam, light olive brown (2.5Y 5/4) and gray (5Y 6/1) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/8) and yellowish red (5YR 4/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

IVC5—45 to 60 inches, light brownish-gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 4/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is dark-gray or gray silt loam, clay loam, or silty clay loam. The upper part of it is mildly alkaline in places. The A horizon ranges from 6 to 16 inches in thickness. The Cca horizon ranges from dark gray to white in hue of 2.5Y or 5Y. It is silt loam, loam, or clay loam, and the calcium carbonate equivalent is 15 percent or more. That part of the C horizon below the Cca horizon is silt loam, loam, clay loam, and sandy loam. It commonly contains few to many stones and cobbles.

Antler soils are mapped with Colvin, Hamerly, and Tonka soils, and they are near Doran and Vallers soils. They have less silt and clay, are less saline, and are better drained than Colvin soils. They are more calcareous and are better drained than Doran and Tonka soils, and unlike those soils Antler soils lack a Bt horizon. Antler soils are more poorly drained than Hamerly soils and are better drained than Vallers soils.

Antler-Colvin silt loams (0 to 2 percent slopes) (Ac).—The soils of this complex are in broad, flat-appearing areas that have many shallow depressions. Antler soils are on very slight rises, and Colvin soils are in the shallow depressions. In places numerous stones are on the surface. Areas range from 20 to 45 acres in size.

About 50 percent of this complex is Antler soils, and about 30 percent is Colvin soils. The rest of the acreage is included soils. These are small areas of Tonka and Vallers soils. Tonka soils are in some depressions. Vallers soils are around the edges of the depressions. Also included are small spots of Marsh in the lowest parts of some depressions.

Runoff is slow, and water ponds on the surface of Colvin soils. Areas of Colvin soils are wet during much of the growing season. The high content of lime causes these soils to blow easily when they are dry and also affects the availability of plant nutrients. Control of soil blowing and im-

provement of drainage and fertility are the main concerns of management in cultivated areas. Drainage improvement measures are not feasible in many areas of Colvin soils.

Most areas of this complex remain in native grass and are used for grazing or for growing hay. Removal of stones is necessary in some areas if they are used for crops or for growing hay. Capability unit IIe–4. Antler soils in Silty range site, windbreak suitability group 1; Colvin soils in Wetland range site, windbreak suitability group 10.

Antler-Tonka silt loams (0 to 2 percent slopes) (At).—The soils of this complex are on uplands in flat-appearing areas where there are many, shallow depressions. Antler soils are in the better-drained parts of the areas, and Tonka soils are in the depressions. Stones and boulders are scattered on and below the surface except in uncleared areas. Areas range from 15 to 150 acres in size. In some cultivated areas Antler soils have a gray surface layer because the surface layer and the underlying layer has been mixed by plowing.

About 45 percent of this complex is Antler soils, and about 25 percent is Tonka soils. The rest of the acreage is included soils. These are small areas of Colvin and Vallers soils in some depressions.

Runoff is slow and is ponded in Tonka soils of the complex. Permeability is moderately slow in Antler soils and is slow in Tonka soils. The high lime content of Antler soils makes these soils blow easily and affects the availability of plant nutrients. Wetness in many small depressions also affects the use of these soils. Control of soil blowing and improvement of drainage are the main concerns of management.

Some areas of this complex are cultivated. Other areas remain in native grass and are used for grazing or for growing hay. Capability unit IIe–4. Antler soils in Silty range site, windbreak suitability group 1. Tonka soils in Wetland range site, windbreak suitability group 10.

Antler and Hamerly soils, 0 to 2 percent slopes (AvA).—These soils are on uplands in broad flats and in irregularly shaped areas around and between sloughs and potholes. Stones and boulders are scattered on and below the surface in uncleared areas. Areas range to as much as 600 acres. Some areas are mostly Antler silt loam, and some are mostly Hamerly loam. Other areas have both of these soils, but proportions differ from one area to the next. The profile of Antler silt loam is the one described as representative of the series.

Included with these soils in mapping are small areas of Colvin, Tonka, and Vallers soils. Colvin and Tonka soils are in small depressions that are less than 2 acres in size. Vallers soils are in low areas adjacent to depressions. These small areas of poorly drained soils are indicated on some detailed maps by the symbol for wet spot.

Runoff is slow. The water table is within 4 feet of the surface during part of the growing season, and wetness commonly delays spring planting and tillage. The high content of lime causes these soils to blow easily and affects the availability of plant nutrients. Control of soil blowing is the main concern of management, but improvement of drainage and maintenance of fertility also are important. Removal of stones is a continuing need in many areas.

Many areas are used for growing corn, barley, oats, alfalfa, and tame grasses. Capability unit IIe–4; Silty range site; windbreak suitability group 1.

Barnes Series

The Barnes series consists of deep, well-drained, rolling to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation is tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray loam about 4 inches thick. The subsoil, about 13 inches thick, is loam that is grayish brown in the upper part and brown in the lower part. It is slightly hard when dry and very friable when moist. The underlying material is light-gray, calcareous clay loam.

Content of organic matter is moderate, and fertility is medium or high in Barnes soils. Available water capacity is high. Permeability is moderate in the subsoil and is moderately slow in the underlying material. Runoff is medium.

Most areas of these soils remain in native grass and are used for grazing or for growing hay.

Representative profile of Barnes loam in an area of Barnes-Buse stony complex, 9 to 40 percent slopes, in native grass, 2,800 feet east and 150 feet south of the northwest corner of sec. 6, T. 123 N., R. 51 W.:

A1—0 to 4 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.

B21—4 to 9 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium subangular blocky; slightly hard, very friable; neutral; clear, smooth boundary.

B22–9 to 17 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

C1ca—17 to 27 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/6) moist; weak, coarse, prismatic structure; slightly hard, friable; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2—27 to 60 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5Yr 5/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

Depth to carbonates commonly is about 18 inches but ranges from 10 to 22 inches. The A horizon is dark-gray or very dark gray loam or silt loam. It ranges from 4 to 9 inches in thickness. The B horizon ranges from dark grayish brown to pale brown. It is loam or light clay loam and ranges from 6 to 13 inches in thickness. The C horizon is clay loam or loam.

Barnes soils are mapped with Buse soils and are near Aastad, Forman, Peever, and Svea soils. They have a thinner A horizon and are better drained than Aastad and Svea soils. They have a B horizon, and Buse soils do not. Also, they are calcareous at a greater depth than Buse soils. Barnes soils have less clay in the B horizon than Forman and Peever soils.

Barnes-Buse stony complex, 9 to 40 percent slopes (BbE).—The soils of this complex are on uplands. Barnes soils are on sides of ridges and hills, and Buse soils are on tops of ridges and hills. Slopes are short and irregular. Areas range from 20 to 500 acres in size. Stony areas, ranging from less than 1 acre to 20 acres in size, are scattered throughout the complex and generally are in the higher part of the landscape. The stones commonly are 2½ to 5 feet apart, and many of them are imbedded in the soil.

About 50 percent of this complex is Barnes loam, and about 25 percent is Buse loam and stony loam. The rest of the acreage is included soils. These are small areas of Parnell, Renshaw, Sioux, Svea, and Tonka soils. Parnell and Tonka soils are in small potholes less than 2 acres in size. The potholes and small spots of Marsh are indicated on the detailed maps by the symbol for wet spots. Renshaw and

Sioux soils are on gravelly, rounded ridgetops. Svea soils are in swales and in the lower part of landscapes near potholes.

Runoff is medium or rapid, and disturbed areas are subject to erosion. These soils are too stony and too erodible to be cultivated. They are better suited to grazing than to most other uses.

Most areas of this complex remain in native grass and are used for grazing. Small areas of Barnes soils that are relatively free of stones are used for growing hay. Barnes and Buse soils in capability unit VIIs–1 and windbreak suitability group, 10. Barnes soils in Silty range site; Buse soils in Thin Upland range site.

Bearden Series

The Bearden series consists of deep, somewhat poorly drained, nearly level, calcareous, silty soils in swales and in flat, basinlike areas on uplands. These soils formed in glacial-lacustrine material. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray, calcareous silty clay loam about 8 inches thick. The underlying material is light-gray, calcareous silty clay loam to a depth of 18 inches. It is slightly hard when dry and friable when moist. Below this depth the underlying material is pale-yellow, calcareous silty clay loam.

Content of organic matter is moderate or high in Bearden soils and fertility is medium. Available water capacity is moderate or high, and runoff is slow. Permeability is moderately slow. The seasonal water table is at a depth ranging from 3 to 5 feet.

Most areas of these soils are cultivated and are used for growing corn, soybeans, flax, small grains, alfalfa, and tame grasses.

Representative profile of Bearden silty clay loam in a cultivated field, 1,425 feet north and 55 feet east of the southwest corner of sec. 2, T. 128 N., R. 52 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1ca—8 to 18 inches, light-gray (N 7/0) silty clay loam, dark grayish brown (2.5Y 4/2) moist; very weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2ca—18 to 32 inches, pale-yellow (2.5Y 7/3) silty clay loam, light olive brown (2.5Y 5/3) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; violent effervescence; moderately alkaline; gradual, wavy boundary.

C3g—32 to 44 inches, pale-yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; common, medium, distinct mottles that are yellowish brown (10YR 5/8) and gray (5Y 5/1) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4g—44 to 60 inches, pale-yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; many, medium, distinct mottles that are yellowish brown (10YR 5/8) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; strong effervescence; moderately alkaline.

These soils commonly are silty clay loam or silt loam throughout, but in a few places the A horizon is silty clay. The A horizon ranges from very dark gray to gray. It ranges from 6 to 14 inches in thickness. The Cca horizon, when moist, ranges from dark grayish brown to olive in a hue of 2.5Y or 5Y. Calcium carbonate equivalent of the Cca horizon ranges from 20 to 35 percent or more.

Bearden soils are near Glyndon, Ludden, Poinsett, and Waubay soils. They are more clayey than Glyndon soils and less clayey than Ludden soils. Bearden soils are more calcareous and are more poorly drained than Poinsett and Waubay soils.

Bearden silty clay loam (0 to 2 percent slopes) (Be).—This soil is on flats and in swales on uplands. Areas range from 4 to 35 acres in size. In places cultivated fields have gray or light gray spots where the surface layer and underlying material have been mixed by plowing.

Included with this soil in mapping are Dovray, Parnell, Poinsett, and Tonka soils. Dovray, Parnell, and Tonka soils are in low, wet spots that are scattered throughout the areas. Many of them are shown on the detailed maps by the symbol for wet spots. Poinsett soils are on slight rises.

Runoff is slow. Wetness delays spring planting and tillage in some years. The high content of lime causes these soils to blow easily and also affects the availability of plant nutrients. Control of soil blowing is the main concern of management.

Most areas of this soil are cultivated and are used for growing corn, soybeans, small grains, alfalfa, and tame grasses. Capability unit IIe–4; Silty range site; windbreak suitability group 1.

Borup Series

The Borup series consists of deep, poorly drained, nearly level, calcareous, silty soils in swales, flats, and closed depressions on uplands. These soils formed in glacial-lacustrine deposit of silt and very fine sand. The native vegetation is mostly tall grasses and sedges.

In a representative profile the surface layer is dark-gray, calcareous silt loam about 8 inches thick. The underlying material, to a depth of 19 inches, is gray, calcareous silt loam that has dark yellowish-brown, yellowish-brown, and very dark gray mottles when moist. It is slightly hard when dry and friable to very friable when moist. Below this to a depth of 44 inches, it is light olive-gray, calcareous silt loam that has mottles of dark yellowish-brown, yellowish-brown, and very dark gray mottles when moist. Below a depth of 44 inches the underlying material is light-gray and pale-olive, calcareous silt loam.

Content of organic matter is moderate, and fertility is medium in Borup soils. Available water capacity is high, and permeability is moderately rapid. Runoff is very slow. The water table is at a depth of 1 to 3 feet during the early part of the growing season.

Many areas of these soils remain in native grass and are used for pasture and hay. Corn, soybeans, small grains, alfalfa, and tame grasses are grown in cultivated areas.

Representative profile of Borup silt loam in a cultivated area 1,134 feet east and 117 feet south of the northwest corner of sec. 1, T. 129 N., R. 49 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1ca—8 to 14 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; few, fine, faint mottles that are yellowish brown (10YR 5/4) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; clear, wavy boundary.

C2cacs—14 to 19 inches, gray (5Y 6/1) silt loam, gray (5Y 5/1) moist; common, fine and medium, distinct mottles that are dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/4), and very dark gray (5Y 3/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, very friable; common, medium nests of gypsum crystals; violent effervescence; moderately alkaline; clear, wavy boundary.

C3g—19 to 25 inches, light olive-gray (5Y 6/2) silt loam, olive gray (5Y

5/2) moist; common, fine and medium, distinct mottles that are yellowish brown (10YR 5/4, 5/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable; few fine threads of segregated lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4g—25 to 44 inches, light olive-gray (5Y 6/2) silt loam, olive gray (5Y 5/2) moist; common, fine and medium, distinct mottles that are yellowish brown (10YR 5/4, 5/6) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C5g—44 to 60 inches, light-gray (5Y 7/1) and pale-olive (5Y 6/3) silt loam, gray (5Y 6/1) and olive (5Y 5/3) moist; many, medium, prominent mottles that are strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The A horizon is dark-gray or gray silt loam or loam. It ranges from 4 to 14 inches in thickness. The C horizon is silt loam, very fine sandy loam, or loamy very fine sand.

Borup soils are near Eckman, Embden, Gardena, and Glyndon soils. They are more poorly drained than any of those soils. Also, Borup soils are more calcareous than Eckman, Embden, and Gardena soils and are less sandy than Embden soils.

Borup silt loam (0 to 2 percent slopes) (Bo).—This soil is in flats, swales, and shallow closed depressions on uplands. Areas range from 2 to 90 acres in size.

Included with this soil in mapping are small areas of Glyndon and Hamar soils. Glyndon soils are on very slight rises. Hamar soils are in some low spots. Also included in some areas is a soil similar to Borup soils, but the underlying material contains more sand that is coarser than very fine sand.

Runoff is very slow. Farming commonly is delayed by wetness caused by the high water table and from runoff from adjacent soils. During wet years crops commonly are drowned unless drainage is provided. The high content of lime affects availability of plant nutrients and also causes the soil to blow easily when it is dry. Wetness is the main concern of management.

Adequately drained areas of this soil are suited to such crops as corn, soybeans, small grains, and alfalfa. Undrained areas are better suited to hay, pasture, or wildlife habitat, but crops can be planted late in the season in these areas some years. Capability unit IIw–2 drained, IVw–2 undrained; Subirrigated range site; windbreak suitability group 2.

Buse Series

The Buse series consits of deep, well-drained, undulating to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation is mostly mid and short grasses and lesser amounts of tall grasses.

In a representative profile the surface layer is dark-gray, calcareous loam about 8 inches thick. The underlying material is light brownish-gray and pale-yellow, calcareous clay loam.

Content of organic matter is moderately low, and fertility is medium or low in Buse soils. Available water capacity is high. Permeability is moderate in the upper part of these soils and is moderately slow in the underlying material. Runoff is rapid or very rapid.

Most areas of these soils are in native grass and are used for grazing or for growing hay. Corn, small grains, and alfalfa are the main crops in cultivated areas.

Representative profile of Buse loam in an area of Forman-Buse loams, 15 to 25 percent slopes, in native grass; 2,595 feet east and 280 feet south of the northwest corner of sec. 32, T. 126 N., R. 52 W.:

A1—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

C1ca—8 to 20 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, fine and medium, subangular blocky structure; hard, friable; violent effervescence; moderately alkaline; gradual, smooth boundary.

C2—20 to 36 inches, pale-yellow (2.5Y 7/3) clay loam, light olive brown (2.5Y 5/4) moist; few, medium, prominent mottles that are reddish brown (5YR 5/4) and gray (N 5/0) moist; massive; hard, firm; strong effervescence; moderately alkaline; gradual, smooth boundary.

C3—36 to 60 inches, pale-yellow (2.5Y 7/3) clay loam, light olive brown (2.5Y 5/4) moist; common, medium, prominent mottles that are reddish brown (5YR 5/4) moist and few, medium, distinct mottles that are light gray (N 6/0) moist; massive; hard, firm; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark-gray loam or clay loam. It ranges from 5 to 10 inches in thickness. The C horizon is loam or clay loam.

Buse soils are mapped with Barnes and Forman soils and are near Hattie and Kloten soils. They do not have a B horizon, and Barnes, Forman, and Hattie soils do. They are calcareous at a shallower depth than Barnes and Forman soils, and they are less clayey than Hattie soils. Buse soils are deeper over shale than Kloten soils.

Buse-Forman loams, 20 to 40 percent slopes (BpF)—The complex of hilly to steep soils is on ridges and valley sides of entrenched streams on uplands. The Buse soils are in the higher parts of the landscape, and the Forman soils are below the Buse soils. Areas range from 7 to 80 acres in size. A few stones or boulders commonly are scattered on the surface. In places the surface layer of the Buse soils is thinner than that in the profile described as representative of the Buse series. In places the surface layer of the Forman soils is thicker than that in the profile described as representative of the Forman series, but in some higher areas both the surface layer and the subsoil are thinner than those in the representative profile.

About 50 percent of this complex is Buse soils, and about 20 percent is Forman soils. The rest of the acreage is included soils. These are areas of Aastad, Parnell, Renshaw, Sioux, and Vallers soils. Aastad soils are the most extensive and make up about 15 percent of some areas. They are in swales and in low areas below Forman soils. Parnell soils are in small depressions, many of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Renshaw and Sioux soils are on rounded ridgetops that have pockets of gravel. Vallers soils are in low areas around small depressions.

Runoff is rapid or very rapid, and the hazard of erosion is severe. Fertility is low or medium in Buse soils. Control of erosion is the main concern of management.

Most areas of this complex remain in native grass and are used for grazing. Most areas are too steep for growing hay and are too erodible to be cultivated. Buse and Forman soils in capability unit VIIe–1 and windbreak suitability group 10. Buse soils in Thin Upland range site; Forman soils in Silty range site.

Cavour Series

The Cavour series consists of deep, moderately well drained, nearly level, loamy soils that have a claypan subsoil. These soils formed in glacial till and are on uplands. The native vegetation is mostly mid and short grasses.

In a representative profile the surface layer is very dark-gray loam about 6 inches thick, and the subsurface layer is gray silt loam about 2 inches thick. The subsoil,

about 24 inches thick, is dark-gray clay in the upper part and grayish-brown clay loam in the lower part. The upper part of the subsoil is extremely hard when dry and very firm when moist. The lower part has spots and streaks of salts. The underlying material is light brownish-gray, calcareous clay loam.

Content of organic matter is moderate in Cavour soils, and fertility is low or medium. Available water capacity is moderate or high. Permeability is very slow, and runoff is slow.

Most areas of these soils are cultivated. Corn, small grains, and alfalfa are the main crops.

Cavour soils in Roberts County are mapped only in complex with Peever soils.

Representative profile of Cavour loam in an area of Peever-Cavour complex, 0 to 3 percent slopes, 162 feet east and 51 feet north of the southwest corner of sec. 19 T. 122 N., R. 49 W.:

A1—0 to 6 inches, very dark-gray (10YR 3/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable; mildly alkaline; abrupt, smooth boundary.

A2—6 to 8 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, platy structure; slightly hard, very friable; neutral; abrupt, wavy boundary.

B21t—8 to 13 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; weak, coarse, columnar structure parting to moderate, medium and fine, prismatic which in turn parts to strong, medium and fine, blocky; extremely hard, very firm; tops of columns coated with light gray (10YR 6/1); moderately alkaline; gradual, irregular boundary.

B22t—13 to 19 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; weak, medium and fine, prismatic structure parting to strong, medium and fine, blocky; extremely hard, firm; moderately alkaline; clear, wavy boundary.

B23tsa—19 to 24 inches, dark-gray (5Y 4/1) clay, very dark grayish brown (2.5Y 3/2) moist; moderate, fine and medium, blocky structure; very hard, firm; common fine and medium nests of salts; strongly alkaline; gradual, wavy boundary.

B3cssa—24 to 32 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and coarse, subangular blocky structure; very hard, firm; many fine and medium nests of gypsum crystals and other salts; slight effervescence; strongly alkaline; gradual, wavy boundary.

C1cs—32 to 43 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common, fine, distinct mottles that are gray (N 5/0) and yellowish brown (10YR 5/6) moist; massive; hard, firm; common fine and medium nests of gypsum crystals; strong effervescence; strongly alkaline; gradual, wavy boundary.

C2cs—43 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; common, fine, prominent mottles that are yellowish red (5YR 5/8) and strong brown (7.5YR 5/6) moist and common, medium, distinct mottles that are gray (5Y 5/1) moist; massive; hard, firm; common fine and medium nests of gypsum crystals; strong effervescence; moderately alkaline.

The A1 horizon is very dark gray or dark-gray loam or clay loam. It ranges from 4 to 8 inches in thickness. The A2 horizon is silt loam or loam and ranges from 1 to 3 inches in thickness. The B2t horizon, when moist, ranges from black to dark grayish brown in hues of 10YR to 5Y. It is clay or clay loam. The B2t horizon ranges from 9 to 24 inches in thickness and the B3 horizon ranges from 4 to 10 inches in thickness. The C horizon ranges from light brownish gray to pale olive in hue of 2.5Y or 5Y. It is clay loam or loam.

Cavour soils are mapped with Peever soils and are near Forman and Tonka soils. They have more clay and sodium in the B horizon than Forman soils. Unlike Peever soils, Cavour soils have an A2 horizon and a claypan B horizon. Cavour soils are better drained and contain more sodium than Tonka soils.

Colvin Series

The Colvin series consists of deep, poorly drained or very poorly drained, level, calcareous, silty soils. These soils are in closed depressions and on low flats on uplands. They formed in glacial-lake sediment. The native vegetation is tall grasses, sedges, and rushes.

In a representative profile the surface layer is dark-gray silt loam about 13 inches thick. Below this is a transition layer of dark-gray and gray silty clay loam about 14 inches thick. Spots and streaks of salts are in both these layers. The underlying material is light-gray silty clay loam to a depth of 36 inches. Below this depth, it is 6 inches of light-gray loamy sand underlain by pale-olive and white silt loam.

Content of organic matter is moderate or high, but fertility is low because the content of lime and other salts is high in the upper part of the Colvin soils. Available water capacity is moderate or high. Permeability is moderately slow. Runoff is very slow, or the surface is ponded. A seasonal water table is at a depth of 1 to 4 feet, and it is at or near the surface early in the growing season.

Most areas of these soils remain in native vegetation and are used for grazing or for growing hay.

Representative profile of Colvin silt loam, saline, 1,680 feet east and 126 feet south of the northwest corner of sec. 9, T. 129 N., R. 47 W.:

A11—0 to 1 inch, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, friable; strong effervescence; moderately alkaline; clear, wavy boundary.

A12—1 to 13 inches, dark-gray (5Y 4/1) silt loam, black (5Y 2/1) moist; moderate, medium and coarse, subangular blocky structure; slightly hard, friable; many fine nests of salts; strong effervescence; moderately alkaline; clear, broken boundary.

ACca—13 to 27 inches, dark-gray (5Y 4/1) and gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) and olive gray (5Y 5/2) moist; few, fine, faint mottles that are dark brown when moist; moderate, medium and coarse, subangular blocky structure; slightly hard, friable; common fine nests and threads of salts; violent effervescence; strongly alkaline; clear, irregular boundary.

C1gca—27 to 36 inches, light-gray (5Y 7/1) silty clay loam, olive gray (5Y 5/2) moist; few, fine and medium, faint and distinct mottles that are yellowish red (5YR 4/6) and olive (5Y 5/4) moist; moderate, medium, subangular blocky structure; slightly hard, friable; violent effervescence; strongly alkaline; clear, wavy boundary.

IIC2g—36 to 42 inches, light-gray (5Y 7/2) loamy sand, olive gray (5Y 5/2) moist; massive; soft, very friable; strongly effervescence; moderately alkaline; clear, wavy boundary.

IIIC3g—42 to 60 inches, pale-olive (5Y 6/3) and white (5Y 8/1) silt loam, gray (5Y 6/1) and olive (5Y 5/3) moist; common, medium, distinct mottles that are yellowish brown (10YR 5/6) moist; massive; slightly hard, friable; few fine segregations of lime; strong effervescence; strongly alkaline.

The A horizon is dark gray or gray in hues of 10YR to 5Y. It is silt loam or silty clay loam. Horizons that have maximum accumulation of free carbonates range from 8 to 29 inches in thickness. The C horizon is dominantly silt loam or silty clay loam, but it is commonly stratified with thin layers of sand or clay below a depth of 36 inches. Colvin soils in this county are more saline than is typical for the series, but this does not greatly alter their usefulness and behavior.

Colvin soils are near Antler, Hamerly, and Tonka soils. They contain more silt and are more poorly drained than Antler or Hamerly soils. Colvin soils do not have the clayey Bt horizon that Tonka soils have, and they are more calcareous than those soils.

Colvin silt loam, saline (0 to 2 percent slopes) (Co).—This soil is in closed depressions and on low flats on uplands. Areas are irregular in shape and range from 3 to 12 acres in size. Few to many stones or boulders are scattered on the surface in many areas.

Included with this soil in mapping are areas of Vallers soils. They commonly form a narrow rim around Colvin soils.

Runoff is very slow, or the surface is ponded. The water table is high during the growing season, and it affects plant growth. Fertility is low because the content of lime and other salts is high. Wetness is the main concern of management. In this county most areas are in positions where drainage improvement measures are not feasible.

Most areas of this soil remain in native grass and are used for grazing or for growing hay. These areas also are well suited to wildlife habitat. Capability unit Vw–2; Wetland range site; windbreak suitability group 10.

Dickey Series

The Dickey series consists of deep, somewhat excessively drained, nearly level to gently undulating, loamy soils on uplands. These soils formed in sandy glacial outwash and the underlying glacial till. The native vegetation is mostly mid and short grasses.

In a representative profile the surface layer is dark-gray fine sandy loam about 16 inches thick. The subsoil, about 27 inches thick, is brown loamy sand in the upper part and brown loam in the lower part. The upper part is soft when dry and very friable when moist. The underlying material is light-gray and pale-yellow, calcareous loam.

Content of organic matter is moderate, and fertility is medium in Dickey soils. Available water capacity is moderate or high. Permeability is moderately rapid in the upper part of the soils and moderate in the underlying material. Runoff is slow or medium.

Most areas of these soils are cultivated and are suited to corn, soybeans, small grains, flax, and alfalfa. A few areas remain in native grass.

Representative profile of Dickey fine sandy loam, 0 to 2 percent slopes, in a cultivated field, 2,598 feet south and 168 feet east of the northwest corner of sec. 5, T. 127 N., R. 29 W.:

Ap—0 to 9 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—9 to 16 inches, dark-gray (10YR 4/1) fine sandy loam, very dark brown (10YR 2/2) moist; weak, medium and coarse, subangular blocky structure parting to weak, fine and medium, granular; soft, very friable; neutral; clear, wavy boundary.

B2—16 to 28 inches, brown (10YR 5/3) loamy sand, dark grayish brown (10YR 4/2) moist; weak, very coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; soft, very friable; neutral; clear, wavy boundary.

IIB3—28 to 43 inches, brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; few, fine and medium, prominent mottles that are yellowish red (5YR 4/8) and dark red (2.5YR 3/6) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; neutral; abrupt, wavy boundary.

IIC—43 to 60 inches, light-gray (2.5Y 7/2) and pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish red (5YR 5/8) and dark red (2.5YR 3/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark-gray loam, fine sandy loam, or sandy loam. It is neutral or slightly acid and ranges from 7 to 16 inches in thickness. The IIB3 horizon is brown or grayish brown in hue of 10YR or 2.5Y. Texture is loam or light clay loam. The IIC horizon ranges from grayish brown to pale yellow and is loam, silt loam, or clay loam.

Dickey soils are near Eckman, Sverdrup, and Towner soils. They contain more sand and less silt than Eckman soils. Unlike Hecla and Sverdrup soils, they are loamy at a depth of less than 40 inches. Dickey soils are better drained than Towner soils. Colors when moist of very dark gray or darker are at shallower depths in Dickey soils than they are in Towner soils.

Dickey fine sandy loam, 0 to 2 percent slopes (DcA).—This soil is on broad flats on uplands. Areas range from 4 to 40 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Eckman, Embden, Heimdal, and Towner soils. Eckman and Heimdal soils are in an erratic pattern throughout. Embden and Towner soils are in slightly depressed areas or swales.

Available water capacity is moderate or high, but this soil is droughty during prolonged dry periods and it blows easily. Runoff is slow. Conservation of moisture and control of soil blowing are the main concerns of management.

Most areas of this soil are cultivated and are used for corn, soybeans, small grain, flax, and alfalfa. Capability unit IIIs–1; Sandy range site; windbreak suitability group 5.

Dickey fine sandy loam, 2 to 6 percent slopes (DcB).—This gently undulating soil is on uplands. Areas range from 4 to 70 acres in size. In places the surface layer is thinner than that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Echman, Embden, Heimdal, and Towner soils. Eckman and Heimdal soils are in an erratic pattern with Dickey soils. Embden and Towner soils are in swales.

Available water capacity is moderate or high, but this soil is droughty during prolonged dry periods. Runoff is medium. Control of soil blowing and control of erosion are the main concerns of management.

Most areas of this soil are cultivated. Corn, small grains, flax, and alfalfa are the main crops. Capability unit IIIe–7; Sandy range site; windbreak suitability group 5.

Divide Series

The Divide series are nearly level, moderately well drained and somewhat poorly drained, calcareous, loamy soils that are moderately deep over sand and gravel. These soils formed in glacial outwash and are on terraces and upland flats. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray and gray, calcareous loam about 12 inches thick. The underlying material is light-gray, calcareous loam to a depth of 22 inches. Below this depth, it is light-gray and light brownish-gray, calcareous sand and gravel.

Content of organic matter is moderate and fertility is medium in Divide soils. Available water capacity is low or moderate. Permeability is moderately rapid in the upper part of these soils and is rapid in the underlying sand and gravel. The seasonal water table is at a depth ranging from 3 to 5 feet during the early part of the growing season.

Most areas of these soils remain in native grass and are used for grazing or for growing hay. A few areas are cultivated.

Representative profile of Divide loam in an area of Divide-Marysland loams; in native grass, 180 feet east and 126 feet north of the southwest corner of sec. 7, T. 127 N., R. 52 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, subangular blocky structure

parting to weak, fine, granular; slightly hard, friable; slight effervescence; moderately alkaline; clear, smooth boundary.

A12—6 to 12 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to weak, fine and medium, subangular blocky; slightly hard, friable; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—12 to 22 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak, coarse and medium, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC2—22 to 32 inches, light-gray (2.5Y 7/2) sand and gravel, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) moist; few, fine, prominent mottles that are yellowish brown (10YR 5/8) moist; single grained; loose; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC3—32 to 60 inches, light brownish-gray (2.5Y 6/2) sand and gravel, grayish brown (2.5Y 5/2) moist; single grained; loose; common stains that are strong brown (7.5YR 5/8) moist; slight effervescence; moderately alkaline.

The A horizon is loam or silt loam and ranges from 7 to 14 inches in thickness. The Cca horizon ranges from very dark gray to grayish brown when moist. It ranges from 9 to 20 inches in thickness. The calcium carbonate equivalent ranges from 15 to 35 percent in the Cca horizon. The proportion of gravel, sand, and fine earth in the IIC horizon differs from one area to another and depends on the source of the glacial outwash.

Divide soils are mapped with Marysland soils and are near Fordville and Renshaw soils. They are more calcareous and are more poorly drained than Fordville and Renshaw soils. Divide soils are better drained than Marysland soils.

Divide-Marysland loams (0 to 2 percent slopes). (Dm).—The soils of this complex are on low terraces and low flats on uplands. The two soils are closely intermingled. The Divide soils are on very slight rises and the Marysland soils are in low areas between the rises. Areas range from 4 to 140 acres in size. The profiles of the Divide and Marysland soils are the ones described as representative of their respective series.

About 55 percent of this complex is Divide soils, and about 40 percent is Marysland soils. The rest of the acreage is included soils. These are areas of Fordville and Renshaw soils on some slight rises.

Available water capacity is low or moderate, and these soils are droughty during extended dry periods. Because the water table rises, wetness during spring delays farming in some years, especially on the Marysland soils. The high content of lime affects the availability of plant nutrients and also causes the soils to blow easily when dry. Conservation of moisture and control of soil blowing are the main concerns of management, but improved drainage of the Marysland soil in the complex and maintenance of fertility also are important needs.

Most areas of this complex remain in native grass and are used for growing hay or for grazing. Corn, barley, and flax are suitable crops in cultivated areas if the Marysland soils are adequately drained. Divide and Marysland soils in capability unit IIIs–4 and windbreak suitability group 2. Divide soils in Silty range site; Marysland soils in Subirrigated range site.

Doran Series

The Doran series consists of deep, somewhat poorly drained, nearly level, loamy soils on uplands. These soils formed in water-worked, glacial deposit and the underlying glacial till. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray loam about 6 inches thick. The subsoil, about 11 inches thick, is grayish-brown clay loam. The upper part of the subsoil is slightly hard when dry and friable when moist. The underlying material is light-gray and light brownish-gray calcareous clay loam.

Content of organic matter is high and fertility is medium or high in Doran soils. Available water capacity is high. Permeability and runoff are slow. The seasonal water table is at a depth of about 4 feet during the early part of the growing season.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa.

Representative profile of Doran loam in a cultivated field 2,528 feet west and 81 feet north of the southeast corner of sec. 2, T. 128 N., R. 48 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B21t—6 to 11 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.

B22t—11 to 17 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; few, fine, faint mottles that are yellowish brown (10YR 5/6) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; hard, firm; mildly alkaline; clear, wavy boundary.

C1ca—17 to 29 inches, light-gray (2.5Y 7/2) and light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; few, fine and medium, distinct mottles that are yellowish brown (10YR 5/8) and strong brown (7.5YR 5/8) moist; massive; hard, firm; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2—29 to 42 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; common, fine and medium, distinct mottles that are strong brown (7.5YR 5/8), yellowish red (5YR 4/8), and dark reddish brown (5YR 2/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—42 to 60 inches, light brownish-gray (2.5Y 6/2) and light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, distinct mottles that are strong brown (7.5YR 5/8) and dark reddish brown (5YR 2/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 11 to 22 inches. The A horizon is very dark gray or dark-gray loam or clay loam. It ranges from 5 to 10 inches in thickness. The B2t horizon is clay or clay loam and ranges from 6 to 12 inches in thickness. The C horizon commonly is clay loam, but in places it is loam.

Doran soils are near Antler, Eckman, and Forman soils. They are less calcareous than Antler soils, and they have a B horizon which is lacking in those soils. Doran soils have more clay in the B horizon than Eckman and Forman soils, and they are more poorly drained than those soils.

Doran loam (0 to 2 percent slopes) (Do).—This is on broad flats on uplands. Areas range from 50 to 400 acres in size. In some areas few to many stones are imbedded in the soil.

Included with this soil in mapping are small areas of Forman, Hamerly, Tonka, and Vallers soils. Forman soils are on slight rises. Hamerly and Vallers soils are in low areas adjacent to closed depressions. Tonka soils are in small depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots.

Available water capacity is high, but permeability is slow in the subsoil. Runoff is slow, and in some years farming is delayed by wetness in spring. During dry periods the subsoil releases moisture slowly to plants. Conservation of moisture, maintenance of tilth, and improvement of water intake into the subsoil are some concerns of management.

Most areas of this soil are cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops. Capability unit IIs–2, Clayey range site; windbreak suitability group 4.

Dovray Series

The Dovray series are deep, poorly drained, nearly level, clayey soils on bottom lands and on low flats on uplands. These soils formed in water-deposited clay. The native vegetation is mainly tall and mid grasses.

In a representative profile the surface layer is very dark-gray clay about 22 inches thick. The subsoil, about 29 inches thick, is calcareous clay that is dark gray in the upper part and gray in the lower part. It is very hard when dry, very firm when moist, and sticky and plastic when wet. The underlying material is gray, calcareous clay.

Content of organic matter is high and fertility is medium or high in Dovray soils. Available water capacity is low or moderate. Permeability and runoff are very slow. The water table is at a depth of about 3 feet during the early part of the growing season in most years.

Most areas of these soils are cultivated and are used for growing corn, flax, small grains, and alfalfa. A few areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Dovray clay in native grass, 2,574 feet west and 219 feet south of the northeast corner of sec. 19, T. 128 N., R. 52 W.:

A11—0 to 7 inches, very dark-gray (N 3/0) clay, black (N 2/0) moist; moderate, fine and medium, subangular blocky structure parting to moderate, fine, granular; hard, firm, sticky and plastic; mildly alkaline; abrupt, smooth boundary.

A12—7 to 22 inches, very dark-gray (N 3/0) clay, black (N 2/0) moist; moderate, medium and coarse, blocky and subangular blocky structure; hard, firm, sticky and plastic; mildly alkaline; clear, wavy boundary.

B21g—22 to 31 inches, dark-gray (5Y 4/1) clay, very dark gray (5Y 3/1) moist; weak, very coarse, prismatic structure parting to strong, medium and coarse, blocky; very hard, very firm, sticky and plastic; common fine and medium segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

B22g—31 to 40 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) moist; weak, very coarse, prismatic structure parting to strong, medium and coarse, blocky; very hard, very firm, sticky and plastic; few fine nests of gypsum crystals; common fine and medium segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

B3g—40 to 51 inches, gray (5Y 5/1) clay, olive gray (5Y 4/2) moist; few, fine, distinct mottles that are dark yellowish brown (10YR 4/1) moist; weak, very coarse, prismatic structure parting to moderate, strong, subangular blocky and blocky; very hard, very firm, sticky and plastic; common fine nests of gypsum crystals; common fine and medium segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

Cg—51 to 60 inches, gray (5Y 5/1) clay, olive gray (5Y 5/2) moist; common, fine and medium, prominent mottles that are dark yellowish brown (10YR 5/4) and yellowish brown (10YR 5/6) moist; massive; very hard, firm, sticky and plastic; common fine nests of gypsum crystals; common fine and medium segregations of lime; strong effervescence; moderately alkaline.

Depth to lime ranges from 20 to 50 inches. These soils are clay or silty clay throughout. The A horizon is very dark gray or dark gray in hue of 10YR, 2.5Y, or 5Y. It ranges from 22 to 30 inches in thickness. Segregations of lime are few or common in the B horizon.

Dovray soils are near Lamoure, Ludden, and Peever soils. They are more clayey than Lamoure soils and are less calcareous than Ludden soils. Dovray soils are more poorly drained than Peever soils.

Dovray clay (0 to 2 percent slopes) (Dv).—This soil is on bottom lands and in valleys and on flats on uplands. Areas are irregular in shape and range from 10 to 400 acres in size.

Included with this soil in mapping are small areas of Bearden, Ludden, and Peever soils. Bearden and Peever soils are on slight rises. Ludden soils are in low, wet areas some of which are shown on the detailed maps by the symbol for wet spots. Also included is a soil similar to Dovray soils that contains lime at depths as shallow as 10 inches.

Available water capacity is low or moderate. Permeability of the subsoil is very slow. Runoff is very slow, and the water table is at a depth of about 3 feet. This soil is wet, and because of this, farming is delayed in the spring some years. This soil puddles and loses tilth if worked when it is wet. During winter the surface layer slakes and blows easily in unprotected, bare areas. Wetness is the main concern of management, but maintenance of tilth, improvement of water intake, and control of soil blowing also are management needs.

Most areas of this soil are cultivated. Corn, flax, small grains, and alfalfa are the main crops. A few areas remain in native grass and are used for growing hay or for grazing. Capability unit IIw–1, Clayey range site, windbreak suitability group 2.

Eckman Series

The Eckman series are deep, well-drained, nearly level to sloping, loamy soils on uplands. These soils formed in lacustrine silt and very fine sand. The native vegetation is tall and mid prairie grasses.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. The subsoil, about 20 inches thick, is silt loam that is grayish brown in the upper part, pale brown in the middle part, and light yellowish brown in the lower part. It is slightly hard when dry and friable when moist. The underlying material is light-gray and light yellowish-brown, calcareous silt loam.

Content of organic matter is moderate and fertility is medium or high in Eckman soils. Available water capacity is high. Permeability is moderate, and runoff is slow or medium.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa.

Representative profile of Eckman loam, 0 to 2 percent slopes, in a cultivated field, 2,328 feet west and 105 feet north of the southeast corner of sec. 7, T. 128 N., R. 49 W.:

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

B21—7 to 12 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

B22—12 to 19 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; gradual, wavy boundary.

B3—19 to 27 inches, light yellowish-brown (2.5Y 6/4) silt loam, olive brown (2.5Y 4/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

C1ca—27 to 42 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, distinct mottles that are gray (N 6/0) moist; weak, medium, subangular blocky structure; slightly hard, friable; violent effervescence; mildly alkaline; gradual, wavy boundary.

C2—42 to 60 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and

yellowish red (5YR 4/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is dark-gray or gray loam, silt loam, or very fine sandy loam. It ranges from 7 to 12 inches in thickness. The B2 horizon, when moist, ranges from very dark brown to brown and is silt loam or very fine sandy loam. It is neutral or mildly alkaline and ranges from 8 to 18 inches in thickness. The B3 horizon, when moist, is olive-brown or light olive-brown silt loam or very fine sandy loam. It ranges from 2 to 10 inches in thickness. The C horizon commonly is stratified with thin lens of silt and very fine sand. Lacustrine sand or loamy glacial till is below a depth of 40 inches in places.

Eckman soils are mapped with Zell soils and are near Gardena, Glyndon, and Poinsett soils. They have thinner dark upper horizons than Gardena soils. They are less calcareous and are better drained than Glyndon soils. They have less clay in the B horizon than Poinsett soils. Eckman soils are deeper to lime than Zell soils, and they have a B horizon which those soils do not have.

Eckman loam, 0 to 2 percent slopes (EcA).—This soil is on uplands. Areas range from 10 to 120 acres in size. The profile of this soil is the one described as representative of the series. In places this soil is slightly eroded because of soil blowing.

Included with this soil in mapping are small areas of Embden, Gardena, and Glyndon soils. These soils are in slightly depressed areas scattered throughout the mapped areas.

Runoff is slow, and limitations to the use of this soil are slight. Control of soil blowing and maintenance of fertility and content of organic matter are the main concerns of management.

Most areas of this soil are cultivated, and the soil is well suited to all crops commonly grown in the county. Corn, soybeans, small grains, flax, and alfalfa are the main crops. Capability unit I–2; Silty range site; windbreak suitability group 3.

Eckman loam, 2 to 6 percent slopes (EcB).—This soil is on uplands. Areas range from 10 to 100 acres in size. In many cultivated areas the soil is slightly or moderately eroded, and in places the surface layer is mixed with the subsoil by plowing. In the lower part of the landscape the surface layer is thicker than that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Embden, Gardena, Glyndon, and Zell soils. Embden, Gardena, and Glyndon soils are in swales. Zell soils are on the tops of low ridges.

Fertility is medium or high, and available water capacity is high. Runoff is medium, and this soil is subject to water erosion and soil blowing. Control of water erosion and control of soil blowing are the main concerns of management.

Most areas of this soil are cultivated, and the soil is well suited to all crops commonly grown in the county. Corn, soybeans, small grains, flax, and alfalfa are the main crops. Capability unit IIe–3; Silty range site; windbreak suitability group 3.

Eckman-Zell complex, 6 to 9 percent slopes (EeC).—The soils of this complex are on uplands. Eckman soils are in the mid and lower parts of the landscape, and Zell soils are in the higher parts of the landscape on the tops and upper sides of ridges. Slopes are long and smooth. In cultivated areas the soils are slightly or moderately eroded. In the lower parts of the landscape Eckman soils have a thicker surface layer than that in the profile described as representative of the Eckman series. Eroded spots of Zell soils have a gray or light brownish-gray surface layer.

About 65 percent of this complex is Eckman loam, and about 25 percent is Zell silt loam. The rest of the acreage is included soils. These are small areas of Embden and Gardena soils. They are in the lower parts of the landscape and in swales.

Runoff is medium, and the hazard of erosion is severe in cultivated areas. In addition content of organic matter is moderately low or low and fertility is low or medium in Zell silt loam. Control of water erosion and soil blowing, conservation of moisture, and maintenance of fertility and content of organic matter are concerns of management.

Most areas of this complex are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa. Capability unit IIIe–2. Eckman soils in Silty range site, windbreak suitability group 3; Zell soils in Thin Upland range site, windbreak suitability group 8.

Embden Series

The Embden series consists of deep, moderately well drained, nearly level, loamy soils on uplands. These soils formed in sandy, glacial melt-water deposit. The native vegetation is tall and mid grasses.

In a representative profile the surface layer is dark-gray fine sandy loam about 13 inches thick. The subsoil is dark grayish-brown fine sandy loam about 20 inches thick. It is soft when dry and very friable when moist. The underlying material is grayish-brown, light brownish-gray, and light yellowish-brown loamy fine sand.

Content of organic matter is moderate and fertility is medium in Embden soils. Available water capacity is moderate. Permeability is moderately rapid. Runoff is slow.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, and alfalfa.

Representative profile of Embden fine sandy loam in a cultivated field of Embden-Hamar fine sandy loams, 360 feet south and 114 feet west of the northeast corner of sec. 8, T. 128 N., R. 49 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine, granular; soft, very friable; neutral; gradual, wavy boundary.

B2—13 to 24 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; moderate, medium, subangular blocky structure; soft, very friable; neutral; gradual, wavy boundary.

B3—24 to 33 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; common, fine and medium, distinct mottles that are dark yellowish brown (10YR 4/4) moist; weak, medium and coarse, subangular blocky structure; soft, very friable; neutral; gradual, wavy boundary.

C1—33 to 44 inches, grayish-brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; many, fine and medium, distinct mottles that are dark yellowish brown (10YR 4/4) moist; massive; soft, very friable; neutral; clear, wavy boundary.

C2—44 to 53 inches, light brownish-gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; common, fine and medium, faint mottles that are grayish brown moist; massive; soft, very friable; neutral; gradual, wavy boundary.

C3—53 to 60 inches, light yellowish-brown (2.5Y 6/3) loamy fine sand, olive brown (2.5Y 4/4) moist; common, fine and medium, prominent mottles that are dark brown (7.5YR 4/4) and grayish brown (2.5Y 5/2) moist; massive; soft, very friable; neutral.

The A horizon is dark gray or gray. It ranges from sandy loam to loam and from 10 to 20 inches in thickness. The B horizon, when moist, ranges from very dark brown to dark brown. It is fine sandy loam or sandy loam. It ranges from 6 to 12 inches in thickness. The B3 horizon

ranges from 4 to 14 inches in thickness. The C horizon ranges from fine sandy loam to fine sand. In places it has thin strata of silt.

Embden soils are mapped with Hamar soils and are near Eckman and Glyndon soils. They are more sandy and have less silt than Eckman and Glyndon soils. Embden soils are less sandy and are better drained than Hamar soils.

Embden-Hamar fine sandy loams (0 to 2 percent slopes) (Eh).—The soils of this complex are on broad flats and in swales on uplands. Hamar soils are in the lowest part of the flats and swales. Areas range from 4 to 85 acres in size.

About 70 percent of this complex is Embden soils, and about 20 percent is Hamar soils. The rest of the acreage is included soils. These are small areas of Glyndon, Hecla, and Towner soils scattered throughout in an erratic pattern.

Available water capacity is moderate in the Embden soils, but these soils are somewhat droughty during extended periods of dry weather. Wetness in the Hamar soils delays farming in some years. Cultivated areas of Embden and Hamar soils blow easily. Control of soil blowing and conservation of moisture are the main concerns of management, but improvement of drainage and the maintenance of content of organic matter and fertility also are important.

Most areas of this complex are cultivated and are well suited to corn, soybeans, small grains, and alfalfa. Capability unit IIIs–1. Embden soils in Sandy range site, windbreak suitability group 1; Hamar soils in Subirrigated range site, windbreak suitability group 2.

Fordville Series

The Fordville series consists of well-drained, nearly level to gently sloping, loamy soils that are moderately deep over sand and gravel. These soils formed in alluvium and are on uplands and stream terraces. The native vegetation is mostly mid and short grasses.

In a representative profile (fig. 7) the surface layer is dark-gray loam about 9 inches thick. The subsoil, about 13 inches thick, is loam that is dark gray in the upper part and dark grayish brown in the lower part. The underlying material is grayish-brown and brown, calcareous sand and gravel.

Content of organic matter is moderate and fertility is medium in Fordville soils. Available water capacity is low or moderate. Permeability is moderate in the subsoil and rapid in the underlying sand and gravel. Runoff is slow or medium.

Most areas of these soils are cultivated and are used for growing corn, small grains, flax, and alfalfa.

Representative profile of Fordville loam, 0 to 3 percent slopes, in a cultivated field, 450 feet north and 252 feet west of the southeast corner of sec. 21, T. 122 N., R. 52 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—6 to 9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium and coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; neutral; clear, wavy boundary.

B21—9 to 17 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak, medium and coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

B22—17 to 22 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium and coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

IIC1ca—22 to 26 inches, grayish-brown (10YR 5/2) sand and gravel, dark grayish brown (10YR 4/2) moist; single grained; loose; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC2—26 to 60 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to sand and gravel ranges from 20 to 40 inches. The A horizon is very dark gray or dark gray and ranges from 6 to 9 inches in thickness. The B horizon, when moist, ranges from very dark gray to dark brown. It is loam or clay loam and ranges from 9 to 16 inches in thickness. The IIC1 horizon is slightly or strongly effervescent.

Fordville soils are mapped with Renshaw soils and are near Divide, Forman, Marysland, and Sioux soils. They are less calcareous and better drained than Divide and Marysland soils. They have sand and gravel at a depth of less than 40 inches and Forman soils do not. Fordville soils are deeper over sand and gravel than Renshaw and Sioux soils.

Fordville loam, 0 to 3 percent slopes (FdA).—This soil is on stream terraces and uplands. It has some gravel and cobbles on the surface in places. Areas are irregular in shape and range from 5 to 50 acres in size. The profile of this soil is the one described as representative for the series.

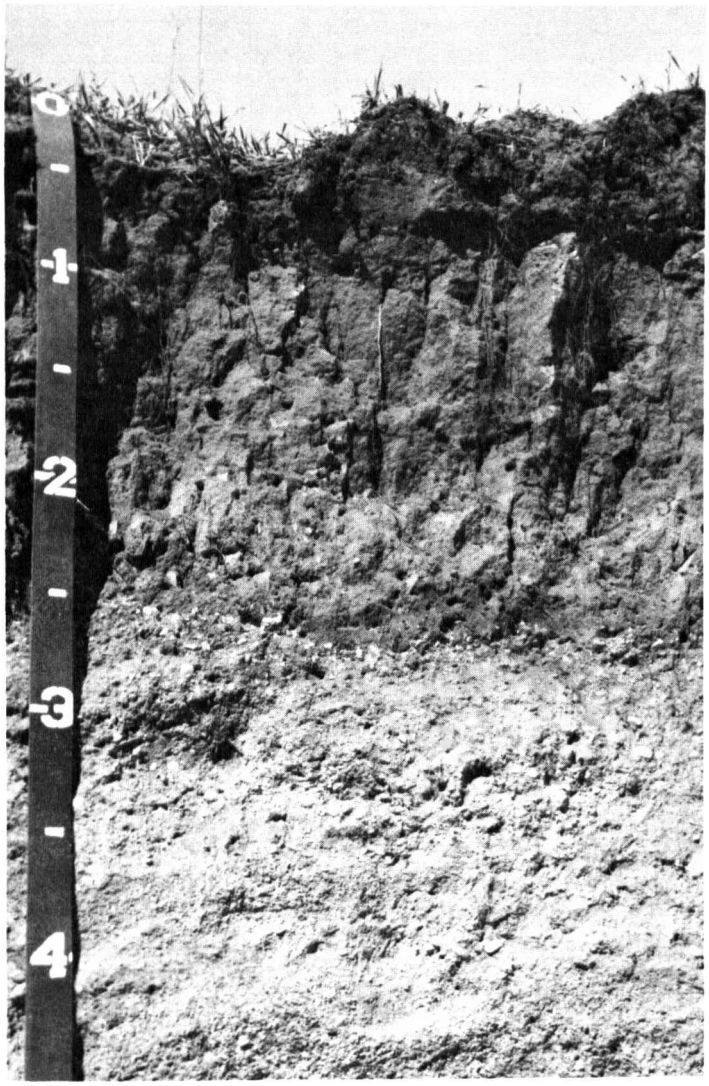

Figure 7.—**Profile of Fordville loam, 0 to 3 percent slopes. Sand and gravel are at a depth of 30 inches.**

Included with this soil in mapping are small areas of Divide and Renshaw soils. Divide soils are in low, wet areas, some of which are indicated on the detailed maps by the symbol for wet spots. Renshaw soils are on the tops of low knolls or rises.

This soil is somewhat droughty. Available water capacity is low or moderate. Conservation of moisture and control of soil blowing are the main concerns of management.

Most areas of this soil are cultivated and are used to grow corn, small grains, flax, and alfalfa. This soil is well suited to irrigation. Capability unit IIs–3; Silty range site; windbreak suitability group 6.

Fordville-Renshaw loams, 3 to 6 percent slopes (FeB).—The soils of this complex are on stream terraces and uplands. The Renshaw soils are commonly on higher parts of the landscape. Areas range from 5 to 40 acres in size.

About 70 percent of this complex is Fordville soils, and about 25 percent is Renshaw soils. The rest of the acreage is included soils. These are small areas of Divide soils in swales and low spots and small areas of Sioux soils on the tops of some of the ridges or knolls.

These soils are droughty. Available water capacity is low or moderate. Runoff is medium. These soils are subject to water erosion and soil blowing. Conservation of moisture and control of water erosion and soil blowing are the main concerns of management.

Many areas of this complex are cultivated and used for growing small grains, flax, and alfalfa. The soils are better suited to crops that mature early than to those that mature late. Capability unit IIIs–2. Fordville soils in Silty range site, windbreak suitability group 6; Renshaw soils in Shallow to Gravel range site, windbreak suitability group 10.

Forman Series

The Forman series consists of deep, well-drained, nearly level to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation is mostly tall and mid grasses.

In a representative profile (fig. 8) the surface layer is dark-gray loam about 6 inches thick. The subsoil, about 23 inches thick, is clay loam that is dark brown in the upper part, brown in the middle part, and light brownish gray and calcareous in the lower part. It is slightly hard when dry and friable when moist. The underlying material is light brownish-gray, calcareous clay loam to a depth of 46 inches. Below this depth, it is light yellowish-brown, calcareous loam.

Content of organic matter is moderate and fertility is medium or high in Forman soils. Available water capacity is high. Permeability is moderate in the subsoil and is moderately slow in the underlying material. Runoff is slow to rapid, depending on slope.

Most areas of these soils are cultivated. They are used for growing corn, soybeans, small grains, flax, and alfalfa. A few areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Forman loam in an area of Forman-Aastad loams, 2 to 6 percent slopes, in a cultivated field; 1,086 feet north and 129 feet east of the southwest corner of sec. 28, T. 126 N., R. 52 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; mildly alkaline; abrupt, smooth boundary.

B21t—6 to 10 inches, dark-brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; weak, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; thin, continuous clay films; mildly alkaline; clear, wavy boundary.

B22t—10 to 19 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; thin, continuous clay films; mildly alkaline; abrupt, wavy boundary.

B3ca—19 to 29 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; common threads and coatings of segregated lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

C1—29 to 46 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/4) moist; many, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

Figure 8.—**Profile of Forman loam in an area of Forman-Aastad loams, 2 to 6 percent slopes. (This profile is representative of the Forman series.)**

C2—46 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; many, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 5/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon ranges from very dark gray to gray. It is loam or clay loam and ranges from 4 to 8 inches in thickness. The B2t horizon ranges from very dark gray to brown or olive brown in hue of 10YR or 2.5Y. It is clay loam or heavy loam, is neutral or mildly alkaline, and ranges from 5 to 13 inches in thickness. The B3 horizon is clay loam or loam and ranges from 4 to 10 inches in thickness.

Forman soils are mapped with Aastad and Buse soils and are near Barnes and Peever soils. They are better drained and have a thinner A horizon than Aastad soils. They have a more distinct increase in clay content in the B horizon than Barnes soils. Forman soils are deeper to free carbonates than Buse soils. They have less clay in the B horizon than Peever soils.

Forman-Aastad loams, 0 to 2 percent slopes (FoA).—The soils of this complex are on uplands. They are nearly level. The Forman soils are on slight rises, and the Aastad soils are in low areas or swales between the rises. A few stones and cobbles are commonly scattered on the surface. Areas range from 8 to 200 acres in size. Slopes are short and convex, and many very gentle undulations are common. The Forman soils have a slightly thicker surface layer and subsoil than those in the profile described as representative of the Forman series. The Aastad soils have a slightly thinner surface layer and subsoil than those in the profile described as representative of the Aastad series.

About 70 percent of this complex is Forman soils, and about 20 percent is Aastad soils, The rest of the acreage is included soils. These are small areas of Hamerly, Parnell, Peever, and Tonka soils. Hamerly soils are in low areas adjacent to small, closed depressions. Parnell and Tonka soils are in the depressions. Most of these depressions are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Peever soils are on some of the rises along with Forman soils.

Fertility is medium or high. Available water capacity is high. Runoff is slow. Farming is delayed in some years because the Aastad soils are temporarily wet, but limitations for crops are slight. Control of soil blowing and maintenance of fertility are the main concerns of management.

Most areas of this complex are cultivated. The soils are well suited to corn, soybeans, small grains, flax, and alfalfa. Capability unit I–2. Forman soils in Silty range site, windbreak suitability group 3; Aastad soils in Overflow range site, windbreak suitability group 1.

Forman-Aastad loams, 2 to 6 percent slopes (FoB).—The soils of this complex are on uplands. The Forman soils are on sides of ridges and knolls, and the Aastad soils are in swales. A few stones and cobbles are commonly scattered on the surface. Areas range from 10 to 600 acres in size. The gently undulating slopes are short and irregular, and many swales and small closed depressions or potholes occur. The profiles of these soils are the ones described as representative of their respective series. In places are areas where Forman soils have a surface layer that is thinner because of erosion and is mixed with the subsoil by plowing.

About 60 percent of this complex is Forman soils, and about 25 percent is Aastad soils. The rest of the acreage is included soils. These are small areas of Buse, Hamerly, Parnell, Peever, Tonka, and Vallers soils. Buse soils are on the tops of some ridges and knolls. Hamerly and Vallers soils are in some swales or low areas adjacent to depressions. Parnell and Tonka soils are in the small depressions or potholes that are indicated on some of the detailed maps by the symbol for wet spots. Peever soils are intermingled with Forman soils.

Runoff is medium, and cultivated areas are subject to erosion. Spring planting is delayed in some years on the Aastad soils in this complex because runoff is received from adjacent soils. Control of erosion is the main concern of management.

Most areas of this complex are cultivated. The soils are well suited to corn, small grains, flax, and alfalfa. Forman and Aastad soils in capability unit IIe–2 and Silty range site; Forman soils in windbreak suitability group 3; Aastad soils in windbreak suitability group 1.

Forman-Aastad loams, 6 to 9 percent slopes (FoC).—This complex of undulating soils is on uplands. The Forman soils are on the mid and upper parts of sides of ridges and knolls, and the Aastad soils are in swales and the lower parts of sides of ridges and knolls. A few stones and cobbles are commonly scattered on the surface. Areas range from 6 to 300 acres in size. Slopes are short and irregular. The Forman soils have a profile similar to the one described as representative of the Forman series, but in places the surface layer is thinner because of erosion and is mixed with the subsoil by plowing. In places the surface layer of the Aastad soils is thicker than that in the profile described as representative of the Aastad series.

About 60 percent of this complex is Forman soils, about 25 percent is Aastad soils, and the rest is included soils. These are small areas of Buse, Hamerly, Parnell, Tonka, and Vallers soils. Buse soils are on the tops and upper parts of sides of ridges and knolls. Hamerly and Vallers soils are in some of the low areas adjacent to small, closed depressions. Parnell and Tonka soils are in the depressions or potholes, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots.

Runoff is medium, and the hazard of erosion in the Forman soils in this complex is severe. Control of erosion is the main concern of management.

Some areas of this complex are cultivated and are used for corn, small grains, flax, alfalfa, and tame grasses. Other areas remain in native grass and are used for grazing or for growing hay. Forman and Aastad soils in capability unit IIIe–1 and Silty range site; Forman soils in windbreak suitability group 3; Aastad soils in windbreak suitability group 1.

Forman-Aastad loams, 9 to 15 percent slopes (FoD).—This complex of rolling soils is on uplands. The Forman soils are on mid and upper parts of sides of ridges, knolls, and entrenched drainageways. The Aastad soils are on lower parts of the landscape and in swales. A few stones and cobbles are commonly scattered on the surface. Areas range from 10 to 500 acres in size. Slopes are short and irregular, and many swales and wet depressions or potholes are in this complex. In many places the surface layer and subsoil of the Forman soils are thinner than those in the profile described as representative of the Forman series. The Aastad soils commonly have a thicker surface layer than that in the profile described as representative of the Aastad series.

About 55 percent of this complex is Forman soils, and about 25 percent is Aastad soils. The rest of the acreage is included soils. These are small areas of Buse, Hamerly, Parnell, Renshaw, Sinai, Sioux, Tonka, and Vallers soils and Marsh. Buse soils are on the tops and upper sides of some ridges and knolls. Hamerly and Vallers soils are in low areas around the edges of small depressions. Parnell and

Tonka soils and spots of Marsh are in closed depressions of potholes. Many of these areas are indicated on the detailed maps by the symbol for wet spots. Renshaw and Sioux soils are on some of the rounded ridgetops that have pockets of gravel. Sinai soils are on mesalike hilltops.

Runoff is medium, and the hazard of erosion is severe in cultivated areas. Control of erosion is the main concern of management.

Most areas of this complex are in native grass and are used for grazing or for growing hay. Small grains, alfalfa, and tame grasses are the main crops in the few cultivated areas. Forman and Aastad soils in capability unit IVe–1 and Silty range site; Forman soils in windbreak suitability group 3; Aastad soils in windbreak suitability group 1.

Forman-Aastad stony complex, 0 to 9 percent slopes (FsB).—This complex of nearly level to undulating soils is on uplands. The Forman soils are on convex rises and sides of ridges or knolls, and the Aastad soils are in swales. Areas range from 4 to 200 acres in size and include stony areas that range from less than 1 acre to as much as 10 acres in size. The stones or boulders, 2½ to 5 feet apart, are mainly on the surface of the Forman soils, but many more are below the surface. In the steeper parts of this complex the surface layer of the Forman soils is thinner than that in the profile described as representative of its series, but in some other areas it is thicker.

About 65 percent of this complex is Forman loam and stony loam, and about 25 percent is Aastad loam. The rest of the acreage is included soils. These are small areas of Buse, Parnell, and Tonka soils. Buse soils are on the tops of some ridges and knolls. Parnell and Tonka soils are in depressions or potholes less than 2 acres in size, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is slow or medium. Areas of these soils are too stony to be satisfactory for cultivation or to be used entirely as hayland. Stoniness is the main concern of management.

Most areas of this complex remain in native grass and are used for grazing. Parts of some areas that are free of stones are used for growing hay. Forman and Aastad soils in capability unit VIIs–1 and windbreak suitability group 10. Forman soils in Silty range site; Aastad soils in Overflow range site.

Forman-Buse loams, 6 to 9 percent slopes, eroded (FuC).—This complex of undulating soils is on uplands. The Forman soils are on sides of ridges and knolls, and the Buse soils are on tops and upper parts of sides of ridges and knolls. Stones and cobbles commonly are scattered on the surface in the higher parts of the landscape. The irregularly shaped areas are mostly around depressions or on the sides of drainageways and range from 5 to 30 acres in size. Because of erosion, the surface layer of Forman and Buse soils is thinner than that in the profile described as representative of their respective series. The surface layer of the Forman soils is browner because it has been mixed with subsoil material by plowing. In many areas the surface layer of the Buse soils has been removed by erosion or has been mixed with the underlying material by plowing.

About 55 percent of this complex is Forman soils, about 25 percent is Buse soils, and the rest is included soils. These are Aastad, Hamerly, Parnell, Tonka, and Vallers soils. The Aastad soils in swales are the most extensive and make up as much as 15 percent of some areas. Hamerly and Vallers soils are in low areas surrounding small depressions or potholes. Parnell and Tonka soils are in wet depressions, most of which are less than 2 acres in size. They are indicated on the detailed maps by the symbol for wet spots.

Runoff is medium or rapid, and the hazard of erosion is severe. Control of further erosion and improvement of fertility and content of organic matter are concerns of management.

Most areas of this complex are now cultivated or have been cultivated in the past. Small grains, flax, and alfalfa are the main crops. Many areas are in alfalfa and tame grasses that are used for pasture or hay (fig. 9). Capability unit IVe–1. Forman soils in Silty range site, windbreak suitability group 3; Buse soils in Thin Upland range site, windbreak suitability group 10.

Forman-Buse loams, 9 to 15 percent slopes, eroded (FuD).—This complex of rolling soils is on uplands. These soils are mostly on the valley sides of entrenched drainageways or are around large depressions. The Forman soils are on mid and lower parts of the landscape, and the Buse soils are on the higher parts. Areas range from 6 to 35 acres in size. The Forman soils have a thinner surface layer and subsoil than those in the profile described as representative for the Forman series. Also, the surface layer is browner because of mixing of the surface layer with subsoil material by plowing. The profile of the Buse soils is similar to that described as representative for the Buse series, but the surface layer in many areas has been removed by erosion or has been mixed with the underlying material by plowing. The eroded Buse soil is easily identified in plowed fields by its light color.

About 55 percent of this complex is Forman soils, and about 25 percent is Buse soils. The rest of the acreage is included soils. These are Aastad, Hamerly, Parnell, and Tonka soils. Aastad soils are in swales, and Hamerly soils rim small depressions or potholes. Parnell and Tonka soils are in depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots.

Runoff is rapid, and the hazard of erosion is very severe. These soils have lost fertility and content of organic matter through erosion. Control of further erosion and improvement of fertility and content of organic matter are the main concerns of management.

Small grains, flax, and alfalfa are grown in cultivated areas, but because of erosion, these soils are better suited to pasture or hay. Forman and Buse soils in capability unit VIe–1 and windbreak suitability group 10. Forman soils in Silty range site; Buse soils in Thin Upland range site.

Forman-Buse loams, 15 to 25 percent slopes (FuE).—This complex of hilly soils is on uplands. The Forman soils are on sides of ridges and knolls, and the Buse soils are on tops and upper parts of sides of ridges and knolls. A few stones or boulders commonly are on the surface in the higher parts of the landscape. Areas are irregular in shape and range from 10 to 600 acres in size. Slopes are short and irregular and are dominantly hilly. Many small potholes or wet spots dot the landscape. In the higher parts of the landscape the surface layer of the Forman soils is thinner than that in the profile described as representative of the Forman series, but in the lower parts the surface layer is thicker. The profile of the Buse soil is the one described as representative of the Buse series.

About 45 percent of this complex is Forman soils, and about 25 percent is Buse soil. The rest of the acreage is included soils. These are small areas of Aastad, Barnes, Parnell, Renshaw, Sinai, Sioux, and Vallers soils and small

Figure 9.—**Area of Forman-Buse loams, 6 to 9 percent slopes, eroded, in alfalfa and smooth bromegrass used for hay.**

areas of Marsh. Aastad soils in swales are the most extensive and make up about 15 percent of many areas. Barnes soils are intermingled with Forman soils. Parnell soils and small areas of Marsh are in small depressions or potholes less than 2 acres in size. Some of the wet potholes are indicated on the detailed maps by the symbol for wet spots. Renshaw and Sioux soils are on rounded ridgetops that have pockets of gravel. Sinai soils are on flat hilltops. Vallers soils are on the rims of potholes.

Most areas of this complex are in native grass. These soils are better suited to grazing or growing hay than most other uses. Forman and Buse soils in capability unit VIe–1 and windbreak suitability group 10. Forman soils in Silty range site; Buse soils in Thin Upland range site.

Forman-Buse stony complex, 9 to 40 percent slopes (FvE).—This complex of rolling to steep soils is on uplands. The Forman soils are on sides of ridges and knolls, and the Buse soils are on tops and upper sides of ridges and knolls. Areas are irregular in shape and range from 10 to 150 acres in size. The stony parts of this complex are mostly in the higher parts of the landscape, and they range from less than 1 acre to as much as 15 acres in size. The stones and boulders are spaced about 2½ to 5 feet apart on the surface, but many more are imbedded in the soil and are not visible. These soils have profiles that are similar to the ones described as representative of their respective series, but in places the surface layer is thinner.

About 55 percent of this complex is Forman loam, about 20 percent is Buse stony loam and loam, and the rest is other included areas. The latter are small areas of Aastad, Barnes, Parnell, Sioux, and Vallers soils and small areas of Marsh, a land type. Aastad soils are the most extensive and are on lower sides of ridges and knolls and in swales. Barnes soils are intermingled with Forman soils. Parnell soils and Marsh are in wet depressions or potholes, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Sioux soils are on ridgetops that have pockets of gravel. Vallers soils are on the rims of potholes.

Runoff is medium or rapid, and the hazard of erosion is severe. The stony areas are not suited to cultivation or to growing hay. Stoniness is the main concern of management.

Most areas of this complex remain in native grass and are used for grazing. Parts that are free of stones are used for growing hay. Forman and Buse soils in capability unit VIIs–1 and windbreak suitability group 10. Forman soil in Silty range site; Buse soil in Thin Upland range site.

Gardena Series

The Gardena soils are deep, moderately well drained, nearly level, silty soils on uplands. These soils formed in lacustrine silt and very fine sand. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is dark-gray silt loam about 8 inches thick. The subsoil, about 12 inches thick, is silt loam that is gray in the upper part and light brownish gray in the lower part. It is slightly hard when dry and friable when moist. The underlying material is white, light-gray, and pale-yellow, calcareous silt loam.

Content of organic matter and fertility are high in Gardena soils. Available water capacity is high, and permeability is moderate. Runoff is slow.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa.

Representative profile of Gardena silt loam, in a cultivated field, 2,112 feet north and 400 feet west of the southeast corner of sec. 32, T. 129 N., R. 49 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, friable; mildly alkaline; abrupt, smooth boundary.

B2—8 to 18 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B3—18 to 20 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, very coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, friable; mildly alkaline; clear, irregular boundary.

C1ca—20 to 30 inches, white (2.5Y 8/2) silt loam, light yellowish brown (2.5Y 6/4) moist; weak, very coarse, prismatic structure; slightly hard, friable; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2—30 to 44 inches, light-gray (2.5Y 7/2) silt loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, distinct mottles that are light brownish gray (2.5Y 6/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—44 to 60 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) moist; common, fine and medium, prominent mottles and stains that are strong brown (7.5YR 5/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon ranges from very dark gray to gray. It is silt loam or very fine sandy loam and ranges from 6 to 10 inches in thickness. The B2 horizon, when moist, is very dark gray or very dark grayish brown in hue of 10YR or 2.5Y. It is silt loam or very fine sandy loam and ranges from 6 to 14 inches in thickness. The B3 horizon is silt loam or very fine sandy loam and ranges from 2 to 5 inches in thickness. The C horizon commonly is silt loam or very fine sandy loam, but in places sandy or loamy horizons are below a depth of 40 inches.

Gardena soils are near Eckman and Glyndon soils. They have thicker horizons that have moist colors of very dark grayish brown or darker than Eckman soils. Gardena soils are less calcareous than Glyndon soils.

Gardena silt loam (0 to 2 percent slopes) (Ga).—This soil is mainly on broad upland flats. Areas range from 25 to 120 acres in size.

Included with this soil in mapping are small areas of Eckman, Embden, and Glyndon soils. Eckman soils are on very slight rises. Embden and Glyndon soils are intermingled with Gardena soils in an erratic pattern.

Fertility is high. Available water capacity is high. Runoff is slow. Some areas receive additional runoff from adjacent soils. In most years the additional moisture is beneficial, but spring planting is delayed in wet years. This soil has few limitations for crops. Control of soil blowing is the main concern of management.

Most areas of this soil are cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops. Capability unit I–3; Silty range site; windbreak suitability group 1.

Glyndon Series

The Glyndon series consists of deep, moderately well drained and somewhat poorly drained, nearly level, calcareous, silty soils on uplands. These soils formed in lacustrine silt and very fine sand. The native vegetation is mostly tall prairie grasses.

In a representative profile the surface layer is dark-gray and gray, calcareous silt loam about 14 inches thick. It is slightly hard when dry and friable when moist. The underlying material is gray, calcareous silt loam to a depth of 22 inches. Below this depth, it is light yellowish-brown and pale-yellow, calcareous silt loam.

Content of organic matter is moderate or high and fertility is medium in Glyndon soils. Available water capacity is high. Permeability is moderate, and runoff is slow. The seasonal water table is at a depth ranging from 2 to 5 feet during much of the growing season.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa.

Representative profile of Glyndon silt loam, 0 to 3 percent slopes, in a cultivated field, 1,030 feet north and 75 feet east of the southwest corner of sec. 26, T. 129 N., R. 49 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

A12ca—8 to 14 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; very weak, medium and coarse, subangular blocky structure parting to weak, medium and coarse, granular; slightly hard, friable; common very fine pores; common coarse masses of segregated lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—14 to 22 inches, gray (N 6/0) silt loam, dark grayish brown (10YR 4/2) moist; very weak, very coarse, subangular blocky structure; slightly hard, friable; common fine pores; many coarse masses of segregated lime; violent effervescence; moderately alkaline; gradual, irregular boundary.

C2—22 to 34 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; few fine pores; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—34 to 55 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; few, fine, distinct mottles that are gray (5Y 5/1) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4—55 to 60 inches, pale-yellow (2.5Y 7/4) coarse silt loam, light olive brown (2.5Y 5/4) moist; few, medium, distinct mottles that are gray (5Y 5/1) moist and common, medium, distinct mottles that are dark brown (7.5YR 4/4) and strong brown (7.5YR 5/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

These soils, to a depth of 40 inches or more, are silt loam or very fine sandy loam that is less than 18 percent clay and less than 15 percent sand coarser than very fine sand. Maximum accumulation of free carbonates commonly exists in the lower part of the A horizon and the upper part of the C horizon. Calcium carbonate equivalent ranges from 15 to 35 percent in these horizons. The A horizon is dark gray or gray and ranges from 7 to 16 inches in thickness. The Cca horizon is gray or light brownish gray in hue of 10YR or 2.5Y and ranges from 6 to 20 inches in thickness.

Glyndon soils are near Borup, Eckman, and Gardena soils. They are similar to Bearden and Hamerly soils, although they have less clay than Bearden soils. They are not so poorly drained as Borup soils, but they are more poorly drained and are more calcareous than Eckman and Gardena soils. Glyndon soils contain more silt and less clay than Hamerly soils.

Glyndon silt loam, 0 to 3 percent slopes (GyA).—This soil is on upland flats. Slopes are long and smooth (fig. 10). Areas range from 10 to 450 acres in size. In places they are gray where the surface layer has been mixed with underlying material by plowing, and in some cultivated areas the surface layer is thinner than it is in others because of erosion and soil blowing.

Included with this soil in mapping are small areas of Borup, Embden, Gardena, and Tonka soils. Borup and Tonka soils are in low areas and small closed depressions, some of which are shown on the detailed maps by the symbol for wet spots. Embden and Gardena soils are scattered throughout in an erratic pattern.

The high content of lime causes this soil to blow easily. It also affects the availability of plant nutrients. Wetness

Figure 10.—**Area of Glyndon silt loam, 0 to 3 percent slopes.**

commonly delays spring planting and tillage. Control of soil blowing is the main concern of management, but wetness is a concern in some years.

Most areas of this soil are cultivated and are used to grow corn, soybeans, small grains, flax and alfalfa. Capability unit IIe–4; Silty range site; windbreak suitability group 1.

Hamar Series

The Hamar series are deep, poorly drained or somewhat poorly drained, nearly level, loamy soils in swales and depressions on uplands and flats. These soils formed in sandy lacustrine and outwash material that has been reworked locally by wind. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is about 16 inches thick. It is dark-gray fine sandy loam in the upper part and grayish-brown loamy fine sand in the lower part. It is loose when dry and very friable when moist. Below the surface layer is a transitional layer of light brownish-gray loamy fine sand about 6 inches thick. The underlying material is pale-olive and light olive-gray loamy fine sand.

Content of organic matter is moderate and fertility is medium in Hamar soils. Available water capacity is low or moderate. Permeability is rapid, and runoff is slow or the surface is ponded. The water table is at a depth of 1 to 3 feet, and during wet periods it is at or near the surface.

Many areas of these soils are cultivated and are used for growing corn, soybeans, and small grains. Other areas remain in native grass and are used for growing hay or for grazing.

Representative profile of Hamar fine sandy loam in a cultivated field, 1,684 feet east and 156 feet south of the northwest corner of sec. 31, T. 129 N., R. 49 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; loose, very friable; neutral; abrupt, smooth boundary.

A12—8 to 16 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; many, fine, distinct mottles that are dark brown (10YR 4/3) moist; very weak, medium and coarse, subangular blocky structure; loose, very friable; neutral; clear, wavy boundary.

AC—16 to 22 inches, light brownish-gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) moist; many, fine, prominent mottles that are dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) moist; very weak, very coarse, prismatic structure parting to very weak, medium and coarse, subangular blocky; loose, very friable; mildly alkaline; gradual, wavy boundary.

C1g—22 to 31 inches, pale-olive (5Y 6/3) loamy fine sand, olive (5Y 5/3) moist; many, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and dark yellowish brown (10YR 4/4) moist; single grained; loose, very friable; mildly alkaline; gradual, wavy boundary.

C2g—31 to 60 inches, light olive-gray (5Y 6/2) loamy fine sand, olive gray (5Y 5/2) moist; many, fine and medium, prominent mottles that are strong brown (7.5YR 5/6) and dark yellowish brown (10YR 4/4); single grained; loose, very friable; moderately alkaline.

The A horizon ranges from very dark gray to grayish brown and is fine sandy loam, loamy fine sand, or loamy sand. It ranges from 10 to 24 inches in thickness. The C horizon ranges from dark gray to pale

olive in hue of 2.5Y or 5Y. In places thin layers of loamy or silty material are below a depth of 40 inches.

Hamar soils are mapped with Embden and Hecla soils. They are more poorly drained than those soils. Hamar soils also are more sandy than Embden soils.

Hamar fine sandy loam (0 to 2 percent slopes) (Ha).—This nearly level soil is on flats and in swales and depressions on uplands. Areas range from 4 to 10 acres in size.

Included with this soil in mapping are Embden and Ulen soils on slight rises within and on the edges of the areas.

Wetness from the water table commonly delays spring planting and tillage. Cultivated areas blow easily when the soil is dry. Improvement of drainage and control of soil blowing are the main concerns of management.

Some areas of this soil are cultivated and are used for growing corn, soybeans, and small grains. Other areas are in tame grasses or remain in native grass and are used for grazing or for growing hay. Capability unit IIIw–4; Subirrigated range site; windbreak suitability group 2.

Hamerly Series

The Hamerly series consists of deep, moderately well drained and somewhat poorly drained, loamy soils on uplands. These soils are nearly level to gently undulating. They are calcareous, and they formed in glacial till. The native vegetation is tall and mid grasses.

In a representative profile the surface layer is dark-gray, calcareous loam about 11 inches thick. The underlying material is light-gray, calcareous loam to a depth of about 20 inches. It is slightly hard when dry and friable when moist. Below this depth is pale-yellow and light yellowish-brown, calcareous loam.

Content of organic matter is moderate and fertility is medium in Hamerly soils. Available water capacity is high. Permeability is moderate in the upper part of the soils and moderately slow in the underlying material. Runoff is slow or medium. The seasonal water table is at a depth of 3 to 4 feet during the early part of the growing season.

Most areas of these soils are cultivated. Corn, small grains, flax, and alfalfa are the main crops.

Representative profile of Hamerly loam in an area of Hamerly-Tonka complex, 0 to 3 percent slopes, in a cultivated field; 2,082 feet east and 80 feet north of the southwest corner of sec. 2, T. 126 N., R. 51 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—6 to 11 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine and medium, granular; slightly hard, friable; slight effervescence; mildly alkaline; clear, wavy boundary.

C1ca—11 to 20 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; violent effervescence; moderately alkaline; clear, wavy boundary.

C2ca—20 to 29 inches, pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; common fine and medium nests of gypsum crystals; violent effervescence; moderately alkaline; gradual, wavy boundary.

C3—29 to 43 inches, pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/8) and gray (5Y 6/1) moist; massive; hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4—43 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/8), strong brown (7.5YR 5/8), and gray (5Y 6/1) moist; massive; hard, friable; common medium nests of gypsum crystals; strong effervescence; moderately alkaline.

The upper part of the A horizon commonly is noncalcareous in areas that are in native grass. The A horizon is dark gray or gray in hue of 10YR or 2.5Y. It is loam or silt loam and ranges from 5 to 12 inches in thickness. The C horizon ranges from dark gray to pale yellow in hue of 10YR or 2.5Y. It is loam or clay loam. The Cca horizon ranges from 10 to 25 inches in thickness.

Hamerly soils are mapped with Antler, Tonka, and Vallers soils and are near Heimdal and Forman soils. They are not so poorly drained as Antler, Tonka, and Vallers soils. Hamerly soils are not so well drained and are more calcareous than Heimdal and Forman soils.

Hamerly-Tonka complex, 0 to 3 percent slopes (HbA).—The soils of this complex are in slightly depressed basins on uplands. Many closed depressions are between slight rises. The Hamerly soils are on the rises, and the Tonka soils are in the depressions. Areas range from 5 to 250 acres in size. The profiles of these soils are the ones described as representative of their respective series. In some cultivated areas the surface layer of Hamerly soils is thinner because of soil blowing and has been mixed with the light-gray underlying material by plowing (fig. 11).

About 45 percent of this complex is Hamerly soils, and about 25 percent is Tonka soils. The rest of the acreage is included soils. These are small areas of Forman, Heimdal, Parnell, and Vallers soils. Of these, Vallers soils are the most extensive and make up about 15 percent of the areas. They are in low areas adjacent to Tonka soils. Forman and Heimdal soils are on some of the rises. Parnell soils are in some of the depressions.

Runoff is slow on the Hamerly soils, and water ponds on the Tonka soils. Spring planting commonly is delayed by wetness, and in wet years crops are drowned in areas of Tonka soils. Hamerly soils are high in content of lime, and they blow easily. Control of soil blowing and improvement of drainage are the main concerns of management.

Most areas of this complex are cultivated. Corn, small grains, flax, and alfalfa are the main crops. Capability unit

Figure 11.—**Area of Hamerly-Tonka complex, 0 to 3 percent slopes. The light-gray spots are exposures of the material underlying Hamerly soils.**

IIe–4. Hamerly soils in Silty range site, windbreak suitability group 1; Tonka soils in Wetland range site, windbreak suitability group 10.

Hamerly-Vallers loams, 0 to 2 percent slopes (HcA).—The soils of this complex are mostly in areas around depressions and sloughs on uplands. Some areas border bottom lands. Hamerly soils are on very slight rises, and Vallers soils are in the lower part of the landscape. A few cobbles and stones are on the surface in some areas. Areas are irregular in shape and range from 2 to 50 acres in size. These soils have profiles similar to the ones described as representative of their respective series. In some cultivated areas, however, the surface layer is thinner and has been mixed with the underlying material by plowing. These spots are conspicuous because they are gray or light gray.

About 65 percent of this complex is Hamerly soils, and about 20 percent is Vallers soils. The rest of the acreage is included soils. These are small areas of Forman, Heimdal, Parnell, and Tonka soils. Forman and Heimdal soils are on some of the slight rises. Parnell and Tonka soils are in wet depressions less than 2 acres in size. They are indicated on some of the detailed maps by the symbol for wet spots.

The high content of lime affects the availability of plant nutrients and also causes the soils to blow easily when they are dry. Spring planting and tillage commonly are delayed because these soils are wet. Control of soil blowing, improvement of drainage, and improvement of fertility are all major concerns of management.

Most areas of this complex are cultivated and are used for growing corn, small grains, flax, and alfalfa. Capability unit IIe–4. Hamerly soils in Silty range site, windbreak suitability group 1; Vallers soils in Subirrigated range site, windbreak suitability group 2.

Hamerly-Vallers loams, 2 to 4 percent slopes (HcB).—This complex of gently undulating soils is around depressions and sloughs on uplands. Some areas are adjacent to bottom lands. Hamerly soils are in the higher and better-drained parts of the landscape, and Vallers soils are in the low areas. Pebbles and cobbles commonly are scattered on the surface and in the soil. Areas range from 5 to 125 acres in size. These soils have profiles similar to the ones described as representative of their respective series, but in some cultivated areas are light-gray eroded spots where the surface layer is thinner and is mixed with the underlying material by plowing.

About 65 percent of this complex is Hamerly soils, and about 20 percent is Vallers soils. The rest of the acreage is included soils. These are small areas of Forman, Heimdal, Parnell, and Tonka soils. Forman and Heimdal soils are on some of the rises. Parnell and Tonka soils are in wet depressions less than 2 acres in size, some of which are indicated on the detailed maps by the symbol for wet spots.

The high lime content causes these soils to blow easily and affects the availability of plant nutrients. Runoff is medium on the Hamerly soils but is slow on the Vallers soils. Spring planting and tillage commonly are delayed by wetness in the Vallers soils. Control of water erosion and soil blowing are the main concerns of management, but improvement of drainage and fertility also are management needs.

Many areas of this complex are cultivated and are used to grow corn, small grains, flax, and alfalfa. Capability group IIIe–8. Hamerly soils in Silty range site, windbreak suitability group 1. Vallers soils in Subirrigated range site, windbreak suitability group 2.

Hattie Series

The Hattie series consists of deep, well-drained, rolling to steep, loamy soils on uplands. These soils formed in glacial till. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is clay loam about 8 inches thick. The upper part is very dark gray, and the lower part is grayish brown and calcareous. The subsoil, about 28 inches thick, is grayish-brown, calcareous clay. It is hard when dry, firm when moist, and sticky and plastic when wet. The underlying material is pale-yellow and light-gray calcareous clay loam.

Content of organic matter is moderate and fertility is medium in Hattie soils. Available water capacity is moderate. Permeability is slow, and runoff is medium or rapid.

Some areas of these soils are cultivated. They are used for growing small grains and alfalfa. Other areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Hattie clay loam, 15 to 40 percent slopes, in native grass; 1,050 feet north and 160 feet west of the southeast corner of sec. 26, T. 124 N., R. 51 W.:

A11—0 to 4 inches, very dark-gray (10YR 3/1) clay loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; clear, irregular boundary.

A12—4 to 8 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, medium and coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable, sticky and plastic; common, fine and medium, black tongues; strong effervescence; moderately alkaline; clear, irregular boundary.

B21ca—8 to 18 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; hard, firm, sticky and plastic; thin, continuous clay films; few, fine, iron stains; common, fine and medium, black tongues; few fine segregations of lime; strong effervescence; moderately alkaline; clear, irregular boundary.

B22ca—18 to 36 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; common, fine, prominent mottles that are dark gray (5Y 4/1) and strong brown (7.5YR 5/8) moist; moderate, coarse, prismatic structure parting to strong, fine and medium, blocky; hard, firm, sticky and plastic; thin, continuous clay films; common, fine, black tongues; common, medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—36 to 43 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common, fine, prominent mottles that are dark gray (5Y 4/1) and strong brown (7.5YR 5/8) moist; weak, medium and coarse, prismatic structure parting to moderate, fine and medium, blocky; hard, firm, sticky and plastic; common medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—43 to 60 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) moist; many, medium, prominent mottles that are dark gray (5Y 4/1) and strong brown (7.5YR 5/8) moist; massive; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

The A horizon is clay loam or clay and ranges from 5 to 12 inches in thickness. The upper part is very dark gray or dark gray and has a hue of 10YR or 2.5Y. The B horizon has moist colors ranging from very dark grayish brown to olive and has a hue of 2.5Y or 5Y. It is clay loam or clay. The C horizon is clay loam or clay.

Hattie soils are mapped with Kloten soils and are near Buse, Forman, and Peever soils. They have more clay than Buse, Forman, and Kloten soils and are deeper over shale than Kloten soils. Hattie soils are calcareous at a shallower depth than Peever soils.

Hattie clay loam, 9 to 15 percent slopes (HdD).—This soil is on uplands. Areas range from 6 to 65 acres in size. Slopes are broken by many small drainageways that dissect the areas. A few cobbles and stones are commonly on the surface. The profile of this soil is similar to the one described as representative of the series, but in some culti-

vated areas the surface layer is thinner because of erosion and has been mixed with subsoil material by plowing.

Included with this soil in mapping are small areas of gently sloping Peever soils.

Available water capacity is moderate, but this soil takes in water slowly, and the subsoil releases moisture slowly to plants. Runoff is medium, and in cultivated areas the hazard of erosion is severe. Control of erosion is the main concern of management.

In places this soil is cultivated and used for growing small grains and alfalfa. Other areas remain in native grass and are used for grazing or for growing hay. Capability unit IVe–5; Clayey range site; windbreak suitability group 4.

Hattie clay loam, 15 to 40 percent slopes (HdE).—This hilly to steep soil is on uplands on the sides of entrenched drainageways. Slopes are short and irregular. Areas range from 5 to 75 acres in size. A few stones and cobbles are commonly scattered on the surface. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Buse, Kloten, and Peever soils. Buse and Kloten soils are in some of the steeper parts of the areas. Peever soils are intermingled with Hattie soils.

Runoff is rapid, and the hazard of erosion is severe in areas that lack adequate plant cover. Control of erosion is the main concern of management.

Most areas of this soil remain in native grass and are used for grazing and for growing hay. Capability unit VIe–3; Clayey range site; windbreak suitability group 10.

Hattie and Kloten soils, 9 to 25 percent slopes (HkD).—These rolling to hilly soils are on uplands. They are on the sides of entrenched drainageways. Most of the irregularly shaped areas are less than 80 acres in size and contain small, short drainageways, some of which are gullied. Landslides or slips are in some areas, and a few stones and cobbles are scattered on the surface in the higher parts of the landscape. Some of the areas are mostly Hattie soils, some are mostly Kloten soils, and other areas have both soils but in proportions that differ from one area to the next. Slopes of the Hattie soils are longer and smoother than the short, irregular slopes of the Kloten soils. The surface layer of Hattie soils is clay loam or clay. The surface layer of Kloten soils is commonly clay loam but in places is loam or silty clay loam. The profile of Kloten clay loam is the one described as representative of the Kloten series.

Included with these soils in mapping are Buse, Forman, and Peever soils. Buse soils are intermingled with Kloten soils in some areas. Forman and Peever soils are below Buse soils. Also included in some areas is a soil similar to Kloten soils, but the underlying shale is between depths of 20 and 40 inches.

Runoff is medium or rapid, and these soils are subject to erosion. Hattie soils take in water slowly and have moderate available water capacity. Kloten soils have low or very low available water capacity and are low in fertility.

Most areas of these soils remain in native grass and are used for grazing. Small grains and alfalfa are the main crops in cultivated areas. Hattie and Kloten soils in capability unit VIe–3 and windbreak suitability group 10. Hattie soils in Clayey range site; Kloten soils in Thin Upland range site.

Hecla Series

The Hecla series consists of deep, moderately well drained, nearly level, sandy soils on uplands. These soils formed in lacustrine and wind-deposited sand. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray loamy fine sand about 21 inches thick. It is soft when dry and very friable when moist. Below this is a transition layer of grayish-brown loamy fine sand about 11 inches thick. The underlying material, to a depth of about 43 inches, is pale-brown loamy fine sand. Below this it is pale-brown, light-gray, and pale-yellow fine sand.

Content of organic matter is moderate and fertility is medium in Hecla soils. Available water capacity is low or moderate. Permeability is moderately rapid to a depth of about 43 inches and is rapid in the underlying fine sand. Runoff is slow. The seasonal water table is at a depth ranging from 4 to 10 feet during most years.

Most areas of these soils are cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops.

Representative profile of Hecla loamy fine sand in a cultivated area of Hecla-Hamar loamy fine sands, 0 to 3 percent slopes, 721 feet east and 240 feet north of the southwest corner of sec. 29, T. 129 N., R. 48 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak, fine and medium, subangular blocky structure parting to weak, fine, granular; soft, very friable; neutral; abrupt, smooth boundary.

A12—7 to 21 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak, medium and coarse, subangular blocky structure parting to weak, fine, granular; soft, very friable; neutral; gradual, wavy boundary.

AC—21 to 32 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; few, fine, faint mottles that are dark yellowish brown moist; very weak, medium, subangular blocky structure parting to weak, fine, granular; soft, very friable; neutral; clear, wavy boundary.

C1—32 to 43 inches, pale-brown (10YR 6/3) loamy fine sand, dark brown (10YR 4/3) moist; few, fine, distinct mottles that are dark yellowish brown (10YR 4/4) moist; single grained; loose, very friable; neutral; gradual, wavy boundary.

C2—43 to 51 inches, pale-brown (10YR 6/3) fine sand, dark brown (10YR 4/3) moist; common, fine, distinct mottles that are yellowish brown (10YR 5/6) moist; single grained; loose; neutral; gradual, wavy boundary.

C3—51 to 60 inches, light-gray (2.5Y 7/2) and pale-yellow (2.5Y 7/3) fine sand, light olive brown (2.5Y 5/4) moist; many, medium, distinct mottles that are yellowish brown (10YR 5/6), brownish yellow (10YR 6/6), and light brownish gray (2.5Y 6/2) moist; single grained; loose; neutral.

The A horizon is very dark gray or dark-gray loamy fine sand or loamy sand. It ranges from 16 to 28 inches in thickness. The AC horizon, where present, ranges from very dark gray to brown and is loamy fine sand or loamy sand. It ranges from 4 to 10 inches in thickness. In places a loam IIC horizon is below a depth of 40 inches.

Hecla soils are mapped with Hamar soils and are near Maddock, Towner, and Ulen soils. They are better drained than Hamar soils. They have a thicker A horizon than Maddock and Ulen soils. Unlike Towner soils, Hecla soils lack a loamy horizon at a depth of less than 40 inches.

Hecla-Hamar loamy fine sands, 0 to 3 percent slopes (HmA).—The nearly level soils of this complex are on uplands. Hecla soils are on very gentle undulations, and Hamar soils are in swales and low areas between the undulations. The surface layer of the Hamar soils is more sandy than that in the profile described as representative of the Hamar series.

About 60 percent of this complex is Hecla soils, and about 30 percent Hamar soils. The rest of the acreage is included soils. These are areas of Embden, Towner, and Ulen soils in some lower parts of the landscape.

Runoff is slow, and water ponds on the surface in some areas of Hamar soils. Wetness of the Hamar soils commonly delays spring planting and tillage, but the Hecla soils are somewhat droughty during extended dry periods. Culti-

vated areas of Hecla and Hamar soils blow easily when they are dry. Control of soil blowing, conservation of moisture in the Hecla soils, and improvement of drainage in the Hamar soils are among the management needs of these soils.

Most areas of this complex are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa. Hecla and Hamar soils in capability unit IVs–1. Hecla soils in Sands range site, windbreak suitability group 1; Hamar soils in Subirrigated range site, windbreak suitability group 2.

Heimdal Series

The Heimdal series consists of deep, well-drained, nearly level to hilly, loamy soils on uplands. These soils formed in loamy glacial drift. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is loam about 11 inches thick. The upper part is dark gray and the lower part is dark grayish brown. The subsoil, about 6 inches thick, is brown loam. It is slightly hard when dry and friable when moist. The underlying material is light-gray and pale-yellow calcareous loam and silt loam.

Content of organic matter is moderate and fertility is medium in Heimdal soils. Available water capacity is high. Permeability is moderately rapid, and runoff is slow or medium.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grains, flax, and alfalfa. Most areas of steeper soils remain in native grass and are used for grazing.

Representative profile of Heimdal loam in an area of Heimdal-Sisseton loams, 2 to 6 percent slopes, in a cultivated field; 395 feet north and 111 feet east of the southwest corner of sec. 35, T. 124 N., R. 50 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium and fine, granular structure; slightly hard, very friable; mildly alkaline; abrupt, smooth boundary.

A12—8 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; very weak, coarse, prismatic structure parting to weak, medium, granular; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

B2—11 to 17 inches, brown (10YR 5/3) loam, dark grayish brown (10YR 4/2) moist; weak, medium and coarse, prismatic structure parting to weak, fine and medium, subangular blocky; slightly hard, friable; mildly alkaline; clear, wavy boundary.

C1ca—17 to 23 inches, light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) moist; very weak, medium, subangular blocky structure; slightly hard, very friable; common fine and medium segregations of lime; violent effervescence; moderately alkaline; clear, wavy boundary.

C2—23 to 35 inches, pale-yellow (2.5Y 8/4) loam, light olive brown (2.5Y 5/6) moist; massive; slightly hard, very friable; few fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—35 to 46 inches, light-gray (2.5Y 7/2) and pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) moist; common, medium, distinct mottles that are yellowish brown (10YR 5/8) moist; massive; slightly hard, very friable; few, fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4—46 to 60 inches, pale-yellow (2.5Y 7/4) loam, light olive brown (2.5Y 5/6) and light brownish gray (2.5Y 6/2) moist; few, fine, distinct mottles that are yellowish brown (10YR 5/8) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The upper part of the A horizon is dark-gray or very dark gray loam or silt loam. The A horizon ranges from 5 to 11 inches in thickness. The B horizon ranges from dark grayish brown to light yellowish brown. It ranges from 6 to 12 inches in thickness. A B3 horizon is present in some places. The C horizon commonly contains a few pebbles and cobbles. It generally has thin layers or pockets of fine sand or silt.

Heimdal soils are mapped with Sisseton and Svea soils and are near Forman and Poinsett soils. They have less clay in the B horizon than Forman, Poinsett, and Svea soils. They are better drained than Svea soils. Heimdal soils are deeper to lime than Sisseton soils.

Heimdal-Sisseton loams, 2 to 6 percent slopes (HsB).—This complex of gently undulating soils is on uplands. The Heimdal soils are on the sides of knolls and rises, and the Sisseton soils are on knolls and ridgetops and are easily identified by their light color. Slopes are short and irregular, and many small, closed depressions are in the areas. A few stones and cobbles commonly are on the surface. These soils have the profiles described as representative of their respective series.

About 55 percent of this complex is Heimdal soils, and about 20 percent is Sisseton soils. The rest of the acreage is included soils. These are small areas of Hamerly, Parnell, Svea, Tonka, and Vallers soils. Of these, Svea soils are the most extensive and make up about 15 percent of the areas. They are in swales and on the lower part of rises. Hamerly and Vallers soils are in swales and low areas adjacent to depressions. Parnell and Tonka soils are in small, wet depressions, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is medium, and available water capacity is moderate or high. Fertility is medium in the Heimdal soils, but fertility and content of organic matter are low in the Sisseton soils. Control of water erosion and soil blowing are the main concerns of management, but the improvement of fertility and content of organic matter in the Sisseton soils also is an important management need.

Most areas of this complex are cultivated and are suited for growing corn, soybeans, small grains, flax, and alfalfa. Capability unit IIe–2. Heimdal soil in Silty range site, windbreak suitability group 3; Sisseton soil in Thin Upland range site, windbreak suitability group 8.

Heimdal-Sisseton loams, 6 to 9 percent slopes (HsC).—This complex of undulating soils is on uplands. Heimdal soils are in the middle and lower elevations in the landscape. Sisseton soils are on the tops and upper sides of knolls (fig. 12). The areas are irregular in shape and range from 5 to 50 acres in size. Slopes are short and irregular. In places a few stones and cobbles are on the surface. In places the surface layer and subsoil of the Heimdal soils are thinner than those in the profile described as representative of the Heimdal series.

About 50 percent of this complex is Heimdal soils, and about 25 percent is Sisseton soils. The rest of the acreage is included soils. These are small areas of Hamerly, Parnell, Renshaw, Svea, Tonka, and Vallers soils. Of these, Svea soils in swales are the most extensive and make up about 15 percent of the areas. Hamerly and Vallers soils are in some swales and in low areas adjacent to depressions. Parnell and Tonka soils are in small depressions, some of which are indicated on the detailed maps by the symbol for wet spots. Renshaw soils are on some knolls where pockets of sand and gravel are in the underlying glacial till.

Runoff is medium, and available water capacity is moderate or high. Fertility and content of organic matter are low in the Sisseton soils. Control of water erosion and soil blowing are the main concerns of management, but the improvement of fertility and content of organic matter in the Sisseton soils also is important.

Most areas of this complex are cultivated. Small grains, flax, and alfalfa are better suited to these soils than row crops because of the erosion hazard. Capability unit IIIe–1. Heimdal soils in Silty range site, windbreak suitability

Figure 12.—**Cultivated field of Heimdal-Sisseton loams, 6 to 9 percent slopes. Sisseton soils are in the lighter areas.**

group 3; Sisseton soils in Thin Upland range site, windbreak suitability group 8.

Heimdal-Svea loams, 0 to 2 percent slopes (HvA).—The Heimdal soils in this complex are on very slight rises, and the Svea soils are in swales. Areas range from 5 to 130 acres in size. A few cobbles and stones are on the surface in most areas.

About 75 percent of this complex is Heimdal soils, and about 15 percent is Svea soils. The rest of the acreage is included soils. These are areas of Forman, Hamerly, Parnell, Poinsett, Sisseton, and Tonka soils. Forman, Poinsett, and Sisseton soils are on some very slight rises along with Heimdal soils. Hamerly soils are in some swales or low areas adjacent to small, wet depressions. Parnell and Tonka soils are in small depressions, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is slow, and water collects in areas of the Svea soils. Spring planting and tillage are delayed in some years by temporary wetness in the Svea soils, but in most years the additional moisture is beneficial. Available water capacity is high. Fertility is medium or high. The soils of this complex have little or no limitations for crops. Control of soil blowing is the main concern of management.

Most areas of this complex are cultivated. The soils are well suited to corn, soybeans, small grains, flax, and alfalfa. Capability unit I–2. Heimdal soils in Silty range site, windbreak suitability group 3; Svea soils in Overflow range site, windbreak suitability group 1.

Heimdal-Svea loams, 2 to 6 percent slopes (HvB).—This complex of gently undulating soils is on uplands. The Heimdal soils are on convex-shaped rises, and the Svea soils are in concave-shaped, low areas and swales. Areas are irregular in shape and range from 20 to 200 acres in size. Small stony areas ranging from less than 1 to 5 acres in size are in some areas. Slopes are short and irregular. Svea soils have the profile described as representative of the Svea series.

About 65 percent of this complex is Heimdal soils, and about 25 percent is Svea soils. The rest of the acreage is included soils. These are areas of Forman, Hamerly, Parnell, Poinsett, Sisseton, and Tonka soils. Forman, Poinsett, and Sisseton soils are on some rises. Hamerly soils are in some low areas adjacent to small, wet depressions. Parnell and Tonka soils are in small depressions or potholes, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is medium on the Heimdal soils of the complex, and water collects on the Svea soils. Available water capacity is high, and fertility is medium or high. Control of water

erosion and soil blowing are the main concerns of management.

Most areas of this complex are cultivated, and the soils are well suited to corn, soybeans, small grains, flax, and alfalfa. Heimdal and Svea soils in capability unit IIe–2 and Silty range site; Heimdal soils in windbreak suitability group 3; Svea soils in windbreak suitability group 1.

Kloten Series

The Kloten series consists of shallow, well-drained, rolling to hilly, loamy soils on uplands. These soils formed in a thin layer of glacial till and are underlain by shale. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray clay loam about 6 inches thick. The underlying material, to a depth of 16 inches, is grayish-brown silty clay loam that contains fragments of shale. Below this is dark-gray, bedded shale.

Content of organic matter is moderate or moderately low and fertility is low in Kloten soils. Available water capacity is low or very low. Permeability is moderate above the shale, but moisture penetrates the underlying shale very slowly. Runoff is rapid.

Most areas of these soils are in native grass and are used for grazing. Small grains and alfalfa are the main crops in the few cultivated areas.

Kloten soils in Roberts County are mapped only with Hattie soils.

Representative profile of Kloten clay loam under native grass in an area of Hattie and Kloten soils, 9 to 25 percent slopes; 2,390 feet west and 366 feet south of the northeast corner of sec. 25, T. 126 N., R. 52 W.:

A1—0 to 6 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) moist; moderate, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, wavy boundary.

C1—6 to 16 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; many shale chips; neutral; gradual, wavy boundary.

C2—16 to 60 inches, dark-gray (5Y 4/1) bedded shale, very dark gray (5Y 3/1) moist; platy; hard; plate surfaces stained with yellowish brown (10YR 5/8) and strong brown (7.5YR 5/8); mildly alkaline.

Depth to the underlying shale ranges from 9 to 20 inches. A few cobbles and stones are above the shale in places. The soil and underlying shale commonly are noncalcareous, but in places the underlying shale and the lower part of the C1 horizon above the shale are calcareous. The A horizon ranges from very dark gray to gray in hue of 10YR or 2.5Y. It is clay loam or loam, and it ranges from 5 to 10 inches in thickness. The C horizon above the shale is silty clay loam, clay loam, or loam.

Kloten soils are mapped with Hattie soils and are near Buse, Forman, and Peever soils. Unlike all of these soils, Kloten soils are shallow to bedded shale.

LaDelle Series

The LaDelle series consists of deep, moderately well drained, nearly level, silty soils on bottom lands and low terraces. These soils formed in alluvium. The native vegetation is mostly tall prairie grasses.

In a representative profile the surface layer is dark-gray, calcareous silt loam about 16 inches thick. The lower part of the surface layer is slightly hard when dry and very friable when moist. The underlying material is gray and dark-gray, calcareous silt loam.

Content of organic matter and fertility are high in LaDelle soils. Available water capacity is high, and permeability is moderate. Runoff is slow, and the soils are flooded by stream overflow for short periods.

Most areas of these soils are cultivated. Corn, soybeans, small grains, and alfalfa are the main crops. A few areas remain in native grass and are used for grazing or for growing hay.

Representative profile of LaDelle silt loam in a cultivated field, 370 feet north and 270 feet west of the southeast corner of sec. 14, T. 122 N., R. 49 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; soft, very friable; slight effervescence; moderately alkaline; abrupt, smooth boundary.

A12—7 to 16 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine and medium, granular; slightly hard, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1—16 to 35 inches, gray (2.5Y 5/1) silt loam, very dark gray (2.5Y 3/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; common fine threads of soft lime; strong effervescence; moderately alkaline; clear, wavy boundary.

A1b—35 to 43 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—43 to 60 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; common, fine, distinct mottles of dark brown; massive; slightly hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline.

The A horizon is very dark gray or dark-gray silt loam, loam, or silty clay loam. It ranges from 12 to 22 inches in thickness. The B horizon, where present, ranges from very dark grayish brown to brown in hue of 10YR or 2.5Y. A buried A horizon is common in the underlying material, but it is not always present. In some profiles the C horizon contains thin strata of sand, silt, or clay below a depth of 40 inches.

LaDelle soils are better drained than Dovray, Lamoure, Ludden, and Playmoor soils, which also are on bottom lands. They contain less clay than Dovray and Ludden soils and less salt than Playmoor soils.

LaDelle silt loam (0 to 2 percent slopes) (La).—This soil is on bottom lands and low terraces along streams and drainageways (fig. 13). Areas are irregular in shape and range from 6 to 400 acres in size. Many areas are dissected by meandering channels.

Included with this soil in mapping are Dovray and Lamoure soils in some lower parts of the landscape.

Runoff is slow, and this soil is subject to flooding from stream overflow. Wetness in the spring delays planting and tillage in some years, but in most years the additional moisture is beneficial. Limitations of this soil for crops are slight.

Most areas of this soil are cultivated. The soil is well suited to corn, soybeans, small grains, and alfalfa. Capability unit I–1; Overflow range site; windbreak suitability group 1.

Lamoure Series

The Lamoure series consists of poorly drained, calcareous, silty soils on bottom lands. These deep soils formed in alluvium. They are nearly level. The native vegetation is mostly tall grasses, but stringers of trees and shrubs are along stream channels.

In a representative profile the surface layer is dark-gray, calcareous silty clay loam about 10 inches thick. The subsoil is gray, calcareous silty clay loam about 11 inches thick. It is hard when dry and friable when moist. Below the subsoil is a buried surface layer consisting of about 6 inches of dark-gray, calcareous silty clay loam. The underlying material is

Figure 13.—**LaDelle silt loam is on the low terraces. Buse-Forman loams, 20 to 40 percent slopes, are on the valley sides.**

gray, calcareous silty clay loam in the upper part, light olive-gray, calcareous silt loam in the middle part, and gray, calcareous silt clay loam in the lower part.

Content of organic matter is high and fertility is medium or high in Lamoure soils. Available water capacity is high. Permeability is moderate, and runoff is slow. The seasonal water table is at a depth of 2 to 5 feet, and the soils are subject to flooding.

Some areas of these soils are used to grow corn, small grains, and alfalfa. Other areas remain in native vegetation and are used to grow hay or are used for grazing and wildlife habitat.

Representative profile of Lamoure silty clay loam in a cultivated field, 1,180 feet north and 102 feet west of the southeast corner of sec. 11, T. 124 N., R. 51 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, fine and medium, granular structure; hard, friable, slightly sticky; strong effervescence; moderately alkaline; abrupt, smooth boundary.

A12—6 to 10 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate, medium and coarse, subangular blocky structure; hard, friable, slightly sticky; strong effervescence; moderately alkaline; abrupt, wavy boundary.

B21g—10 to 16 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) moist; common, fine, faint mottles that are dark brown moist; weak, medium and coarse, prismatic structure parting to moderate, fine and medium, subangular blocky; hard, friable, slightly sticky; strong effervescence; moderately alkaline; abrupt, wavy boundary.

B22g—16 to 21 inches, gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) moist; moderate, medium and coarse, subangular blocky structure; hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

A1b—21 to 27 inches, dark-gray (5Y 4/1) silty clay loam, black (5Y 2/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable, slightly sticky; common fine and medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1—27 to 38 inches, gray (5Y 6/1) silty clay loam, olive gray (5Y 4/2) moist; many, fine and medium, distinct mottles that are dark brown (10YR 3/3) and gray (5Y 5/1) moist; massive; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—38 to 54 inches, light olive-gray (5Y 6/2) silt loam, gray (5Y 5/1) moist; common, fine and medium, prominent mottles that are dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), and dark reddish brown (5YR 3/2) moist; massive; slightly hard, friable, slightly sticky; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—54 to 60 inches, gray (5Y 5/1) silty clay loam, very dark gray (5Y 3/1) moist; common, fine and medium, prominent mottles that are dark brown (10YR 3/3) and reddish brown (2.5YR 4/4) moist; massive; hard, friable, slightly sticky; strong effervescence; moderately alkaline.

The soil material is calcareous to a depth of 10 inches. A buried A horizon is commonly below a depth of 20 inches. The A horizon is dark gray or very dark gray in hue of 10YR, 2.5Y, or 5Y. It is silt loam or silty clay loam, and it ranges from 10 to 18 inches in thickness. The B2 horizon, when moist, is very dark gray or black in hue of 10YR, 2.5Y, or 5Y. It is silt loam or silty clay loam, and it ranges from 10 to 16 inches in thickness. In places sand and gravel are below a depth of 40 inches.

Lamoure soils are on bottom lands as are Dovray, LaDelle, Ludden, and Playmoor soils. They have less clay than Dovray and Ludden

soils. They are more poorly drained than LaDelle soils. Lamoure soils are less saline and are better drained than Playmoor soils.

Lamoure silty clay loam (0 to 2 percent slopes) (Lm).—This soil is on bottom lands along streams. Areas are irregular in shape and range from 8 to 100 acres in size. Many areas are dissected by meandering channels.

Included with this soil in mapping are LaDelle and Playmoor soils. LaDelle soils are on some higher parts of the landscape. Playmoor soils are in low areas.

Wetness from the water table and from flooding commonly delays spring seeding and tillage. In wet years crops are drowned in undrained areas. Improvement of drainage is the main concern of management.

Adequately drained areas of this soil are suited to corn, small grains, flax, and alfalfa. Undrained areas are better suited to late-maturing crops and tame grasses. Some areas remain in native vegetation and are used for grazing, growing hay, and wildlife habitat. Capability unit IIw–3 drained, IVw–2 undrained; Subirrigated range site; windbreak suitability group 2.

Loamy Fluvaquents

Loamy Fluvaquents (0 to 2 percent slopes) (Lt) are nearly level areas that consist of mixed alluvial soils on bottom lands and low terraces along streams and drainageways. The long, narrow areas are mostly less than 70 acres in size and are dissected by meandering channels that range from 4 to 10 feet in depth. These soils are commonly calcareous at or near the surface. The surface layer, when moist, ranges from black to light brownish gray in areas of recently deposited sediment, but in other places the soil is black or very dark grayish brown throughout the profile when moist. The surface layer is loam, silt loam, or silty clay loam, and the underlying material commonly is stratified and ranges from sandy loam to clay. Included in mapping are areas of LaDelle, Lamoure, and Playmoor soils.

Areas of Loamy Fluvaquents are subject to flooding and are also wet periodically because of a fluctuating water table. Intensive use is impractical in many areas because of stream channels.

Most areas of Loamy Fluvaquents remain in native vegetation that consists of tall grasses and stringers of trees and shrubs along the stream channels. Areas are better suited to grazing and wildlife habitat than to other uses. Capability unit VIw–2; Overflow range site; windbreak suitability group 10.

Ludden Series

The Ludden series consists of deep, poorly drained, nearly level, calcareous, clayey soils on bottom lands and in flat basins on uplands. These soils formed in clayey alluvium. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray, calcareous clay about 34 inches thick. It is very hard when dry, firm when moist, and sticky and plastic when wet. The underlying material is gray, calcareous clay in the upper part and light-gray, calcareous silty clay in the lower part.

Content of organic matter is high and fertility is medium in Ludden soils. Available water capacity is low or moderate. Permeability is very slow, and runoff is slow or is ponded. The seasonal water table is at a depth ranging from 2 to 3 feet early in the growing season, and the soils are subject to flooding.

A few areas of these soils are cultivated and are used mainly to grow small grains and flax. Many areas remain in native grass and are used for growing hay or for grazing.

Representative profile of Ludden clay in a cultivated field, 297 feet west and 115 feet north of the southeast corner of sec. 10, T. 128 N., R. 52 W.:

Ap—0 to 7 inches, dark-gray (N 4/0) clay, black (N 2/0) moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; very hard, firm, sticky and plastic; strong effervescence; moderately alkaline; abrupt, smooth boundary.

A12—7 to 19 inches, dark-gray (N 4/0) clay, black (5Y 2/1) moist; moderate, medium and coarse, subangular blocky and blocky structure; very hard, firm, sticky and plastic; strong effervescence; common fine gypsum crystals; moderately alkaline; gradual, wavy boundary.

A13g—19 to 34 inches, dark gray (N 4/0) clay, black (5Y 2/1) moist; moderate, medium, blocky and subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium gypsum crystals; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1gca—34 to 44 inches, gray (5Y 6/1) clay, dark gray (5Y 4/1) moist; common, fine and medium, prominent mottles that are light olive brown (2.5Y 5/6) moist; massive; very hard, firm, sticky and plastic; common fine and medium gypsum crystals; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2g—44 to 60 inches, light-gray (5Y 7/1) silty clay, gray (5Y 5/1) moist; common, fine and medium, prominent mottles that are light olive brown (2.5Y 5/6) moist; massive; very hard, firm, sticky and plastic; few, fine and medium gypsum crystals; strong effervescence; moderately alkaline.

The A horizon, when moist, is black or very dark gray in hue of 10YR to 5Y. This horizon is clay or silty clay. It is mildly or moderately alkaline and ranges from 20 to 40 inches in thickness. Calcium carbonate equivalent of the C1gca horizon ranges from 10 to 20 percent.

Ludden soils are near Dovray and Playmoor soils. Unlike Dovray soils, they have a calcareous A horizon. Ludden soils are more clayey than Playmoor soils.

Ludden clay (0 to 2 percent slopes) (Lu).—This soil is on bottom lands and in flat-appearing basins on uplands. Areas are irregular in shape and range from 6 to 190 acres in size. Some are dissected by meandering stream channels. Included in mapping are Dovray soils on very slight rises.

This soil takes in water very slowly and has low or moderate available water capacity. Runoff is slow or the surface is ponded, and most areas of this soil are subject to flooding. Wetness from the water table or from flooding commonly delays farming in the spring, and the soil dries slowly. The soil blows easily in barren, dry cultivated areas. Improvement of drainage is the main concern of management.

Adequately drained areas of this soil are suited to small grains, flax, and alfalfa. Late-maturing crops and tame grasses are better suited to undrained areas. Many areas remain in native grasses and are used for growing hay or for grazing. Capability unit IIw–3 drained, IVw–2 undrained; Overflow range site; windbreak suitability group 10.

Maddock Series

The Maddock series consists of deep, well-drained, nearly level to hilly, sandy soils on uplands. These soils formed in lacustrine sand that has been reworked by wind in many areas. The native vegetation is tall and mid grasses.

In a representative profile the surface layer is dark-gray loamy fine sand about 14 inches thick. It is loose when dry and very friable when moist. Below this is a transition layer

of grayish-brown loamy fine sand about 8 inches thick. The underlying material is brown and yellowish-brown fine sand.

Content of organic matter is moderate or moderately low, and fertility is medium or low in Maddock soils. Available water capacity is low. Permeability is rapid, and runoff is slow.

Some areas of these soils are cultivated. Corn, small grains, and alfalfa are the main crops. Other areas are in native grass and are used for grazing and for growing hay.

Representative profile of Maddock loamy fine sand, 6 to 25 percent slopes, in native grass, 704 feet west and 1,000 feet south of the northeast corner of sec. 27, T. 124 N., R. 52 W.:

A11—0 to 11 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; weak, fine and medium, subangular blocky structure parting to single grained; loose, very friable; neutral; clear, wavy boundary.

A12—11 to 14 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) moist; weak, medium and coarse, subangular blocky structure parting to single grained; loose, very friable; neutral; gradual, wavy boundary.

AC—14 to 22 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak, medium and coarse, subangular blocky structure parting to single grained; loose, very friable; neutral; gradual, wavy boundary.

C1—22 to 44 inches, brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grained; loose; neutral; gradual, wavy boundary.

C2—44 to 60 inches, yellowish-brown (10YR 5/4) fine sand, dark yellowish brown (10YR 4/4) moist; single grained; loose; neutral.

Depth to free carbonates ranges from 24 to more than 60 inches. The A horizon ranges from very dark gray to gray. It is loamy fine sand, fine sandy loam, or sandy loam and ranges from 10 to 16 inches in thickness. The B horizon or AC horizon ranges from dark grayish brown to pale brown. It is loamy fine sand, fine sandy loam, or sandy loam and ranges from 4 to 16 inches in thickness. Below a depth of 40 inches the C horizon ranges from sand to clay loam.

Maddock soils are near Hecla, Heimdal, and Sverdrup soils. They are better drained and have a thinner A horizon than Hecla soils. They are more sandy than Heimdal soils. They are deeper to lime than Sverdrup soils. Maddock soils also have more sand in the upper part of their profile than Sverdrup soils.

Maddock loamy fine sand, 0 to 6 percent slopes (MaB).—This nearly level to gently undulating soil is on uplands. Areas are irregular in shape and range from 6 to 95 acres in size.

Included with this soil in mapping are small areas of Heimdal and Sverdrup soils. They are scattered throughout some of the areas in an erratic pattern.

Runoff is slow, and permeability is rapid. Available water capacity is low, and the soil is droughty during dry periods. Content of organic matter is moderate or moderately low and fertility is medium or low in this soil. Soil blows easily in cultivated areas. Controlling soil blowing, conserving moisture, and maintaining fertility and content of organic matter are major concerns of management.

Most areas of this soil are cultivated and are used to grow corn, small grain, and alfalfa. Capability unit IVs–1; Sands range site; windbreak suitability group 7.

Maddock loamy fine sand, 6 to 25 percent slopes (MaD).—This undulating to hilly soil is on uplands. Areas range from 10 to 55 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are areas of Eckman, Heimdal, and Zell soils. They commonly are in the higher parts of the landscape. Also, in eroded spots and in hilly areas, is a soil similar to this Maddock soil except it has a thinner surface layer and is calcareous at or near the surface.

This soil is droughty, and it blows easily. Fertility is medium or low. Control of soil blowing and conservation of moisture are the main concerns of management.

Most areas of this soil remain in native grass and are used for grazing or for growing hay. Capability unit VIs–1; Sands range site; windbreak suitability group 10.

Marsh

Marsh (0 to 1 percent slope) (Mr) is a land type in level, closed depressions that are wet throughout the growing season and in some years are under water much of the time. Some of the more deeply entrenched spots have open areas of water in the center of depressions. Smaller spots are dry at the surface late in summer, except in wet years. Areas are 5 to 30 acres in size.

Most areas of Marsh are too wet for pasture plants and are covered by cattails, rushes, and sedges. These areas are better suited to wildlife habitat than to other uses. Capability unit VIIIw–1; range site and windbreak suitability group not assigned.

Marysland Series

The Marysland series consists of poorly drained, nearly level, calcareous loamy soils that are moderately deep over sand and gravel. These soils are on bottom lands and in low areas on uplands. They formed in alluvium. The native vegetation is mostly tall grasses, sedges, and rushes.

In a representative profile the surface layer is dark-gray, calcareous loam and silt loam about 12 inches thick. The underlying material is gray and light-gray, calcareous loam to a depth of 36 inches. It is hard when dry and friable when moist. Below this depth it is light brownish-gray, calcareous sand and gravel.

Content of organic matter is high and fertility is medium in Marysland soils. Available water capacity is low or moderate. Permeability is moderately rapid to a depth of about 35 inches and is rapid in the underlying sand and gravel. Runoff is slow. The seasonal water table is at a depth ranging from 1 to 4 feet and is at the surface for short periods early in the growing season. Most areas of these soils are subject to flooding.

Most areas of these soils remain in native vegetation and are used for growing hay or for grazing. A few small areas are cultivated.

Representative profile of Marysland loam under native grass in an area of Divide-Marysland loams, 210 feet east and 126 feet north of the southwest corner of sec. 7, T. 127 N., R. 52 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; strong effervescence; moderately alkaline; clear, smooth boundary.

A12—6 to 12 inches, dark-gray (N 4/0) silt loam, black (N 2/0) moist; moderate, fine and medium, subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—12 to 24 inches, gray (N 6/0) loam, dark gray (N 4/0) moist; weak, fine and medium, subangular blocky structure; hard, friable; violent effervescence; moderately alkaline; abrupt, wavy boundary.

C2ca—24 to 35 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; common, fine, prominent mottles that are yellowish brown (10YR 5/8) moist; massive; hard, friable; violent effervescence; moderately alkaline; abrupt, wavy boundary.

IIC3—35 to 60 inches, light brownish-gray (2.5Y 6/2) sand and gravel, grayish brown (2.5Y 5/2) moist; common, fine, prominent mottles that are strong brown (7.5YR 5/8) moist; single grained; loose; slight effervescence; moderately alkaline.

The A horizon is dark gray or gray in hues ranging from 10YR to neutral. It is loam, silt loam, or clay loam, and it ranges from 9 to 15 inches in thickness. The C horizon ranges from gray to pale olive in hues ranging from 2.5Y to neutral. The upper part of the C horizon is loam or clay loam. In places a layer of cobbles and stones is at the contact between the C horizon and the IIC horizon.

Marysland soils are mapped with Divide soils and are near Fordville and Renshaw soils. They are more poorly drained than all those soils. Marysland soils also are more calcareous than Fordville and Renshaw soils.

Marysland silt loam, wet (0 to 2 percent slopes) (Mw).—This soil is on bottom lands. Areas are long and narrow and range from 10 to 150 acres in size. They commonly are dissected by meandering stream channels. The profile of this soil is similar to the one described as representative of the series, but the surface layer is silt loam. Also this soil is more poorly drained than the representative soil, and it remains wet throughout the growing season.

Included with this soil in mapping are small areas of Divide, Lamoure, and Vallers soils that are in slightly better positions for drainage. These soils are scattered throughout the areas in an erratic pattern.

This soil commonly is flooded early in the growing season, and the water table remains high throughout the year. This soil is too wet to be cultivated.

Most areas of this soil remain in native vegetation and are used for grazing, growing hay, and wildlife habitat. Capability unit Vw–1; Wetland range site; windbreak suitability group 10.

Parnell Series

The Parnell series consists of deep, poorly drained and very poorly drained, silty soils in closed depressions on uplands. These soils formed in alluvium washed from adjacent soils. The native vegetation is mostly tall grasses, sedges, and rushes.

In a representative profile the surface layer is dark-gray silty clay loam about 18 inches thick. The subsoil is dark-gray clay about 20 inches thick. It is hard when dry, firm when moist, and sticky and plastic when wet. The underlying material is gray clay to a depth of 43 inches. Below this depth is light-gray clay loam.

Content of organic matter and fertility are high in Parnell soils. Available water capacity is high. Permeability is slow, and the surface ponds. The seasonal water table is within a depth of 4 feet of the surface and is near the surface some years.

Most areas of these soils remain in native vegetation and are used for grazing or for growing hay. Drained areas are cultivated and are used for growing corn, small grains, and flax.

Representative profile of Parnell silty clay loam in native grass, 135 feet north and 85 feet east of the southwest corner of sec. 7, T. 126 N., R. 50 W.:

A11—0 to 6 inches, dark-gray (5Y 4/1) silty clay loam, black (N 2/0) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and plastic; neutral; abrupt, wavy boundary.

A12—6 to 18 inches, dark-gray (5Y 4/1) silty clay loam, black (5Y 2/1) moist; weak, fine and medium, subangular blocky structure parting to weak, fine and medium, granular; slightly hard, friable, sticky and plastic; neutral; gradual, wavy boundary.

B2t—18 to 33 inches, dark-gray (5Y 4/1) clay, black (5Y 2/1) moist; weak, medium and coarse, prismatic structure parting to moderate, fine and medium, blocky and subangular blocky; hard, firm, sticky and plastic; thin, continuous clay films; neutral; gradual, wavy boundary.

B3g—33 to 38 inches, dark-gray (5Y 4/1) clay, very dark gray (5Y 3/1) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; hard, firm, sticky and plastic; mildly alkaline; gradual, wavy boundary.

C1g—38 to 43 inches, gray (5Y 5/1) clay, very dark gray (5Y 3/1) moist; common, fine, distinct mottles that are olive (5Y 4/4) and light olive brown (2.5Y 5/6) moist; massive; hard, firm, sticky and plastic; mildly alkaline; clear, wavy boundary.

C2g—43 to 60 inches, light-gray (5Y 7/2) clay loam, light olive gray (5Y 6/2) moist; common, fine and medium, distinct mottles that are yellowish brown (10YR 5/8) and light olive brown (2.5Y 5/6) moist; massive; hard, firm, slightly sticky and plastic; slight effervescence in lower part; mildly alkaline.

The A horizon is dark gray or gray in hues of neutral to 10YR. It is silt loam, silty clay loam, or silty clay and ranges from 12 to 26 inches in thickness. The B2t horizon, when moist, ranges from black to olive gray in hue of 10YR, 2.5Y, or 5Y. It is clay, silty clay, or silty clay loam and ranges from 15 to 28 inches in thickness. The B3 horizon, where present, ranges from 3 to 6 inches in thickness. The C horizon has a hue of 5Y or 2.5Y.

Parnell soils are near Forman, Heimdal, and Peever soils and, like Tonka soils, are in depressions. They have poorer drainage than the well-drained Forman, Heimdal, and Peever soils. Parnell soils do not have the distinct A2 horizon of Tonka soils.

Parnell silty clay loam (0 to 1 percent slopes) (Pa).—This soil is on uplands in closed depressions. The depressions are circular in shape and range from 3 to 25 acres in size.

Included with this soil in mapping are small areas of Hamerly and Vallers soils that form a rim around the Parnell soil. Also included are areas where a thin layer of mucky, partly decomposed organic matter is on the surface of the Parnell soil.

Water ponds on the surface of this soil, and areas commonly are flooded in spring. Available water capacity and fertility are high, but permeability in the subsoil is slow. Wetness is the main concern of management.

Adequately drained areas of this soil are suited to corn, small grains, and flax. Undrained areas can be farmed only in dry years, and in most years they are better suited to tame pasture or to native vegetation used for grazing, growing hay, or wildlife habitat. Capability unit IIIw–1 drained, Vw–2 undrained; Wetland range site; windbreak suitability group 10.

Peever Series

The Peever series consists of deep, well-drained, nearly level to sloping, loamy soils on uplands. These soils formed in glacial till. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray clay loam about 7 inches thick. The subsoil, about 42 inches thick, is dark-gray and dark grayish-brown clay in the upper part and light brownish-gray clay and clay loam in the lower part. The upper part is slightly hard when dry, firm when moist, and slightly sticky and plastic when wet. The lower part is calcareous. The underlying material is light brownish-gray, calcareous clay loam.

Content of organic matter is moderate or high and fertility is medium or high in Peever soils. Available water capacity is moderate or high. Permeability is slow, and runoff is slow or medium.

Most areas of these soils are cultivated and are used for growing corn, small grains, flax, and alfalfa.

Representative profile of Peever clay loam, 0 to 2 percent slopes, in a cultivated field, 528 feet east and 150 feet north of the southwest corner of sec. 1, T. 123 N., R. 51 W.:

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

B21t—7 to 12 inches, dark-gray (10YR 4/1) clay, black (10YR 2/1) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, firm, slightly sticky and plastic; thin, continuous clay films; common, fine and medium, black tongues; neutral; gradual, irregular boundary.

B22t—12 to 20 inches, dark-gray (10YR 4/1) and dark grayish-brown (2.5Y 4/2) clay, very dark gray (10YR 3/1) and very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; moderate, prismatic structure parting to strong, fine and medium, blocky; hard, firm, sticky and plastic; thin, continuous clay films; common, fine and medium, black tongues; neutral; abrupt, irregular boundary.

B23tca—20 to 32 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium and coarse, blocky; hard, firm, sticky and plastic; common, fine, black tongues; many medium masses of segregated lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

B31ca—32 to 39 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; common, fine, prominent mottles that are strong brown (7.5YR 5/8) and gray (N 5/0) moist; weak, medium and coarse, prismatic structure parting to moderate, medium and coarse, blocky; hard, firm, sticky and plastic; common medium and fine masses of segregated lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

B32ca—39 to 49 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, distinct and prominent mottles that are strong brown (7.5YR 5/8), dark red (2.5YR 3/6), and gray (N 5/0) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline; gradual, wavy boundary.

C—49 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, distinct and prominent mottles that are strong brown (7.5YR 5/8), dark red (2.5YR 3/6), and gray (N 5/0) moist; massive; hard, firm, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

Depth to lime ranges fom 13 to 26 inches. The A horizon is very dark gray or dark-gray clay loam or silty clay loam. It ranges from 6 to 10 inches in thickness. The B2t horizon is clay loam, clay, or silty clay and ranges from 9 to 28 inches in thickness. The B3 horizon and C horizon range from light brownish gray to pale yellow and are clay loam or clay. The B3 horizon ranges from 6 to 18 inches in thickness. Segregations of lime in the Bca horizon range from fine to coarse.

Peever soils are mapped with Cavour and Tonka soils and are near Forman, Hattie, and Rentill soils. They are better drained than Cavour and Tonka soils and do not have the A2 horizon that those soils have. They have a a thicker and more clayey B horizon than Forman and Rentill soils. Lime is deeper in Peever soils than it is in Hattie soils.

Peever clay loam, 0 to 2 percent slopes (PeA).—This soil is on uplands. Areas range from 10 to 200 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Cavour, Parnell, Rentill, and Tonka soils. Cavour soils are in slightly depressed, low areas and swales. Parnell and Tonka soils are in wet, closed depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Rentill soils are intermingled with Peever soils in an erratic pattern.

Runoff is slow. Fertility is medium or high. Available water capacity is moderate or high, but the subsoil takes in water slowly and releases it slowly to plants. Cultivated areas easily lose tilth, and unprotected, bare areas blow easily when the soil is dry. Improvement of tilth and water intake and control of soil blowing are the main concerns of management.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Capability unit IIs–2; Clayey range site; windbreak suitability group 4.

Peever clay loam, 2 to 6 percent slopes (PeB).—This soil is on uplands. Areas range from 10 to 300 acres in size. Most areas of this soil are gently sloping, but in places relief is gently undulating. A few stones and cobbles are on the surface in places. The profile of this soil is similar to the one described as representative of the series, but in places the surface layer is thinner and has been mixed with the subsoil by plowing.

Included with this soil in mapping are small areas of Aastad, Cavour, Forman, Hamerly, Kloten, Parnell, and Tonka soils. Aastad and Cavour soils are in swales. Forman soils are intermingled with Peever soils. Hamerly soils are in low areas adjacent to depressions. Kloten soils are in the higher parts of the landscape in areas west of the town of Sisseton. Parnell and Tonka soils are in wet, closed depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots.

Runoff is medium. The soil takes in water slowly and releases it slowly to plants. Control of water erosion and soil blowing are the main concerns of management, but improvement of tilth and intake of water also are important.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Capability unit IIIe–3; Clayey range site; windbreak suitability group 4.

Peever clay loam, 6 to 9 percent slopes (PeC).—This soil is on uplands. Areas range from 4 to 110 acres in size. Slopes are mostly long and smooth. A few stones and cobbles commonly are on the surface, especially in areas that remain in native grass. The profile of this soil is similar to the one described as representative of the series, but in eroded spots and in the higher parts of the landscape the surface layer is thinner and has been mixed with the subsoil by plowing. In a few places all of the original surface layer has been removed by erosion.

Included with this soil in mapping are small areas of Aastad and Hattie soils. Aastad soils are in swales, and Hattie soils are in the higher parts of the landscape.

Runoff is medium, and the hazard of erosion is severe. This soil takes in water slowly and releases it slowly to plants. Cultivated areas lose tilth easily. Control of erosion is the main concern of management, but improvement of tilth and intake of water also are important management needs.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Some areas in native grass have stones and cobbles that must be removed before the soil can be used for cultivated crops or hay. Capability unit IIIe–4; Clayey range site; windbreak suitability group 4.

Peever-Cavour complex, 0 to 3 percent slopes (PhA).—The soils of this complex are on uplands. Areas range from 4 to 60 acres in size. Peever soils are on very slight rises, and Cavour soils are between the rises in low spots and swales that are irregular in shape. In places the surface and subsurface layers of the Cavour soils have been mixed with the subsoil by plowing.

About 70 percent of this complex is Peever clay loam, and about 25 percent is Cavour loam. The rest of the acreage is included soils. These are small areas of Rentill and Tonka soils. Rentill soils are intermingled with Peever soils. Tonka soils are in small, wet depressions, some of which are indicated on the detailed maps by the symbol for wet spots.

Runoff is slow, and the soils take in water slowly or very slowly. These soils dry slowly in spring, and they are difficult to work when wet. The development of plant roots is restricted by the dominantly clayey subsoil and especially by the claypan subsoil of the Cavour soils in the complex. Improvement of tilth and intake of water are the main concerns of management.

Most areas of this complex are cultivated and are used for corn, small grains, flax, and alfalfa. Capability unit IIs–2. Peever soils in Clayey range site, windbreak suitability group 4; Cavour soils in Claypan range site, windbreak suitability group 9.

Peever-Tonka complex (0 to 3 percent slopes) (Pk).—The soils of this complex are in areas of slight rises that are interspersed with many closed depressions. Peever soils are on rises, and Tonka soils are in depressions. Areas are irregular in shape and range from 5 to 90 acres in size.

About 60 percent of this complex is Peever clay loam, and about 30 percent is Tonka silt loam. The rest of the acreage is included soils. These are areas of Forman, Hamerly, Parnell, and Vallers soils. Forman soils are on some rises along with Peever soils. Hamerly and Vallers soils are on rims of depressions. Parnell soils are in some of the depressions.

Runoff is slow in the Peever soils, and water ponds in the depressions. These soils take in water slowly and are difficult to work when wet. Spring planting and tillage commonly are delayed by wetness in the Tonka soils, and in some years crops are drowned in ponded areas of Tonka soils. Improvement of tilth and intake of water in Peever soils is the main concern of management, but wetness of the Tonka soils also limits the use of this complex.

Many areas of this complex are cultivated and are used for corn, small grains, flax, and alfalfa. Undrained areas of Tonka soil are not suited to alfalfa, and in some years other crops grow poorly. Capability unit IIs–2. Peever soils in Clayey range site, windbreak suitability group 4; Tonka soils in Wetland range site, windbreak suitability group 10.

Playmoor Series

The Playmoor series consists of deep, poorly drained, nearly level, calcareous, silty soils that contain salt at or near the surface. These soils formed in alluvium and are on bottom lands. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is dark-gray, calcareous silty clay loam about 6 inches thick. The underlying material is gray and dark-gray, calcareous silty clay loam. The upper part of the underlying material, to a depth of about 23 inches, has spots and streaks of salt. The lower part of it has mottles that are very dark grayish brown when moist.

Content of organic matter is high and fertility is medium in Playmoor soils. Available water capacity is high. Permeability is moderately slow, and runoff is slow. The seasonal water table is at or near the surface during spring and is within a depth of 3 feet during most of the growing season. The soils are subject to flooding.

Most areas of these soils remain in native grass and are used for growing hay or for grazing. A few areas are cultivated.

Representative profile of Playmoor silty clay loam, 2,212 feet east and 1,760 feet north of the southwest corner of sec. 31, T. 123 N., R. 49 W.:

A1—0 to 6 inches, dark-gray (5Y 4/1) silty clay loam, black (5Y 2/1) moist; weak, fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; common segregations of salts; strong effervescence; moderately alkaline; clear, wavy boundary.

C1gsacs—6 to 16 inches, gray (N 5/0) silty clay loam, very dark gray (5Y 3/1) moist; weak, medium and coarse, subangular blocky structure parting to weak, fine and medium, granular; slightly hard, friable, slightly sticky and slightly plastic; many fine segregations of salt; common fine gypsum crystals; strong effervescence; moderately alkaline; abrupt, wavy boundary.

A1b—16 to 23 inches, dark-gray (N 4/0) silty clay loam, black (5Y 2/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine segregations of salt; few medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2g—23 to 38 inches, gray (N 5/0) silty clay loam, very dark gray (5Y 3/1) moist; few, fine, faint mottles that are very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure; hard, friable, sticky and slightly plastic; few fine and medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C3g—38 to 60 inches, gray (5Y 6/1) silty clay loam, dark gray (5Y 4/1) and gray (5Y 5/1) moist; many, fine, distinct mottles that are very dark grayish brown (10YR 3/2) moist and few, medium, distinct mottles that are yellowish brown (10YR 5/6) moist; massive; hard, firm, sticky and plastic; few fine and medium segregations of lime; strong effervescence; moderately alkaline.

The soils are silty clay loam or silt loam to a depth of 40 inches. They are 25 to 35 percent clay to this depth. Segregations of salt range from few to many in the A and C1 horizons. A buried A horizon is common but is not present in some profiles. The A horizon ranges from very dark gray to gray in hues that range from neutral to 10YR. It ranges from 6 to 22 inches in thickness. The C horizon ranges from dark gray to light gray in hues that range from neutral to 2.5Y. In places the C horizon below a depth of 40 inches is stratified with thin layers of sand, silt, or clay. In places glacial till is below a depth of 40 inches.

Playmoor soils are on bottom lands, and in this respect they are similar to Dovray, LaDelle, Lamoure, and Ludden soils. They contain less clay than Dovray and Ludden soils and are more saline than LaDelle and Lamoure soils.

Playmoor silty clay loam (0 to 2 percent slopes) (Pm).—This soil is along streams on bottom lands and along drainageways on uplands. Areas range from 5 to 500 acres in size.

Included with this soil in mapping are small areas of Hamerly, Lamoure, and Vallers soils on slight rises or on the edges of the mapped areas.

Runoff is slow. This soil is subject to flooding, and the water table commonly is at or near the surface early in the growing season. Wetness commonly delays farming, and in some years crops are destroyed by excess water. The high content of lime and the presence of salt limits crop selection. Wetness is the main concern when this soil is used for crops.

Most areas of this soil remain in native grass and are used for grazing or for growing hay. Corn, barley, and other feed crops are grown in the few cultivated areas. Capability unit IVw–2; Subirrigated range site; windbreak suitability group 10.

Poinsett Series

The Poinsett series consists of deep, well-drained, nearly level to gently sloping, silty soils on uplands. These soils formed in silty glacial drift. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray silt loam about 6 inches thick. The subsoil, about 19 inches thick, is silty clay loam. It is dark grayish brown in the upper part, grayish brown in the middle part, and light yellowish brown in the lower part. It is slightly hard when dry and friable when moist. The lower part is calcareous.

The underlying material is pale-yellow and light-gray, calcareous silt loam.

Content of organic matter is moderate and fertility is medium or high in Poinsett soils. Available water capacity is high. Permeability is moderate, and runoff is slow.

Most areas of these soils are cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops.

Representative profile of Poinsett silt loam, 0 to 2 percent slopes, in a cultivated field, 2,250 feet south and 82 feet east of the northwest corner of sec. 35, T. 124 N., R. 49 W.:

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

B21—6 to 9 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.

B22—9 to 16 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, coarse, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B23—16 to 21 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, olive brown (2.5Y 4/4) moist; weak, coarse, prismatic structure parting to moderate, coarse, subangular blocky; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

B3ca—21 to 25 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—25 to 32 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; weak, coarse, prismatic structure; slightly hard, friable; many medium segregations of lime; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C2—32 to 60 inches, light-gray (2.5Y 7/2) silt loam and thin strata of loam and very fine sandy loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

Depth to lime ranges from 14 to 25 inches. The A horizon is dark-gray or very dark gray silt loam or silty clay loam. It ranges from 6 to 10 inches in thickness. The B2 horizon ranges from dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is silty clay loam or silt loam and ranges from 8 to 20 inches in thickness. The B3 horizon, where present, ranges from 4 to 6 inches in thickness. In places, the C horizon is clay loam glacial till below a depth of 40 inches.

Poinsett soils are near Eckman, Heimdal, and Waubay soils. They have more clay in the B horizon than Eckman and Heimdal soils. Poinsett soils have a thinner A horizon than Waubay soils.

Poinsett silt loam, 0 to 2 percent slopes (PoA).—This soil is on uplands. Areas are irregular in shape and range from 5 to 90 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Bearden, Eckman, Parnell, Sinai, Tonka, and Waubay soils. Bearden soils are on rims of small depressions. Eckman and Sinai soils are in an erratic pattern along with Poinsett soils. Parnell and Tonka soils are in wet depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Waubay soils are in swales.

Runoff is slow, and the hazard of erosion is very slight. Fertility is medium or high. Available water capacity is high. This soil has no serious limitations when used to grow crops.

Most areas of this soil are cultivated. The soil is well suited to corn, soybeans, flax (fig. 14), small grains, and alfalfa. Capability unit I–2; Silty range site; windbreak suitability group 3.

Poinsett silt loam, 2 to 6 percent slopes (PoB).—This soil is on uplands. Slopes are fairly long and smooth. Areas range from 5 to 50 acres in size. The profile of this soil is similar to the one described as representative of the series, but in places the surface layer is thinner than the one in the representative profile because of erosion.

Included with this soil in mapping are small areas of Eckman, Heimdal, Parnell, Sinai, Tonka, and Waubay soils. Eckman and Heimdal soils are on some rises along with Poinsett soils. Parnell and Tonka soils are in wet depressions, most of which are less than 2 acres in size and are indicated on the detailed maps by the symbol for wet spots. Sinai soils are on ridgetops, and Waubay soils are in swales.

Runoff is medium, and the hazard of erosion is moderate. Fertility is medium or high. Available water capacity is high. Control of erosion is the main concern of management.

Most areas of this soil are cultivated. The soil is well suited to corn, soybeans, flax, small grains, and alfalfa. Capability unit IIe–3; Silty range site; windbreak suitability group 3.

Rauville Series

The Rauville series consists of deep, very poorly drained, nearly level, calcareous silty soils in low areas on uplands. These soils formed in silty alluvium washed from adjacent soils. The native vegetation is mostly tall grasses, sedges, and rushes.

In a representative profile the surface layer is calcareous, mucky silt loam and silt loam about 27 inches thick. It is black or very dark gray when moist. The upper 18 inches of the surface layer is soft when dry and friable when moist. The underlying material, to a depth of 53 inches, is calcareous silt loam that is dark gray when moist. Below this it is calcareous silty clay loam that is very dark brown when moist.

Content of organic matter is very high and fertility is medium in Rauville soils. Available water capacity is high. Permeability is moderate in the thick surface layer and is moderately slow in the underlying material. Runoff is very slow, or the surface is ponded. The seasonal water table is at or near the surface during much of the growing season.

Most areas of these soils remain in native vegetation and are used for grazing or as wildlife habitat.

Representative profile of Rauville mucky silt loam in native grass, 1,910 feet west and 123 feet south of the northeast corner of sec. 9, T.125 N., R. 52 W.:

A11—0 to 5 inches, very dark-gray (10YR 3/1) mucky silt loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, friable; many fragments of snail shells; strong effervescence; moderately alkaline; clear, irregular boundary.

A12—5 to 11 inches, light-gray (10YR 7/1) and gray (5Y 5/1) mucky silt loam, very dark gray (10YR 3/1) moist; weak, medium and fine, granular structure; soft, friable; many fragments of snail shells; strong effervescence; moderately alkaline; clear, irregular boundary.

A13—11 to 18 inches, dark-gray (5Y 4/1) mucky silt loam, black (5Y 2/1) moist; weak, medium, granular structure; soft, friable; few fragments of snail shells; strong effervescence; mildly alkaline; gradual, wavy boundary.

A14—18 to 27 inches, gray (10YR 5/1) silt loam, black (10YR 2/1) moist; weak, medium and fine, granular structure; slightly hard, friable, slightly sticky; violent effervescence; mildly alkaline; gradual, wavy boundary.

C1g—27 to 41 inches, gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; massive; slightly hard, friable, slightly sticky; violent effervescence; mildly alkaline; gradual, wavy boundary.

C2g—41 to 53 inches, light-gray (10YR 7/1) silt loam, dark gray (10YR 4/1) moist; massive; slightly hard, friable, slightly sticky; violent effervescence; moderately alkaline; gradual, wavy boundary.

Figure 14.—**Windrows of flax on Poinsett silt loam, 0 to 2 percent slopes.**

A1b—53 to 60 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; common, medium, distinct mottles that are dark brown (10YR 4/3) moist; massive; slightly hard, friable, sticky and plastic; strong effervescence; mildly alkaline; abrupt, wavy boundary over white silty marl.

These soils are silt loam or silty clay loam to a depth of 40 inches or more. Calcium carbonate equivalent of the A horizon and Cg horizon ranges from 20 to 50 percent. The A horizon, when moist, is black or very dark gray in hues that range from neutral to 10YR. It ranges from 23 to 35 inches in thickness. The Cg horizon, when moist, is dark gray or gray in hues that range from neutral to 10YR.

Rauville soils are near Marysland and Parnell soils. They are more silty than Marysland soils and are deeper over sand and gravel than those soils. Rauville soils have less clay than Parnell soils.

Rauville mucky silt loam (0 to 2 percent slopes) (Ra).—This soil is on uplands in seepy areas along drainageways, in swales, and on flats. Areas range from 5 to 100 acres in size. The surface layer commonly is uneven because of small hummocks (fig. 15) that range from less than 1 foot to 2 feet in height. In places the underlying material below a depth of 40 inches is sand and gravel.

Included with this soil in mapping are small areas of Marysland and Vallers soils. Vallers soils are mostly on the edges of mapped areas.

The seasonal water table is at or near the surface during much of the growing season. Runoff is very slow, or the surface is ponded. This soil is too wet to be cultivated.

Most areas of this soil remain in native vegetation and are used for grazing, growing hay, or wildlife habitat. Capability unit Vw–1; Wetland range site; windbreak suitability group 10.

Renshaw Series

The Renshaw series consists of somewhat excessively drained, nearly level to steep, loamy soils that are shallow over sand and gravel. These soils are on uplands and stream terraces. They formed in alluvium. The native vegetation is mostly mid and short grasses.

In a representative profile (fig. 16) the surface layer is dark-gray loam about 5 inches thick. The subsoil, about 10 inches thick, is loam that is dark gray in the upper part and dark grayish brown in the lower part. It is slightly hard when dry and friable when moist. The underlying material is grayish-brown and brown, calcareous sand and gravel.

Content of organic matter is moderate and fertility is low in Renshaw soils. Available water capacity is low. Permeability is moderately rapid in the subsoil and is rapid in the underlying sand and gravel. Runoff is slow or medium.

Many areas of these soils are cultivated and are used for small grains, flax, corn, and alfalfa. Other areas remain in native grass and are used for grazing.

Representative profile of Renshaw loam, 0 to 3 percent slopes, in a cultivated field, 1,050 feet north and 195 feet west of the southeast corner of sec. 21, T. 122 N., R. 52 W.:

Figure 15.—**Area of Rauville mucky silt loam that has many small hummocks. Areas of Buse-Forman loams, 20 to 40 percent slopes, are in the background.**

Ap—0 to 5 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B21—5 to 9 inches, dark-gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

B22—9 to 15 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium and coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, friable; neutral; clear, wavy boundary.

IIC1—15 to 20 inches, grayish-brown (10YR 5/2) sand and gravel, dark grayish brown (10YR 4/2) moist; single grained; loose; slight effervescence; moderately alkaline; gradual, wavy boundary.

IIC2—20 to 60 inches, brown (10YR 5/2) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to sand and gravel ranges from 10 to 20 inches. The A horizon is dark gray or very dark gray, and it ranges from 4 to 8 inches in thickness. The B horizon ranges from very dark gray to brown, and it ranges from 6 to 12 inches in thickness. It is neutral or mildly alkaline. In places pebbles in the upper part of the IIC horizon are coated with lime.

Renshaw soils are mapped with Fordville and Sioux soils, and they are near Divide, Forman, and Marysland soils. They are shallower over sand and gravel than Divide, Fordville, and Marysland soils. They are better drained and less calcareous than Divide and Marysland soils. Unlike Forman soils they have a IIC horizon of sand and gravel. Renshaw soils are deeper over sand and gravel than Sioux soils.

Renshaw loam, 0 to 3 percent slopes (ReA).—This soil is on uplands. Areas range from 5 to 80 acres in size. In some areas gravel and cobbles are scattered on the surface. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are Divide, Fordville, and Sioux soils in an erratic pattern.

This soil is droughty. Available water capactiy is low. Runoff is slow. Conservation of moisture is the main concern of management, but control of soil blowing also is an important management need.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Small grains and flax are better suited to the soil than corn. Capability unit IIIs–3; Shallow to Gravel range site; windbreak suitability group 10.

Renshaw loam, 3 to 9 percent slopes (ReB).—This soil is on uplands. Areas are irregular in shape and range from 5 to 70 acres in size. Gravel and cobbles are scattered on the surface in some areas.

Included with this soil in mapping are Divide, Fordville, and Sioux soils. Divide and Fordville soils are in swales and the lower parts of the landscape. Sioux soils are on the tops and upper sides of ridges and knolls.

This soil is droughty. Runoff is medium. Conservation of

Figure 16.—**Profile of Renshaw loam, 0 to 3 percent slopes. Sand and gravel are at a depth of about 15 inches. Numbers on tape are depth in feet.**

moisture and the control of water erosion and soil blowing are the main concerns of management.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Small grains and flax are better suited to the soil than corn. Capability unit IVs–2; Shallow to Gravel range site; windbreak suitability group 10.

Renshaw-Sioux loams, 3 to 9 percent slopes (RhB).—This complex of gently sloping to undulating soils is on uplands. The Sioux soils are in the higher parts of the landscape on the tops and upper sides of ridges and knolls. Areas are irregular in shape and range from 5 to 40 acres in size. Small amounts of gravel, cobbles, and stones are scattered on the surface in some of the areas. The Sioux soils have the profile described as representative of the series. In a few places, however, the surface layer of the Sioux soils is sandy loam.

About 70 percent of the complex is Renshaw soils, and about 20 percent is Sioux soils. The rest of the acreage is included soils. These are areas of Divide and Fordville soils. Divide soils are in swales. Fordville soils are on the lower parts of sides of ridges and knolls.

These soils are droughty. Available water capacity is low or very low. Runoff is medium in the Renshaw soils of the complex. Conservation of moisture and control of water erosion and soil blowing are the main concerns of management.

Many areas of this complex are cultivated and are used for growing small grains, flax, and alfalfa. Early maturing crops are better suited to these soils than to corn. Some areas are in native or tame grasses and are used for grazing. Renshaw and Sioux soils in capability unit IVs–2 and windbreak suitability group 10; Renshaw soils in Shallow to Gravel range site; Sioux soils in Very Shallow range site.

Renshaw-Sioux loams, 9 to 20 percent slopes (RhD).—This complex of rolling to hilly soils is on glacial moraines on uplands. Renshaw soils are on sides of ridges and knolls. Sioux soils are on the tops and upper sides of ridges and knolls. Areas are irregular in shape and range from 4 to 40 acres in size. Small amounts of gravel and stones are on the surface in places. The profiles of these soils are similar to the ones described as representative of their respective series, but in places the surface layer is sandy loam.

About 50 percent of this complex is Renshaw soils, and about 40 percent is Sioux soils. The rest of the acreage is included soils. These are areas of Fordville soils in the lower parts of the landscape.

These soils are droughty. Runoff is medium in the Renshaw soils. Disturbed areas are subject to water erosion and soil blowing. Fertility is low.

Most areas of this complex are in native grass and are used mainly for grazing. These soils are not suited to cultivation. Renshaw and Sioux soils in capability unit VIe–6 and windbreak suitability group 10; Renshaw soils in Shallow to Gravel range site; Sioux soils in Very Shallow range site.

Renshaw-Sioux stony loams, 9 to 40 percent slopes (RsE).—The rolling to steep soils of this complex are on gravelly ridges or glacial moraines on uplands. Renshaw soils are on the sides of ridges and knolls, and Sioux soils are on the tops and upper sides. Areas are long and narrow and range from 6 to 50 acres in size. Slopes are rolling to steep, and they are convex, short, and irregular. The stony areas are mainly in the higher parts of the landscape and range from less than 1 acre to as much as 10 acres in size. The stones are about 2½ to 5 feet apart. A few large boulders are present. In the lower parts of the landscape the surface layer of Renshaw soils is thicker than that of the representative profile, and in places the surface layers of Renshaw and Sioux soils are sandier; otherwise the profiles of these soils are similar to the ones described as representative of their respective series.

About 50 percent of this complex is Renshaw soils, and about 35 percent is Sioux soils. The rest of the acreage is included soils. These are areas of Barnes, Buse, and Fordville soils. Barnes and Buse soils are in areas where the underlying material is glacial till instead of sand and gravel. Fordville soils are in the lower part of some areas.

Fertility is low, and these soils are too stony and too droughty to be cultivated. Also, large areas are too stony for harvesting hay.

Most areas of this complex are in native grass and are used for grazing. Some less stony areas of the Renshaw soils are used for growing hay. Renshaw and Sioux soils in capability unit VIIs–1 and windbreak suitability group 10; Renshaw soils in Shallow to Gravel range site; Sioux soils in Very Shallow range site.

Rentill Series

The Rentill series consists of deep, well-drained, nearly level to gently undulating, loamy soils on uplands. These soils formed in a thin mantle of glacial outwash material. They are underlain by glacial till. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray loam about 7 inches thick. The subsoil, about 8 inches thick, is grayish-brown loam in the upper part and brown gravelly loam in the lower part. It is slightly hard when dry and very friable when moist. The underlying material is 45 inches thick. The upper part of it is brown, calcareous sand and gravel about 6 inches thick. The middle part is light brownish-gray, calcareous clay about 16 inches thick. The lower part is light yellowish-brown, calcareous clay loam.

Content of organic matter is moderate and fertility is medium in Rentill soils. Available water capacity is moderate or high. Permeability is moderate in the subsoil and is moderately slow or slow in the underlying material. Runoff is slow.

Most areas of these soils are cultivated. Corn, small grains, flax, and alfalfa are the main crops.

Representative profile of Rentill loam, 0 to 2 percent slopes, in a cultivated field, 1,260 feet east and 135 feet north of the southwest corner of sec. 8, T. 122 N., R. 50 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and medium, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B2—7 to 12 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak, medium and coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; slightly hard, very friable; neutral; clear, smooth boundary.

B3—12 to 15 inches, brown (10YR 5/3) gravelly loam, dark brown (10YR 4/3) moist; very weak, coarse, prismatic structure; slightly hard, very friable; mildly alkaline; abrupt, wavy boundary.

IIC1—15 to 21 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; strong effervescence; moderately alkaline; abrupt, wavy boundary.

IIIC2ca—21 to 37 inches, light brownish-gray (2.5Y 6/2) clay, olive brown (2.5Y 4/4) moist; many, fine and medium, prominent mottles that are brownish yellow (10YR 6/8), strong brown (7.5YR 5/8), and light gray (2.5Y 7/2) moist; strong, medium, prismatic structure parting to moderate, medium, blocky and subangular blocky; hard, firm, sticky and plastic; thin, continuous clay films; many medium and coarse segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIIC3—37 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are brownish yellow (10YR 6/8), strong brown (7.5)YR 5/8), and light gray (2.5Y 7/2) moist; weak, very coarse, prismatic structure; hard, firm, sticky and plastic; few fine and medium segregations of lime; strong effervescence; moderately alkaline.

Depth to the underlying glacial till ranges from 15 to 38 inches. The A horizon is dark-gray or very dark gray loam or fine sandy loam. It ranges from 5 to 8 inches in thickness. The B2 horizon ranges from dark grayish brown to brown. It is loam or fine sandy loam and ranges from 5 to 10 inches in thickness. The B3 horizon ranges from dark grayish brown to pale brown. It commonly is gravelly loam or gravelly sandy loam, but in places it is loam or sandy loam. It ranges from 3 to 8 inches in thickness. The IIC horizon is loamy sand, gravelly loamy sand, or sand and gravel. It ranges from 2 to 12 inches in thickness. Mottles in the IIIC horizon range from few to many.

Rentill soils are near Fordville, Peever, and Renshaw soils. They have a C horizon of glacial till at a depth of less than 40 inches, but such a horizon is not present in Fordville and Renshaw soils. They have less clay in the B horizon than Peever soils, and they have a thin layer of sand and gravel in the C horizon above the glacial till that is not present in Peever soils.

Rentill loam, 0 to 2 percent slopes (RtA).—This soil is on uplands. Areas range from 5 to 80 acres in size. Pebbles and cobbles commonly are scattered on the surface and in the soil. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Fordville, Peever, and Renshaw soils. Fordville and Renshaw soils are in areas that have thick layers of sand and gravel below the subsoil. Peever soils are in areas where clayey glacial till is near the surface.

Fertility is medium. Available water capacity is moderate or high, but because sand and gravel is in the upper part of the underlying material this soil is somewhat droughty. Runoff is slow. Conservation of moisture is the main concern of management. Control of soil blowing also is a management need.

Most areas of this soil are cultivated and are used for growing corn, small grains, flax, and alfalfa. Capability unit IIs–3; Silty range site; windbreak suitability group 3.

Rentill loam, 2 to 6 percent slopes (RtB).—This gently undulating soil is on uplands. Areas are irregular in shape and range from 3 to 15 acres in size. Slopes are short and irregular. Pebbles and small cobbles commonly are scattered on the surface and in the soil. The profile of this soil is similar to the one described as representative of the series, but the surface layer of this soil is thinner than that in the representative profile in some areas.

Included with this soil in mapping are small areas of Fordville, Peever, and Renshaw soils. Fordville and Renshaw soils are in areas where thick layers of sand and gravel are in the underlying material. Peever soils are in areas where glacial till is near the surface.

Available water capacity is moderate or high, but this soil is somewhat droughty because sand and gravel is in the upper part of the underlying material. The hazards of water erosion and soil blowing are moderate in cultivated areas. Conservation of moisture is the main concern of management, but control of water erosion and soil blowing are also concerns.

Most areas of this soil are cultivated and are used for corn, small grains, flax, and alfalfa. Capability unit IIIs–2; Silty range site; windbreak suitability group 3.

Sandy Lake Beaches

Sandy lake beaches (Sb) are nearly level and gently undulating areas of mixed soils and soil material on flats and beach ridges around edges of lakes and former lakes. Slopes range from 0 to 6 percent. Areas near present lakes are submerged when the water level of the lakes is high. The surface layer ranges from loam to sand. The underlying material commonly is sandy but ranges from loam to coarse sand and gravel. Reaction ranges from neutral to moderately alkaline.

Most areas of Sandy lake beaches are somewhat poorly drained or poorly drained, but some beach ridges are excessively drained. The water table generally is high, and the level corresponds to the water level of the lakes.

The plant cover is tall grasses, sedges, reeds, and native trees, but areas recently disturbed by wave action are barren. Areas of Sandy lake beaches are best suited to pasture or wildlife habitat. Capability unit VIw–2; Subirrigated range site; windbreak suitability group 10.

Sieche Series

The Sieche series consists of deep, well-drained, moder-

ately steep to steep, loamy soils on uplands. These soils formed in clay loam glacial till. The native vegetation is deciduous trees and an understory of shrubs and grass.

In a representative profile the surface layer is dark-gray loam about 9 inches thick. It is covered by about 1 inch of matted leaves and partly decomposed organic matter. The subsoil, about 22 inches thick, is clay loam that is dark gray in the upper part and light brownish gray in the lower part. The upper part is hard when dry and friable when moist. The lower part is calcareous. The underlying material is light brownish-gray, calcareous clay loam.

Content of organic matter is high and fertility is medium or high in Sieche soils. Available water capacity is high. Permeability is moderate in the subsoil and moderately slow in the underlying material. Runoff is rapid.

Most areas of these soils remain in native vegetation and are used for grazing and wildlife habitat.

Representative profile of Sieche loam, 15 to 40 percent slopes, in native woodland, 1,260 feet east and 581 feet south of the northwest corner of sec. 28, T. 124 N., R. 51 W.:

O—1 inch to 0, dark-gray (10YR 4/1) matted leaves and partly decomposed organic matter, black (10YR 2/1) moist.

A1—0 to 9 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to moderate, fine, granular; slightly hard, friable; neutral; clear, wavy boundary.

B21t—9 to 17 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; moderate, fine and medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few bleached sand grains and pockets that are gray (10YR 5/1) moist; neutral; clear, irregular boundary.

B22t—17 to 24 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; few, medium, prominent mottles that are strong brown (7.5YR 5/6) moist; moderate, medium, blocky structure; hard, firm, sticky and plastic; thin, continuous clay films; neutral; clear, wavy boundary.

B3ca—24 to 31 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, prominent mottles that are dark reddish brown (5YR 3/4) moist; moderate, fine and medium, blocky structure; hard, firm, slightly sticky and plastic; common fine segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1—31 to 41 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine, distinct mottles that are dark gray (10YR 4/1) and yellowish brown (10YR 5/6) moist; massive; hard, firm, slightly sticky and plastic; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—41 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; many, fine and medium, prominent mottles that are strong brown (7.5YR 5/6) and dark yellowish brown (10YR 4/4) moist; massive; hard, firm, slightly sticky and plastic; strong effervescence; moderately alkaline.

The A horizon is dark-gray or very dark gray loam or clay loam. It ranges from 9 to 20 inches in thickness. A thin B&A horizon that ranges from dark gray to light brownish gray is present in places. The B2t horizon has a hue of 10YR or 2.5Y. It is clay loam or clay, and its clay content ranges from 35 to 50 percent. It ranges from 8 to 15 inches in thickness. The B3ca horizon ranges from 6 to 13 inches in thickness. The C horizon ranges from light brownish gray to pale yellow.

Sieche soils are near Aastad, Buse, and Forman soils. They have more clay in the B horizon than Aastad and Forman soils. Sieche soils have a thicker A horizon and are deeper to lime than Buse soils.

Sieche loam, 15 to 40 percent slopes (ScF).—This soil is mainly in wooded coulees or drainageways that dissect uplands to a depth ranging from 50 to 150 feet. Also, a few wooded areas of this soil are around permanent lakes. Areas are irregular in shape and range from 30 to 150 acres in size. A few stones or boulders commonly are scattered on the surface in the higher parts of landscapes. Spring-fed streams commonly are in the bottoms of the coulees.

Included with this soil in mapping are small areas of Aastad, Buse, and Forman soils and small areas of Loamy Fluvaquents. These areas make up as much as 30 percent of some mapped areas. Aastad, Buse, and Forman soils are in the parts of the mapped areas that have grass vegetation. Loamy Fluvaquents are in narrow bottoms of some coulees.

Runoff is rapid, and disturbed areas erode easily. Fertility is medium or high, and available water capacity is high, but this soil is too erodible to be cultivated.

Most areas of this soil are in native woodland. They are better suited to wildlife habitat and recreation than to other uses. Capability unit VIIe–1; range site not assigned; windbreak suitability group 10.

Sinai Series

The Sinai series consists of deep, well-drained, nearly level to gently sloping, clayey soils on uplands. These soils formed in glacial-lacustrine deposit. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray silty clay about 6 inches thick. The subsoil, about 30 inches thick, is silty clay that is dark gray in the upper part, grayish brown in the middle part, and light brownish gray in the lower part. The subsoil is hard when dry, firm when moist, and sticky and plastic when wet. The lower part of it is calcareous. The underlying material is light-gray, calcareous silty clay and clay.

Content of organic matter and fertility are high in Sinai soils. Available water capacity is moderate or high. Permeability is slow, and runoff is slow or medium.

Most areas of these soils are cultivated. Corn, small grains, flax, and alfalfa are the main crops.

Representative profile of Sinai silty clay, 0 to 2 percent slopes, in a cultivated field, 2,586 feet south and 415 feet east of the northwest corner of sec. 34, T. 123 N., R. 51 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate, fine and medium, granular structure; hard, friable, sticky and plastic; neutral; abrupt, smooth boundary.

B21—6 to 11 inches, dark-gray (10YR 4/1) and grayish brown (2.5Y 5/2) silty clay, very dark gray (10YR 3/1) and very dark grayish brown (2.5Y 3/2) moist; coats on faces of peds that are black (10YR 2/1) moist; weak, medium and coarse, prismatic structure parting to moderate, fine and medium, subangular blocky; hard, firm, sticky and plastic; neutral; gradual, wavy boundary.

B22—11 to 17 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; coats on faces of peds that are black (10YR 2/1) moist; moderate, medium and coarse, prismatic structure parting to moderate, fine and medium, blocky and subangular blocky; hard, firm, sticky and plastic; mildly alkaline; clear, wavy boundary.

B3ca—17 to 33 inches, light brownish-gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) moist; coats on faces of peds that are black (10YR 2/1) moist; few, fine and medium, distinct mottles that are yellowish brown (10YR 5/6), dark brown (7.5YR 4/4), and gray (5Y 5/1) moist; weak, medium and coarse, prismatic structure parting to moderate, fine, medium and coarse, subangular blocky; hard, friable, sticky and plastic; few fine segregations of lime; strongly effervescent; moderately alkaline; gradual, wavy boundary.

C1—33 to 44 inches, light-gray (2.5Y 7/2) silty clay, grayish brown (2.5Y 5/2) moist; common, fine and medium, prominent mottles that are dark brown (7.5YR 4/4) and strong brown (7.5YR 5/8) moist; massive; hard, friable, sticky and plastic; strongly effervescent; moderately alkaline; gradual, wavy boundary.

C2—44 to 60 inches, light-gray (2.5Y 7/2) clay, grayish brown (2.5Y 5/2) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8), yellowish red (5YR 4/6), and gray (5Y 5/1) moist; massive; hard, firm, sticky and plastic; strongly effervescent; moderately alkaline.

The A horizon is dark-gray or very dark gray silty clay or silty clay

loam. It ranges from 6 to 10 inches in thickness. The B2 horizon ranges from very dark gray to pale brown in hue of 10YR or 2.5Y. It is silty clay or silty clay loam, and it ranges from 7 to 16 inches in thickness. The B3ca horizon is grayish brown or light brownish gray in hue of 10YR or 2.5Y. It is silty clay or silty clay loam, and it ranges from 3 to 16 inches in thickness. The C horizon is clay, silty clay, or silty clay loam.

Sinai soils are near Forman, Poinsett, and Waubay soils. They are more clayey than those soils.

Sinai silty clay, 0 to 2 percent slopes (SnA).—This soil is in higher parts of uplands on mesalike flats. Areas range from 6 to 55 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Forman and Poinsett soils on the edges of the mapped areas.

Fertility is high. Available water capacity is moderate or high, but the soil takes in water slowly and it is difficult to work. It loses tilth easily if worked when wet. The soil blows easily in dry, unprotected areas, and control of soil blowing is a management need. Maintenance of tilth and improvement of water intake are the main concerns of management.

Most areas of this soil are cultivated. The soil is well suited to corn, small grains, flax, and alfalfa. Capability unit IIs–2; Clayey range site; windbreak suitability group 4.

Sinai silty clay, 2 to 6 percent slopes (SnB).—This soil is on uplands. Areas are irregular in shape and range from 5 to 50 acres in size. Slopes are long, smooth, and slightly convex. The profile of this soil is similar to the one described as representative of the series, but glacial till is at a depth of less than 40 inches in some areas. Also, in some cultivated areas of slightly eroded soil, lime is shallower than that in the representative profile and the surface layer is thinner.

Included with this soil in mapping are Forman and Poinsett soils on the edges of the mapped areas.

Available water capacity is moderate or high, but the soil takes in water slowly and it is difficult to work when wet. Runoff is medium, and the soil erodes easily. The soil blows easily in dry, unprotected areas. Control of water erosion and soil blowing are the main concerns of management. Maintenance of tilth and the improvement of water intake also are important management needs.

Most areas of this soil are cultivated. This soil is suited to corn, small grains, flax, and alfalfa. Capability unit IIIe–3; Clayey range site; windbreak suitability group 4.

Sioux Series

The Sioux series consists of excessively drained, undulating to steep, loamy soils that are very shallow over sand and gravel. These soils formed in glacial outwash and are on stream terraces and uplands. The native vegetation is mostly mid and short grasses.

In a representative profile the surface layer is dark-gray loam about 4 inches thick. Below this is a transitional layer of dark-gray gravelly loam about 3 inches thick. It is soft when dry and very friable when moist. The underlying material is grayish-brown. Below this depth is pale-brown and light yellowish-brown, calcareous sand and gravel.

Content of organic matter is moderately low and fertility is low in Sioux soils. Available water capacity is low or very low. Permeability is rapid, and runoff is slow.

Most areas of these soils remain in native grass and are used for grazing, but some areas are cultivated.

Sioux soils in Roberts County are mapped only in complex with Renshaw soils.

Representative profile of Sioux loam in native grass in an area of Renshaw-Sioux loams, 3 to 9 percent slopes; 2,265 feet south and 144 feet east of the northwest corner of sec. 24, T. 124 N., R. 51 W.:

A1—0 to 4 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine and coarse, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

AC—4 to 7 inches, dark-gray (10YR 4/1) gravelly loam, very dark gray (10YR 3/1) moist; weak, coarse, granular structure; soft, very friable; mildly alkaline; abrupt, wavy boundary.

IIC1—7 to 15 inches, grayish-brown (10YR 5/2) sand and gravel, dark grayish brown (10YR 4/2) moist, single grained; loose; strong effervescence; moderately alkaline; abrupt, wavy boundary.

IIC2—15 to 31 inches, pale-brown (10YR 6/3) sand and gravel, dark brown (10YR 4/3) moist; single grained; loose; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC3—31 to 60 inches, light yellowish-brown (10YR 6/4) sand and gravel, yellowish brown (10YR 5/4) moist; single grained; loose; strong effervescence; moderately alkaline.

Depth to sand and gravel ranges from 7 to 14 inches. The A horizon is very dark gray or dark-gray loam, gravelly loam, or sandy loam. It ranges from 4 to 8 inches in thickness. The AC horizon ranges from dark gray to light brownish gray. It ranges from 3 to 6 inches in thickness.

Sioux soils are mapped with Renshaw soils and are near Fordville soils. They are shallower to sand and gravel than those soils.

Sisseton Series

The Sisseton series consists of deep, well-drained, gently undulating to steep, calcareous, loamy soils on uplands. These soils formed in stratified, loamy and silty glacial drift. The native vegetation is mostly mid and short grasses.

In a representative profile the surface layer is light brownish-gray and pale-yellow, calcareous loam about 8 inches thick. The underlying material is light-gray, calcareous loam to a depth of 18 inches. It is slightly hard when dry and very friable when moist. Below this depth is pale-yellow calcareous loam and silt loam.

Content of organic matter and fertility are low in Sisseton soils. Available water capacity is moderate or high. Permeability is moderate, and runoff is medium or rapid.

Many areas of these soils are cultivated and are used for growing corn, small grains, soybeans, flax, and alfalfa. Most areas of rolling to steep soils remain in native grass and are used for grazing or for growing hay.

Representative profile of Sisseton loam in an area of Heimdal-Sisseton loams, 2 to 6 percent slopes, in a cultivated field; 2,112 feet east and 132 feet north of the southwest corner of sec. 4, T. 124 N., R. 50 W.:

Ap—0 to 8 inches, light brownish-gray (2.5Y 6/2) and pale-yellow (2.5Y 7/3) loam, dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) moist; cloddy parting to weak, fine, granular structure; slightly hard, very friable; common cobbles and pebbles on the surface and throughout the horizon; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1ca—8 to 18 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; weak, coarse, prismatic structure; slightly hard, very friable; common pebbles throughout; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2ca—18 to 36 inches, pale-yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish red (5YR 5/8) and reddish brown (5YR 4/4) moist; weak, medium, subangular blocky structure; slightly hard, very friable; common pebbles throughout; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C3—36 to 60 inches, pale-yellow (2.5Y 7/4) silt loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish red (5YR 5/8) and reddish brown (5YR 4/4) moist, massive; slightly hard, very friable; common peb-

bles throughout; few medium segregations of lime; strong effervescence; moderately alkaline.

These soils are mainly calcareous throughout their profile, but the upper part of the A horizon in some areas in native grass is noncalcareous. Calcium carbonate equivalent ranges from 15 to 35 percent in all horizons. The soils are loam or silt loam to a depth of 40 inches or more. In undisturbed areas in native grass the A horizon ranges from very dark grayish brown to light brownish gray and commonly ranges from 2 to 4 inches in thickness. The Ap horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y. It is as thick as 8 inches. The lower part of the C horizon commonly is stratified with thin layers of sandy loam.

Sisseton soils are mapped with Heimdal soils and are similar to Buse and Zell soils. They have a thinner A1 horizon than those soils. Also, they have less clay than Buse soils and less silt and more fine sand than Zell soils.

Sisseton loam, 25 to 40 percent slopes (SsF).—This soil is on uplands. Areas are long and narrow and range from 10 to 350 acres in size. Stony areas ranging from ½ to 20 acres in size are in some of the mapped areas. Some areas in native grass have a thin, dark-gray surface layer ranging from 2 to 4 inches in thickness; otherwise, the profile of this soil is similar to the one described as representative of the series.

Included with this soil in mapping are small areas of Heimdal, Renshaw, Sioux, and Svea soils. These areas make up as much as 30 percent of some mapping units. Of these, Svea soils are the most extensive and are in swales and the lower parts of landscapes. Heimdal soils are in the middle parts of landscapes below Sisseton soils. Renshaw and Sioux soils are in areas where the underlying material is sand and gravel.

Fertility and content of organic matter are low. Runoff is rapid, and the soil is too steep and too susceptible to erosion to be cultivated.

Most areas of this soil are in native grass and are used for grazing. Capability unit VIIe–1; Thin Upland range site; windbreak suitability group 10.

Sisseton-Heimdal loams, 9 to 25 percent slopes (StD).—This complex of rolling to hilly soils is on uplands. Sisseton soils are on the tops and upper sides of ridges and knolls. In cultivated areas their presence is easily observed by their light color (fig. 17). Most mapped areas are long and narrow and range from 5 to 50 acres in size. Slopes are short and irregular. A few stones and cobbles are scattered on the surface in many of the areas. In native grass the Sisseton soils have a thin, dark-gray surface layer ranging from 2 to 4 inches in thickness, but in cultivated areas these soils commonly are eroded and the surface is light gray. In places the surface layer of the Heimdal soils is thinner than it is in the profile described as representative of the series, but in the areas at lower elevations the surface layer is thicker.

Figure 17.—**Area of Sisseton-Heimdal loams, 9 to 25 percent slopes. The lighter spots are Sisseton soils.**

About 45 percent of this complex is Sisseton soils, about 30 percent is Heimdal soils, and the rest is included soils. These are areas of Renshaw, Sioux, and Svea soils. Of these, Svea soils in swales are the most extensive. Small areas of Renshaw and Sioux soils are in areas where the underlying material is sand and gravel.

Fertility and content of organic matter are low in Sisseton soils. Runoff is rapid in the Sisseton soils. These soils are too susceptible to erosion to be cultivated.

Some areas of this complex are cultivated. Other areas remain in native grass and are used for grazing or for growing hay. Sisseton and Heimdal soils in capability unit VIe–3 and windbreak suitability group 10; Sisseton soils in Thin Upland range site; Heimdal soils in Silty range site.

Svea Series

The Svea series consists of deep, moderately well drained, nearly level to sloping, loamy soils on uplands. These soils formed in local alluvium and underlying glacial till. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray loam about 13 inches thick. The subsoil, about 12 inches thick, is loam that is dark gray in the upper part and grayish brown in the lower part. It is slightly hard when dry and friable when moist. The underlying material is light brownish-gray, light-gray, and light yellowish-brown, calcareous loam.

Content of organic matter and fertility are high in Svea soils. Available water capacity is high. Permeability is moderate in the subsoil and slow in the underlying material. Runoff is slow or medium.

Most areas of these soils are cultivated. Corn, soybeans, small grains, flax, and alfalfa are the main crops.

Representative profile of Svea loam in an area of Heimdal-Svea loams, 2 to 6 percent slopes, in a cultivated field; 339 feet south and 45 feet west of the northeast corner of sec. 1, T. 125 N., R. 51 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

A12—8 to 13 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate, medium and coarse, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; neutral; clear, wavy boundary.

B21—13 to 20 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B22—20 to 25 inches, grayish-brown (10YR 5/2) loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

C1ca—25 to 30 inches, light brownish-gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/4) moist; few, fine and medium, distinct mottles that are yellowish brown (10YR 5/6) and gray (5Y 5/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; clear, wavy boundary.

C2ca—30 to 43 inches, light-gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 4/8) moist; massive; slightly hard, friable; violent effervescence; moderately alkaline; gradual, wavy boundary.

C3—43 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are strong brown (7.5YR 5/8) and yellowish red (5YR 4/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is dark gray or very dark gray in hue of 10YR. It is loam or silt loam and ranges from 8 to 20 inches in thickness. The B2 horizon ranges from dark gray to brown. It is loam or light clay loam and ranges from 8 to 16 inches in thickness. The C horizon commonly is loam or clay loam glacial till.

Svea soils are mapped with Heimdal soils. Their position in the landscape is similar to that of Aastad and Waubay soils. They have less clay in the B horizon than Aastad soils. They have a thicker A horizon than Heimdal soils. Svea soils have less silt in the B horizon than Waubay soils.

Svea loam, 5 to 9 percent slopes (SvC).—This soil is on uplands in areas immediately below steeper soils. Areas are long and narrow and range from 5 to 30 acres in size. The profile of this soil is similar to the one described as representative of the series, but the surface layer is thicker than the one in that profile in places.

Included with this soil in mapping are areas of Heimdal soils in the higher parts of the areas.

Fertility is high. Available water capacity is high, but runoff is medium and cultivated areas are subject to erosion. Control of erosion is the main concern of management.

Most areas of this soil are cultivated. This soil is suited to corn, small grains, and alfalfa. Capability unit IIIe–2; Silty range site; windbreak suitability group 1.

Sverdrup Series

The Sverdrup series consists of deep, somewhat excessively drained, nearly level to undulating, loamy soils on uplands. These soils formed in sandy deposits of glacial outwash. The native vegetation is mostly tall and mid grasses.

In a representative profile the surface layer is dark-gray sandy loam about 14 inches thick. The subsoil, about 8 inches thick, is brown sandy loam. The underlying material is pale-brown and light brownish-gray, calcareous sand.

Content of organic matter is moderate or moderately low and fertility is medium in Sverdrup soils. Available water capacity is low or moderate. Permeability is moderately rapid, and runoff is slow or medium.

Most areas of these soils are cultivated. Corn, small grains, flax, and alfalfa are the main crops.

Representative profile of Sverdrup sandy loam, 0 to 3 percent slopes, in a cultivated field, 2,112 feet east and 93 feet north of the southwest corner of sec. 9, T. 128 N., R. 50 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

A12—8 to 14 inches, dark-gray (10YR 4/1) sandy loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, very friable; neutral; clear, wavy boundary.

B2—14 to 22 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; slightly hard, very friable; neutral; clear, wavy boundary.

IIC1—22 to 34 inches, pale-brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; loose; slight effervescence; mildly alkaline; gradual, wavy boundary.

IIC2—34 to 60 inches, light brownish-gray (10YR 6/2) sand, brown (10YR 5/3) moist; single grained; loose; slight effervescence; moderately alkaline.

The A horizon ranges from very dark gray to gray. It is sandy loam or loam and ranges from 10 to 16 inches in thickness. The B horizon ranges from dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is sandy loam or loamy sand and ranges from 4 to 8 inches in thickness. A thin B3 horizon of loamy sand is present in places. The C horizon is sand or fine sand.

Sverdrup soils are near Eckman, and Heimdal soils. They have more sand and less silt and clay than those soils.

Sverdrup sandy loam, 0 to 3 percent slopes (SwA).—This soil is on upland flats. Areas are irregular in shape

and range from 5 to 50 acres in size. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Eckman, Embden, and Heimdal soils. Eckman and Heimdal soils are intermingled with Sverdrup soils in an erratic pattern. Embden soils are in low areas or swales.

This soil is somewhat droughty. Available water capacity is low or moderate. Content of organic matter is moderate or moderately low, and the soil blows easily. Control of soil blowing, conservation of moisture, and maintenance of organic-matter content and fertility are the main concerns of management.

Most areas of this soil are cultivated. Under careful management, the soil is suited to corn, small grains, flax, and alfalfa. Capability unit IIIs–1; Sandy range site; windbreak suitability group 5.

Sverdrup sandy loam, 3 to 9 percent slopes (SwB) — This complex of gently undulating to undulating soils is on uplands. Mapped areas range from 5 to 75 acres in size. Slopes are mainly less than 6 percent. The profile is similar to the one described as representative of the series, but the surface layer is thinner than that in the representative profile in places.

Included with this soil in mapping are small areas of Eckman, Embden, and Heimdal soils. Eckman and Heimdal soils are intermingled in an erratic pattern along with Sverdrup soils. Embden soils are in swales.

This soil is droughty during extended dry periods. Runoff is medium, and cultivated areas are subject to water erosion and soil blowing. Control of water erosion and soil blowing, conservation of moisture, and maintenance of fertility and organic-matter content are important management needs.

Most areas of this soil are cultivated and are used to grow corn, small grains, flax, and alfalfa. This soil is better suited to early-maturing or drought-resistant crops than it is to other crops. Capability unit IIIe–7; Sandy range site; windbreak suitability group 5.

Tonka Series

The Tonka series consists of deep, poorly drained, level, silty soils in closed depressions on uplands. These soils formed in alluvium washed from adjacent soils. The native vegetation is mostly tall grasses, sedges, and rushes.

In a representative profile the surface layer is dark-gray silt loam about 10 inches thick. The subsurface layer is gray silt loam about 8 inches thick. The subsoil, about 30 inches thick, is clay that is dark gray in the upper part and gray in the lower part. It is very hard when dry and very firm when moist. The underlying material is gray clay loam.

Content of organic matter is high, and fertility is medium or high in Tonka soils. Available water capacity is high. Permeability is slow, and the surface ponds.

Many areas of these soils are cultivated. Adequately drained areas are suited to most crops commonly grown in the county. Other areas remain in native grass and are used for grazing, for growing hay, or as wildlife habitat.

Representative profile of Tonka silt loam, from an area of Hamerly-Tonka complex, 0 to 3 percent slopes, in a cultivated field, 540 feet west and 69 feet south of the northeast corner of sec. 27, T. 127 N., R. 51 W.:

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

A12—6 to 10 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; neutral; abrupt, smooth boundary.

A2—10 to 18 inches, gray (10YR 6/1) silt loam, dark gray (10YR 4/1) moist; many, medium, prominent mottles that are dark brown (10YR 3/3) and dark yellowish brown (10YR 4/4) moist; moderate, medium, platy structure; slightly hard, friable; neutral; abrupt, irregular boundary.

B2t—18 to 39 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; strong, medium and coarse, prismatic structure parting to strong, fine and medium, blocky; very hard, very firm; neutral; gradual, wavy boundary.

B3—39 to 48 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; common, fine, distinct mottles that are dark yellowish brown (10YR 4/4) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, blocky; very hard, very firm; neutral; gradual, wavy boundary.

Cg—48 to 60 inches, gray (5Y 6/1) clay loam, olive gray (5Y 5/2) moist; common, fine and medium, distinct mottles that are dark brown (7.5YR 4/4) and strong brown (7.5YR 5/8) moist; massive; hard, friable; neutral.

Depth to carbonates ranges from 28 to more than 60 inches. The A1 horizon is dark-gray or gray silt loam, silty clay loam, or loam. It ranges from 6 to 16 inches in thickness. The A2 horizon is gray or light gray in hue of 10YR or 2.5Y. It is silt loam or loam and ranges from 4 to 16 inches in thickness. The B horizon, when moist, ranges from black to olive gray in hue of 10YR, 2.5Y, or 5Y. It is clay loam, silty clay loam, or clay. The B2t horizon ranges from 12 to 27 inches in thickness, and the B3 horizon ranges from 6 to 9 inches in thickness. The C horizon is either alluvium or glacial till and commonly is calcareous in the lower part.

Tonka soils are mapped with Hamerly and Peever soils and are near Forman soils. They are more poorly drained than all of those soils. Tonka soils also have more clay in the B horizon than Forman soils.

Tonka silt loam (0 to 1 percent slopes) (Tk) —This soil is in closed depressions on uplands. Most areas are circular in shape and range from 2 to 10 acres in size. The profile of this soil is similar to the one described as representative of the series, but in some cultivated areas the surface layer is gray because it has been mixed with the subsurface layer by plowing.

Included with this soil in mapping are small areas of Bearden, Hamerly, and Vallers soils on edges of depressions.

Runoff is ponded, and wetness commonly delays seeding and tillage. In undrained areas crops generally are drowned during wet years. Wetness is the main concern of management.

Many small areas of this soil are farmed along with adjacent soils. Adequately drained areas of this soil are suited to most crops commonly grown in the county. Undrained areas are better suited to late-planted crops or to pasture and hay. Alfalfa grows poorly in undrained areas. Capability unit IIw–1 drained, IVw–2 undrained; Wetland range site; windbreak suitability group 10.

Towner Series

The Towner series consists of deep, moderately well drained, nearly level, loamy soils on uplands. These soils formed in sandy, glacial melt water deposit and the underlying glacial till. The native vegetation is tall and mid grasses.

In a representative profile the surface layer is about 20 inches thick. It is dark-gray fine sandy loam in the upper part and dark-gray loamy fine sand in the lower part. It is loose when dry and very friable when moist. The underlying material is grayish-brown loamy fine sand to a depth of 25 inches. Below this depth, it is grayish-brown, white, light brownish-gray, and light-gray loam. Below a depth of 35 inches the underlying material is calcareous.

Content of organic matter is moderate and fertility is

medium in Towner soils. Available water capacity is moderate or high. Permeability is rapid in the sandy material in the upper part of the soils and is slow in the underlying glacial till. Runoff is slow. The water table is at a depth ranging from 2 to 3 feet during the early part of the growing season.

Most areas of these soils are cultivated and are used for growing corn, soybeans, small grain, and flax.

Representative profile of Towner fine sandy loam, in a cultivated field, 1,390 feet west and 134 feet south of the northeast corner of sec. 3, T. 239 N., R. 48 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) moist; weak, fine, granular structure; loose, very friable; neutral; abrupt, smooth boundary.

A12—8 to 20 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) moist; very weak, coarse, subangular blocky structure parting to weak, fine, granular; loose, very friable; neutral; gradual, wavy boundary.

C1—20 to 25 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; few, fine, faint mottles that are dark yellowish brown moist; very weak, coarse, subangular blocky structure parting to single grained; loose, very friable; neutral; clear, wavy boundary.

IIB2b—25 to 35 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; common, medium, distinct mottles that are dark brown (7.5YR 4/4) moist; moderate, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, firm; neutral; clear, wavy boundary.

IIC2ca—35 to 51 inches, white (5Y 8/1) loam, light olive gray (5Y 6/2) moist; common, medium, distinct mottles that are yellowish brown (10YR 5/6) moist; massive; hard, firm; violent effervescence; moderately alkaline; gradual, wavy boundary.

IIC3—51 to 60 inches, light brownish-gray (2.5Y 6/2) and light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/4) moist; common, fine, distinct mottles that are dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) moist; massive; hard, firm; strong effervescence; moderately alkaline.

The sandy material over glacial till ranges from 20 to 40 inches in thickness. A buried A horizon or B horizon commonly is in the upper part of the IIC horizon below a depth of 20 inches. The upper part of the A horizon is dark gray or very dark gray. The A12 horizon ranges from very dark gray to grayish brown in hue of 10YR or 2.5Y. It is loamy sand or loamy fine sand. The A horizon ranges from 15 to 28 inches in thickness. The C1 horizon is loamy sand, loamy fine sand, or fine sand. It ranges from 5 to 12 inches in thickness. The IIC horizon and buried horizons within it are loam or clay loam.

Towner soils are near Glyndon and Hecla soils. They have more sand and less silt than Glyndon soils. The C horizon of Towner soils is more clayey than that of Hecla soils.

Towner fine sandy loam (0 to 2 percent slopes) (To).—This soil is on uplands in basins and on flats. Areas range from 15 to 100 acres in size.

Included with this soil in mapping are small areas of Hamar, Hamerly, Hecla, and Vallers soils. Hamar, Hamerly, and Vallers soils are in some low areas. Hecla soils are on very slight rises.

Runoff is slow. Spring planting is delayed by wetness in some years, but during dry periods this soil blows easily. Control of soil blowing is the main concern of management.

Most areas of this soil are cultivated and are used to grow corn, soybeans, flax, and small grain. Capability unit IIIs–1; Sandy range site; windbreak suitability group 1.

Ulen Series

The Ulen series consists of deep, somewhat poorly drained, nearly level, calcareous, loamy soils in swales and on flats on uplands. These soils formed in sandy lacustrine deposit. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is dark-gray sandy loam about 7 inches thick. The underlying material is light-gray, calcareous sandy loam to a depth of 20 inches. It is slightly hard when dry and friable when moist. Below a depth of 20 inches, it is light-gray, calcareous loamy sand and sand.

Content of organic matter is moderate or moderately low and fertility is medium or low in Ulen soils. Available water capacity is low. Permeability is rapid, and runoff is slow. The seasonal water table is at a depth ranging from 2 to 4 feet during part of the growing season.

Most areas of these soils are cultivated and are used for growing corn, soybeans, flax, and alfalfa.

Representative profile of Ulen sandy loam, in a cultivated field, 2,290 feet west and 350 feet south of the northeast corner of sec. 35, T. 128 N., R. 50 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1) moist; weak, coarse, subangular blocky structure parting to weak, fine and medium, granular; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

C1ca—7 to 14 inches, light-gray (2.5Y 7/2) sandy loam, grayish brown (2.5Y 5/2) moist; weak, coarse, subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2ca—14 to 20 inches, light-gray (2.5Y 7/2) sandy loam, light brownish gray (2.5Y 6/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—20 to 35 inches, light-gray (2.5Y 7/2) loamy sand, grayish brown (2.5Y 5/2) moist; common, fine and medium, prominent mottles that are yellowish red (5YR 4/8) and white (N 8/0) moist; single grained; loose, slight effervescence; moderately alkaline; gradual, wavy boundary.

C4—35 to 60 inches, light-gray (2.5Y 7/2) sand, grayish brown (2.5Y 5/2) moist; single grained; loose; common stains that are yellowish red (5YR 4/8) and dark reddish brown (5YR 3/3) moist; slight effervescence; moderately alkaline.

The A horizon is dark-gray or gray sandy loam or fine sandy loam. It ranges from 6 to 10 inches in thickness. The Cca horizon ranges from grayish brown to light gray in hue of 10YR or 2.5Y. It is sandy loam or fine sandy loam. Calcium carbonate equivalent of the Cca horizon ranges from 10 to 15 percent. The C horizon below the Cca horizon commonly is loamy sand or sand, but in some places the upper part of it is loamy fine sand.

Ulen soils in Roberts County have more medium and coarse sand at depths between 10 and 40 inches than the defined range for the series, but this does not alter their usefulness and behavior.

Ulen soils are near Hecla, Heimdal, and Sverdrup soils. They have a thinner A horizon and are more calcareous than Hecla soils. They are sandier and more poorly drained than Heimdal soils. Ulen soils are more poorly drained and more calcareous than Sverdrup soils.

Ulen sandy loam (0 to 2 percent slopes) (Un).—This soil is on uplands on flats and in swales. Areas are irregular in shape and range from 10 to 120 acres in size.

Included with this soil in mapping are small areas of Glyndon and Hamar soils in lower parts of the areas.

Fertility is medium or low, and this soil blows easily when it is dry. Wetness delays spring planting in some years, but available water capacity is low and the soil is droughty during extended periods of dry weather. Control of soil blowing is the main concern of management.

Most areas of this soil are cultivated, and the soil is suited to corn, soybeans, small grain, and alfalfa. Capability unit IIIs–5, Sandy range site; windbreak suitability group 2.

Vallers Series

The Vallers series consists of deep, poorly drained, nearly level, calcareous, loamy soils in low areas on uplands. These soils formed in glacial till. The native vegetation is mostly tall grasses.

In a representative profile the surface layer is gray, cal-

careous loam about 9 inches thick. The underlying material to a depth of 27 inches is gray and light olive-gray, calcareous loam that has nests of gypsum crystals. It is slightly hard when dry and friable when moist. Below a depth of 27 inches, it is light-gray, calcareous loam.

Content of organic matter is moderate and fertility is medium in Vallers soils. Available water capacity is high. Permeability is moderately slow, and runoff is slow. The seasonal water table is at a depth ranging from 2 to 4 feet during much of the growing season.

Some areas of these soils are cultivated. Corn, small grain, flax, and alfalfa are the main crops. Other areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Vallers loam from an area of Vallers-Hamerly loams, 0 to 2 percent slopes, in a cultivated field, 830 feet west and 100 feet south of the northeast corner of sec. 32, T. 123 N., R. 49 W.:

Ap—0 to 6 inches, gray (10YR 5/1) loam, black (10YR 2/1) moist; weak, fine, granular structure; slightly hard, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

A12—6 to 9 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) moist; weak, medium, subangular blocky structure parting to weak, fine, granular; slightly hard, friable; few, fine nests of gypsum crystals; strong effervescence; moderately alkaline; clear, wavy boundary.

C1gca—9 to 16 inches, gray (5Y 6/1) loam, dark gray (5Y 4/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; few, fine nests of gypsum crystals; violent effervescence; moderately alkaline; clear, wavy boundary.

C2gca—16 to 27 inches, light olive-gray (5Y 6/2) loam, gray (5Y 5/1) moist; common, fine and medium, distinct mottles that are light olive brown (2.5Y 5/6) moist; weak, coarse, subangular blocky structure; slightly hard, friable; common, fine nests of gypsum crystals; violent effervescence; moderately alkaline; clear, wavy boundary.

C3g—27 to 38 inches, light-gray (5Y 7/1) loam, light olive gray (5Y 6/2) moist; common, fine, distinct mottles that are light olive brown (2.5Y 5/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C4g—38 to 60 inches, light-gray (5Y 7/1) loam, olive gray (5Y 5/2) moist; many, fine and medium, prominent mottles that are yellowish brown (10YR 5/8) and yellowish red (5YR 5/8) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

The A horizon is black or very dark gray when moist in hue of 10YR, 2.5Y, or 5Y. It is loam or clay loam and ranges from 8 to 16 inches in thickness. The C horizon has a hue of 5Y or 2.5Y and is loam or clay loam. Calcium carbonate equivalent of the Cca horizon ranges from 15 to 25 percent. The Cca horizon ranges from 6 to 24 inches in thickness.

Vallers soils are mapped with Hamerly soils and are near Forman, Heimdal, Parnell, and Tonka soils. They are more poorly drained and are more calcareous than Forman and Heimdal soils. They are more poorly drained than Hamerly soils. Vallers soils are better drained and are more calcareous than Parnell and Tonka soils.

Vallers-Hamerly loams, 0 to 2 percent slopes (VhA).—The soils of this complex are on uplands in swales around and between wet depressions. Areas range from 2 to 25 acres in size. Hamerly soils are on slight rises that are better drained.

About 60 percent of this complex is Vallers soils, about 30 percent is Hamerly soils, and the rest is included soils. These are areas of Parnell and Tonka soils in wet depressions less than 2 acres in size, some of which are shown on the detailed maps by the symbol for wet spots.

Runoff is slow, and wetness commonly delays spring planting and tillage. During wet years crops grow poorly on undrained areas of Vallers soils of the complex. During dry periods both soils blow easily. Wetness is the main concern of management.

Adequately drained areas of this complex are suited to corn, small grain, flax, and alfalfa. Undrained areas are better suited to late-sown crops or to pasture and hay. Capability unit IIw–2 drained, IVw–2 undrained; Vallers soils in Subirrigated range site, windbreak suitability group 2. Hamerly soils in Silty range site windbreak, suitability group 1.

Vienna Series

The Vienna series consists of deep, well-drained, nearly level to sloping, silty soils on uplands. These soils formed in a thin layer of loess and underlying glacial till. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray silt loam about 11 inches thick. The subsoil, about 19 inches thick, is grayish-brown silt loam in the upper part, light olive-brown loam in the middle part, and pale-yellow clay loam in the lower part. The subsoil is slightly hard when dry and friable when moist. The lower part of it is calcareous. The underlying material is pale-yellow, calcareous clay loam.

Content of organic matter is moderate and fertility is medium or high in Vienna soils. Available water capacity is high. Permeability is moderate in the subsoil and is moderately slow in the underlying material. Runoff is slow or medium.

Most areas of these soils are cultivated and are used for corn, small grain, flax, and alfalfa.

Representative profile of Vienna silt loam, 0 to 2 percent slopes, 2,640 feet west and 125 feet north of the southeast corner of sec. 16, T. 123 N., R. 52 W.:

A11—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

A12—6 to 11 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium and coarse, subangular blocky structure; slightly hard, friable; neutral; clear, wavy boundary.

B21—11 to 15 inches, grayish-brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; mildly alkaline; clear, wavy boundary.

IIB22—15 to 21 inches, light olive-brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) moist; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, friable; thin, patchy clay films; mildly alkaline; clear, wavy boundary.

IIB3ca—21 to 30 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; weak, medium and coarse, prismatic structure parting to weak, coarse, subangular blocky; slightly hard, friable; common, fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC1ca—30 to 38 inches, pale-yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/4) moist; massive; slightly hard, friable; common, fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC2—38 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/6) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 17 to 30 inches. The A horizon is dark-gray or very dark gray silt loam or loam. It ranges from 7 to 12 inches in thickness. The B21 horizon ranges from very dark gray to grayish brown in hue of 10YR or 2.5Y. It is silt loam or silty clay loam. The B22 horizon ranges from dark grayish brown to light olive brown in hue of 10YR or 2.5Y. It is loam or clay loam. The B2 horizon ranges from 10 to 18 inches in thickness. The B3 horizon is clay loam or loam and ranges from 4 to 10 inches in thickness. The C horizon is clay loam or loam.

Vienna soils are near Forman soils and have a silty A horizon as do Poinsett soils. They have more silt in the A horizon and upper part of the B horizon than Forman soils. Vienna soils are less silty in the lower part of the B horizon and in the C horizon than Poinsett soils.

Vienna silt loam, 0 to 2 percent slopes (VnA).—This soil is on uplands. Areas are broad and range from 15 to 800 acres in size. Slopes are long and smooth. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are small areas of Fordville, Renshaw, and Tonka soils. Fordville and Renshaw soils are in spots underlain by sand and gravel. Tonka soils are in wet depressions most of which are less than 2 acres in size and are shown on the detailed maps by the symbol for wet spots.

Fertility is medium or high. Available water capacity is high. Runoff is slow. The soil has little or no limitations for crops.

Most areas of this soil are cultivated. The soil is well suited to corn, small grain, flax, and alfalfa. Capability unit I–2; Silty range site; windbreak suitability group 3.

Vienna silt loam, 2 to 6 percent slopes (VnB).—This soil is on uplands. Areas range from 15 to 500 acres in size. Slopes are long, smooth, and well rounded. In higher parts of the landscape, the surface layer and subsoil are thinner than in the profile described as representative of the series, but in some lower areas the surface layer is thicker and the depth to glacial till is more than 20 inches.

Included with this soil in mapping are small areas of Fordville, Hamerly, Renshaw, and Tonka soils. Fordville and Renshaw soils are in spots underlain by sand and gravel. Hamerly soils are in low areas and swales adjacent to small depressions. Tonka soils are in wet depressions, most of which are less than 2 acres in size and are shown on the detailed maps by the symbol for wet spots.

This soil is medium or high in fertility, but runoff is medium and the soil is subject to erosion. Control of erosion is the main concern of management.

Most areas of this soil are cultivated and are used for growing corn, flax, small grain, and alfalfa. Capability unit IIe–2; Silty range site; windbreak suitability group 3.

Vienna silt loam, 6 to 9 percent slopes (VnC).—This soil is on uplands on the sides of valleys and along well-defined drainageways. Areas are irregular in shape and range from 10 to 80 acres in size. In the higher parts of landscapes the surface layer and subsoil are thinner than in the profile described as representative of the series, but in some lower areas the surface layer is thicker.

Included with this soil in mapping are small areas of Buse, Hamerly, and Tonka soils. Buse soils are on the tops of knolls, some of which are eroded. Hamerly soils are in swales and low areas adjacent to depressions. Tonka soils are in depressions less than 2 acres in size, which are shown on the detailed maps by the symbol for wet spots.

Runoff is medium, and the hazard of erosion is severe in cultivated areas. Control of erosion is the main concern of management.

Most areas of this soil are cultivated. Small grain, flax, and alfalfa are the main crops. A few areas remain in native grass and are used for grazing or for growing hay. Capability unit IIIe–1; Silty range site; windbreak suitability group 3.

Waubay Series

The Waubay series consists of deep, moderately well drained, nearly level, silty soils on uplands in swales and low areas. These soils formed in silty glacial drift. The native vegetation is mixed tall, mid, and short grasses.

In a representative profile the surface layer is dark-gray silty clay loam about 12 inches thick. The subsoil, about 20 inches thick, is silty clay loam that is dark grayish brown in the upper part, light olive brown in the middle part, and light yellowish brown in the lower part. It is slightly hard when dry and friable when moist. The lower part is calcareous. The underlying material is light yellowish-brown, calcareous silty clay loam to a depth of about 47 inches. Below this depth, it is light yellowish-brown, calcareous silty clay.

Content of organic matter is high and fertility is high in Waubay soils. Available water capacity is high. Permeability is moderate in much of these soils, but it is moderately slow below a depth of about 47 inches. Runoff is slow.

Most areas of these soils are cultivated and are used for growing corn, soybeans, flax, small grain, and alfalfa.

Representative profile of Waubay silty clay loam, in a cultivated field, 1,515 feet west and 102 feet north of the southeast corner of sec. 5, T. 127 N., R. 48 W..

Ap—0 to 7 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, fine, granular structure; soft, friable, slightly sticky and plastic; neutral; abrupt, smooth boundary.

A12—7 to 12 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, medium, subangular blocky structure parting to moderate, fine and medium, granular; soft, friable, slightly sticky and plastic; neutral; clear, wavy boundary.

B21—12 to 18 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; tongues that are black (10YR 2/1) moist; weak, medium, prismatic structure parting to moderate, fine and medium, subangular; slightly hard, friable, slightly sticky and plastic; neutral; clear, wavy boundary.

B22—18 to 24 inches, light olive-brown (2.5Y 5/3) silty clay loam, dark grayish brown (2.5Y 4/2) moist; few, fine, faint mottles that are dark yellowish brown moist; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; mildly alkaline; abrupt, wavy boundary.

B3ca—24 to 32 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) moist; few, fine, distinct mottles that are yellowish brown and gray moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; slightly hard, friable, slightly sticky and plastic; few, fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—32 to 47 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/8), strong brown (7.5YR 5/8), and light brownish gray (2.5Y 6/2) moist; massive; slightly hard, friable, slightly sticky and plastic; common, fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—47 to 60 inches, light yellowish-brown (2.5Y 6/3) silty clay, light olive brown (2.5Y 5/4) moist; common, fine and medium, prominent mottles that are yellowish brown (10YR 5/8), strong brown (7.5Y 5/8), and light brownish gray (2.5Y 6/2) moist; massive; hard, firm, sticky and plastic; strong effervescence; moderately alkaline.

These soils are silt loam or silty clay loam to a depth of 40 inches or more. The A horizon is dark gray or very dark gray and ranges from 12 to 18 inches in thickness. The B21 horizon, when moist, commonly is very dark grayish brown or very dark brown in hue of 10YR or 2.5Y. The B2 horizon ranges from 10 to 18 inches in thickness. The B3ca horizon ranges from grayish brown to light yellowish brown. It ranges from 4 to 9 inches in thickness. The C horizon below a depth of 40 inches commonly is silty clay loam, silt loam, or loam, but in some places it is stratified with fine sand to clay or silty clay.

Waubay soils are near Heimdal and Poinsett soils. They are not so well drained as those oils and have a thicker A horizon. Waubay soils also have more clay than Heimdal soils.

Waubay silty clay loam (0 to 2 percent slopes) (Wa).—This soil is on uplands on low flats and in swales. Areas range from 3 to 10 acres in size.

Included with this soil in mapping are small areas of Bearden and Poinsett soils. Bearden soils are in some low areas. Poinsett soils are on slight rises.

Fertility is high. Available water capacity is high. Runoff is slow, and this soil receives runoff from adjacent areas. Wetness delays spring planting and tillage in some years, but in most years the additional moisture is beneficial. This soil has few or no limitations for crops.

Most areas of this soil are cultivated. The soil is well suited to corn, soybeans, flax, small grain, and alfalfa. Capability unit I–3; Silty range site; windbreak suitability group 1.

Zell Series

The Zell series are deep, well-drained, sloping to moderately steep, calcareous, silty soils on uplands. These soils formed in glacial-lacustrine sediment. The native vegetation is mostly mid and short grasses.

In a representative profile the surface layer is dark-gray, calcareous silt loam about 6 inches thick. Below the surface layer is a transition layer of light brownish-gray, calcareous silt loam about 6 inches thick. It is soft when dry and very friable when moist. The underlying material is light-gray, calcareous silt loam to a depth of 27 inches. Below this depth, it is light-gray, calcareous very fine sandy loam about 14 inches thick which is underlain by pale-yellow, calcareous silt loam.

Content of organic matter is moderately low or low and fertility is low or medium in Zell soils. Available water capacity is high. Permeability is moderate, and runoff is medium or rapid.

Some areas of these soils are cultivated, but many areas remain in native grass and are used for grazing or for growing hay.

Representative profile of Zell silt loam from an area of Zell-Eckman complex, 9 to 25 percent slopes, in native grass, 900 feet west and 84 feet north of the southeast corner of sec. 35, T. 128 N., R. 48 W.:

A1—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak, fine and medium, subangular blocky structure parting to weak, fine, granular; soft, very friable; slight effervescence; moderately alkaline; clear, wavy boundary.

AC—6 to 12 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; few, fine, distinct mottles that are strong brown (7.5YR 5/8) moist; weak, medium and coarse, subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—12 to 27 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) moist; common, medium and coarse, prominent mottles that are yellowish red (5YR 5/8) moist; massive; soft, very friable; few, fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—27 to 41 inches, light-gray (2.5Y 7/2) very fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; soft, very friable; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—41 to 60 inches, pale-yellow (2.5Y 7/3) silt loam, light yellowish brown (2.5Y 6/3) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

These soils are calcareous at or near the surface. The A horizon is mainly dark gray or very dark gray, but in some cultivated areas the Ap horizon is gray or grayish brown. The A horizon is silt loam or loam and ranges from 4 to 10 inches in thickness. The AC horizon ranges in color from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It ranges from 4 to 8 inches in thickness. The C horizon is mainly loam, silt loam, silt, and very fine sandy loam. It is commonly stratified or laminated.

Zell soils are mapped with Eckman soils and are near Buse soils. They are more silty and have less clay than Buse soils. They do not have a B horizon and Eckman soils do. Also Zell soils are calcareous at or near the surface, and Eckman soils are not.

Zell-Eckman complex, 9 to 25 percent slopes (ZeD).—The soils of this complex are on sides of valleys and entrenched drainageways. Zell soils are on the tops and upper sides of ridges and knolls. Eckman soils are below the Zell soils and have slopes that are mainly less than 15 percent. Areas are irregular in shape and range from 5 to 30 acres in size. In places the Zell soils are eroded and have a surface layer that is lighter in color than the one in the representative profile.

About 60 percent of this complex is Zell silt loam, about 25 percent is Eckman loam, and the rest is included soils. These are small areas of Gardena soils in swales and low areas.

Runoff is rapid on the Zell soils. The hazard of erosion is severe in cultivated areas. Zell soils are moderately low or low in content of organic matter. These soils are too erodible to be cultivated.

Many areas of this complex remain in native grass and are used for grazing or for growing hay. Capability unit VIe–3. Zell soils in Thin Upland range site, windbreak suitability group 10; Eckman soils in Silty range site, windbreak suitability group 3.

Use and Management of the Soils

In this section the use and management of the soils in Roberts County are discussed. Information is given on uses for crops, pasture, range, trees and shrubs in farmstead protection and field windbreaks, wildlife, engineering, and town and country planning, including recreation.

Use of the Soils for Crops [3]

[3] By PAUL BODEN, conservation agronomist, Soil Conservation Service.

About 64 percent of the land area of Roberts County is used for crops. Oats, flax, corn, wheat, alfalfa, and soybeans are the main crops. Other crops grown include rye, barley, and tame grasses.

The main concerns in managing soils used for crops are control of water erosion and soil blowing, conservation of moisture, and maintenance or improvement of fertility, content of organic matter, and tilth. Removal of stones, reduction of salinity, and drainage measures that reduce excessive wetness also are management needs on certain soils.

The application of conservation practices, either singly or in combination, helps to meet the management needs of most soils. An essential part of any such combination of practices is the use of a cropping system based on the kind of soil and its properties such as permeability, fertility, and tilth. Grasses and legumes generally are a part of the conservation cropping system on all soils.

Among the other conservation practices that help to control erosion and to conserve moisture are stubble mulching, keeping crop residue on the soils, contour farming, contour stripcropping, terracing, grassed waterways, and minimum tillage.

Practices that help to control soil blowing include stubble mulching, keeping crop residue on the soils, wind stripcropping, field windbreaks, growing cover crops, and minimum tillage.

Growing green-manure crops, applying animal manure, growing grasses and legumes in the cropping system, keeping crop residue on the soils, and stubble mulching help to maintain or to improve fertility and content of organic matter. These practices also help to improve tilth and water intake.

Excessive tillage breaks down the structure of the soil and compacts the soil. Using a pony press drill in planting small grain after spring plowing helps to prevent soil compaction. Alternating the depth of tillage operations helps to prevent a plowpan from forming. Chiseling or subsoiling helps to break up existing tillage pans. Timely tillage on clayey soils such as the Peever and Sinai soils helps to maintain the tilth of the surface layer.

Many soils in the county need chemical fertilizers so that crops grow well. Soils that have been cultivated for many years show evidence of nitrogen deficiency. Soils such as Glyndon and Hamerly are high in content of lime and generally are low in available nitrogen and phosphorus. The kind and amount of fertilizer needed for a specific crop is determined by soil test.

Excessive water is a problem on several soils in the county. Drainage can be improved on some of these soils by installing surface or subsurface drainage systems. Improved drainage also lowers salinity in some of the soils where a salinity problem occurs. An economical alternative on some poorly drained soils used for crops is planting adapted grasses for use as pasture or hay. Conservation treatment to reduce runoff from nearby soils also helps to reduce wetness in areas of poorly drained 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 (*7*). The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that need special management.

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold to too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–7. 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.

Management by capability units

In the following pages the capability units in Roberts County are described, and suggestions for the use and management of the soils are given. The capability units within a capability subclass are not numbered consecutively because not all of the units in the statewide system are used in this county.

If a soil is a part of a mapping unit complex, the capability unit can be different than when the soil is alone in a mapping unit, because a complex is treated as a whole in its management for crops. To find the capability classification of a given soil in Roberts County, refer to that soil in the section "Descriptions of the Soils" or to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

LaDelle silt loam, the only soil in this unit, is a deep, moderately well drained, nearly level soil on bottom lands and low terraces. The soil is calcareous silt loam throughout.

Fertility and the content of organic matter are high. Available water capacity is high. In some years flooding in spring delays farming, but in most years the additional moisture is beneficial. The risk of damage is slight where this soil is farmed intensively.

This soil is used mainly for growing corn, soybeans, oats, barley, and alfalfa. Some flax also is grown.

Keeping crop residue on the surface and growing grasses and legumes in the cropping system help to maintain fertility, content of organic matter, and tilth. Response to phosphate fertilizer generally is good.

CAPABILITY UNIT I-2

This unit consists of deep, well-drained, nearly level soils. These soils have a surface layer of loam or silt loam and a subsoil of loam, silt loam, clay loam, or silty clay loam.

These soils are easy to work. Fertility is medium or high. Permeability is moderate or moderately rapid, and available water capacity is high. In areas that receive runoff from adjacent soils, farming operations in spring during some years are delayed in places. A slight hazard of soil blowing exists, but otherwise these soils have few limitations for crops.

These soils are well suited to all crops commonly grown in the county. Corn, soybeans, oats, flax, rye, wheat, barley, and alfalfa are the main crops grown.

Stubble mulching, keeping crop residue on the soils, and growing grasses and legumes in the cropping system help to control soil blowing and maintain fertility, content of organic matter, and tilth. Stripcropping and using field windbreaks and minimum tillage also help to control soil blowing.

CAPABILITY UNIT I-3

This unit consists of deep, moderately well drained, nearly level soils. These soils have a surface layer of loam, silt loam, or silty clay loam and a subsoil of silt loam, clay loam, or silty clay loam.

Fertility is high. Available water capacity is high. Permeability is moderate in the subsoil. Runoff is slow. Some years farming operations in spring are delayed for short periods because runoff is received from adjacent soils. In most years, however, the additional moisture is beneficial. These soils have few limitations for crops.

These soils are well suited to all crops commonly grown in the county. Corn, soybeans, oats, rye, wheat, barley, flax, and alfalfa are the main crops grown.

Keeping crop residue on the soils and growing grasses and legumes in the cropping system help to maintain fertility, content of organic matter, and tilth.

CAPABILITY UNIT IIe-2

This unit consists of deep, well-drained, gently undulating and gently sloping soils. These soils have a surface layer of loam or silt loam and a subsoil of loam or clay loam.

These soils are easy to work. Fertility is mainly medium or high. Permeability is moderate or moderately rapid in the subsoil. Available water capacity is high. Runoff is medium. Control of erosion is the main concern in cultivated areas. Small areas of soils that are low in fertility and in content of organic matter are highly susceptible to soil blowing.

These soils are used mainly for growing corn, oats, flax, rye, wheat, barley, and alfalfa.

Keeping crop residue on the soils, stubble mulching, and contour farming or terracing help to control erosion. If slopes are too short and irregular for contour farming, an alternative is growing close-sown crops and grasses and legumes in the cropping system. These practices also help to control soil blowing and to maintain or improve fertility, content of organic matter, and tilth. Grassed waterways help to prevent gullies from forming.

CAPABILITY UNIT IIe-3

This unit consists of deep, well-drained, gently sloping soils. These soils have a surface layer of loam or silt loam and a subsoil of silt loam or silty clay loam. In some areas the soils are slightly or moderately eroded.

Fertility is medium or high, and the content of organic matter is moderate. Permeability is moderate, and available water capacity is high. Runoff is medium, and the hazard of erosion is moderate. Soil blowing is a hazard in some areas. The main management practices needed are those that control erosion and soil blowing and maintain fertility, content of organic matter, and tilth.

These soils are well suited to corn, soybeans, small grains, flax, and alfalfa.

Stubble mulching or keeping crop residue on the soils and contour farming help to control erosion and soil blowing. Terraces also help in the control of erosion. Growing grasses and legumes in the cropping system help to maintain fertility, content of organic matter, and tilth. Grassed waterways help to prevent gullies from forming.

CAPABILITY UNIT IIe-4

This unit consists of deep, moderately well drained to poorly drained, nearly level, calcareous soils. These soils have a surface layer and underlying material of silt loam, loam, or silty clay loam.

Fertility is medium, and the content of organic matter is moderate. Permeability ranges from moderate to slow, and available water capacity is moderate or high. Because of the rise of the water table, wetness delays spring planting and tillage in some years. The high content of lime causes these soils to blow easily and also affects the availability of plant nutrients. Management practices are needed that control soil blowing and maintain content of organic matter, fertility, and tilth. Drainage improvement also is needed in some areas of the very poorly drained soils.

These soils are suited to corn, soybeans, oats, flax, wheat, barley, alfalfa, and tame grasses. If the poorly drained soils are not adequately drained, they are better suited to late-planted crops or to pasture and hay than to other uses.

Stubble mulching or keeping crop residue on the soils, using timely and minimum tillage, and growing grasses and legumes in the cropping system help to control soil blowing and to maintain content of organic matter, fertility, and soil tilth. Wind stripcropping and using field windbreaks and cover crops also help to control soil blowing. Crops grown on these soils respond well to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIw-1

This unit consists of drained areas of deep, poorly drained, nearly level and level soils. These soils have a surface layer of silt loam or clay and a clayey subsoil.

Fertility is medium or high. Available water capacity is low, moderate, or high. Runoff is very slow or the surface is ponded. The water table fluctuates. Planting and tillage operations are delayed by wetness in some years, but drainage systems have been installed that control wetness in most years. These soils lose their tilth if cultivated when wet. Soils that have a surface layer of clay blow easily when they are dry. Controlling wetness and improving tilth and water intake are the main concerns of management.

These soils are suited to most crops commonly grown in the county if they are drained. Corn, small grains, flax, and alfalfa are the main crops grown. Late-planted crops such as sudangrass or millet are used if wetness delays spring farming.

Bedding, diversion ditches, and open drains, if properly maintained, help to control wetness. Keeping crop residue on the soils, using animal manure, growing grasses and legumes in the cropping system, and using timely tillage help to maintain or to improve tilth and water intake and also help to control soil blowing.

CAPABILITY UNIT IIw-2

This unit consists of drained areas of deep, poorly drained, nearly level, calcareous soils. These soils have a surface layer and underlying material of silt loam or loam.

Fertility is medium, but the availability of plant nutrients is affected by the very high content of lime. Available water capacity is high, and permeability is moderately rapid in some areas and moderately slow in others. Runoff is very slow or slow. Wetness from flooding or from the rise of the water table delays spring planting and tillage in some years, but in most years installed drainage allows the use of these soils for crops. Areas of moderately well drained soils do not need drainage. Control of wetness is the main concern, but control of soil blowing also is important.

These soils are suited to corn, small grains, flax, alfalfa, sweetclover, and tame grasses if they are properly drained.

Diversion terraces on adjacent soils help to control wetness. Keeping crop residue on the soils, using animal manure, growing grasses and legumes in the cropping system, and using timely tillage help to control soil blowing and to maintain fertility and tilth. Crops grown on these soils respond well to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIw-3

This unit consists of drained areas of deep, poorly drained, nearly level, calcareous soils. These soils have a surface layer and subsoil of silty clay loam or clay.

Fertility is medium, or high although the availability of plant nutrients is affected by the high content of lime. Available water capacity is low, moderate, or high, and permeability is moderate or very slow. Wetness from flooding and the fluctuating water table delays spring planting and tillage, but if a drainage system is installed these soils can be used for crops in most years. Wetness is the main concern, but controlling soil blowing and maintaining tilth also are management concerns.

Drained areas of these soils are suited to corn, small grains, flax, alfalfa, and tame grasses. The clayey soil is better suited to small grains and flax than to corn.

Bedding and open drains help to remove excess water. Keeping crop residue on the soils, growing green-manure crops and grasses and legumes in the cropping system, and using timely tillage help to control soil blowing and to maintain fertility and tilth. Because of wetness, fall is a better time to plow these soils than spring. Leaving the surface layer rough after fall plowing helps to control soil blowing in the winter.

CAPABILITY UNIT IIs-2

This unit consists of deep, somewhat poorly drained and well drained, nearly level soils. These soils have a surface layer of loam, clay loam, or silty clay and a subsoil of clay loam, clay, or silty clay.

Fertility is medium or high. Available water capacity is moderate or high. These soils take in water slowly and are difficult to work. Cultivated areas easily lose their tilth. During dry periods the soils blow easily. Maintaining or improving tilth and water intake and controlling soil blowing are important management concerns. Permeability is very slow and tilth is poor in some small areas. Wetness is a concern in some areas of poorly drained soils.

These soils are well suited to most crops commonly grown in the county. Corn, small grains, flax, and alfalfa are the main crops grown. Soybeans are grown in some areas.

Stubble mulching or keeping crop residue on the soils, using green-manure crops and animal manure, growing grasses and legumes in the cropping system, using timely tillage, and chiseling or subsoiling are some practices that help to maintain or to improve tilth, fertility, and water intake, and they also help to control soil blowing.

CAPABILITY UNIT IIs-3

This unit consists of well-drained, nearly level, loamy soils. These soils have a subsoil of loam or gravelly loam. Most are underlain by sand and gravel at a depth between 20 and 40 inches; however, some have a thin layer of sand and gravel in the underlying material that is in turn underlain by glacial till.

Fertility is medium, but these soils are somewhat droughty because the underlying material is sand and gravel. Available water capacity is low, moderate, or high. Runoff is slow, but during dry periods some hazard of soil blowing occurs. Conserving moisture and controlling soil blowing are the main concerns of management.

These soils are used mainly for corn, oats, flax, rye, wheat, barley, and alfalfa.

Stubble mulching or keeping crop residue on the soils and growing grasses and legumes in the cropping system help to conserve moisture and control soil blowing. Wind stripcropping and using field windbreaks also help to control soil blowing and to conserve moisture.

CAPABILITY UNIT IIIe-1

This unit consists of deep, well-drained, undulating and sloping soils. These soils have a surface layer of loam or silt loam and a subsoil of clay loam or loam.

Fertility is mainly medium or high. Available water capacity is high. Runoff is medium, and the hazard of erosion is severe in cultivated areas. Some areas are low in fertility and in content of organic matter and need management that improves content of organic matter and fertility. Controlling erosion and soil blowing is the main concern of management.

These soils are used for corn, oats, wheat, rye, barley, flax, alfalfa, and tame grasses. Because of the hazard of

erosion, close-sown crops are better suited than corn.

Stubble mulching or keeping crop residue on the soils and contour farming and terracing help to control erosion. In areas where slopes are too irregular for contour farming and terracing, the alternative is growing close-sown crops and grasses and legumes in the cropping system. Grassed waterways help prevent gullies from forming.

CAPABILITY UNIT IIIe-2

This unit consists of deep, well drained and moderately well drained, sloping soils. These soils have a surface layer of loam and a subsoil of loam or silt loam.

These soils are easy to work, and available water capacity is high. Fertility is mainly medium or high. Fertility is low or medium in some areas and these areas blow easily. Permeability is moderate, and runoff is medium. Controlling erosion and soil blowing is the main concern of management. Improvement of fertility and content of organic matter is important in areas where the soils are low in fertility and where they blow easily.

Corn, soybeans, small grains, flax, and alfalfa are the main crops grown. Row crops are not so well suited as close-sown crops because of the erosion hazard.

Stubble mulching or keeping crop residue on the soils and contour farming or terraces help to control erosion and soil blowing. Contour stripcropping, growing close-sown crops, and using grassed waterways also help to control erosion. Growing legumes and grasses in the cropping system help to maintain or to improve fertility and content of organic matter.

CAPABILITY UNIT IIIe-3

This unit consists of deep, well-drained, gently sloping and gently undulating soils. These soils have a surface layer of clay loam or silty clay and a subsoil of clay or silty clay.

Fertility is medium or high, and available water capacity is moderate or high but these soils are difficult to work. The clayey subsoil takes in water slowly and restricts the development of plant roots. When the soils are dry, they blow easily. Runoff is medium, and the hazard of erosion is moderate. Controlling erosion and soil blowing is the main concern of management. Improving tilth and water intake also is an important management concern.

These soils are used mainly for corn, oats, flax, rye, wheat, barley, alfalfa, and tame grasses.

Stubble mulching or keeping crop residue on the soils and contour farming or terracing help to control erosion and soil blowing. Growing grasses and legumes in the cropping system, growing green-manure crops, chiseling and subsoiling, and using timely tillage help to maintain or to improve tilth and to improve movement of water in the soil.

CAPABILITY UNIT IIIe-4

Peever clay loam, 6 to 9 percent slopes, is the only soil in this unit. The surface layer is clay loam and the subsoil is clay.

Fertility is medium or high, and available water capacity is high, but this soil is difficult to work. The clayey subsoil takes in water slowly and restricts the development of plant roots. Runoff is medium, and in some cultivated areas the soil is moderately eroded. Controlling erosion is the main concern of management. Controlling soil blowing and improving tilth and water intake also are concerns of management.

This soil is used mainly for corn, small grains, flax, and alfalfa. Corn is not so well suited as close-sown crops because of the hazard of erosion.

Stubble mulching or keeping crop residue on the soils and terracing help to control erosion. Contour stripcropping, growing close-sown crops, and using grassed waterways also help to control erosion. Growing grasses and legumes in the cropping system, using green-manure crops, chiseling or subsoiling, and using timely and minimum tillage help to improve tilth and water intake.

CAPABILITY UNIT IIIe-7

This unit consists of deep, somewhat excessively drained, gently undulating to undulating soils. These soils have a surface layer of fine sandy loam or sandy loam and a subsoil of sandy loam or loamy sand.

These soils are easy to work, and they take in water readily. Available water capacity is low, moderate, or high. Fertility is medium, and content of organic matter is moderate or moderately low. These soils blow easily, and some are droughty during dry periods. Runoff is medium. Controlling soil blowing and erosion is the main concern of management. Conserving moisture and maintaining fertility and content of organic matter are other concerns of management.

These soils are used mainly for corn, small grains, flax, and alfalfa. Early-maturing crops are better suited to these soils than other crops.

Stubble mulching or keeping crop residue on the soils, growing close-sown crops, stripcropping, and using field windbreaks help to control soil blowing and erosion. Growing cover crops helps to control soil blowing in areas where crop residue is lacking. Growing grasses and legumes in the cropping system helps to maintain fertility and content of organic matter.

CAPABILITY UNIT IIIe-8

This unit consists of gently undulating, calcareous, loamy soils. These soils are moderately well drained or somewhat poorly drained and poorly drained.

The high content of lime causes these soils to blow easily and also affects the availability of plant nutrients. Runoff is medium and slow. Spring planting and tillage commonly are delayed by wetness. Controlling erosion and soil blowing and improving drainage and fertility are management concerns.

These soils are used mainly for corn, small grains, flax, and alfalfa. Some areas are used for tame or native pasture because of wetness.

Stubble mulching or keeping crop residue on the soils, stripcropping, using field windbreaks, and growing cover crops help to control erosion and soil blowing. Growing grasses and legumes in the cropping system helps to maintain or to improve fertility. Crops grown on these soils respond well to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIIw-1

This unit consists of drained areas of Parnell silty clay loam. This poorly drained and very poorly drained soil has a surface layer of silty clay loam and a subsoil of clay.

Fertility is high. Available water capacity is high. Permeability of the subsoil is slow, and runoff is ponded. Wetness commonly delays spring planting and tillage, but installed drainage allows the use of the areas for annual crops in most years. Wetness is the main concern of management.

This soil is used for corn, small grains, flax, and tame

grasses. Late-planted crops such as millet or sudangrass are used in wet years.

Fall plowing reduces the amount of trapped snow and allows the soil to dry more rapidly in spring. Maintenance of installed drainage helps control wetness. Timely tillage helps maintain tilth.

CAPABILITY UNIT IIIw–4

Hamar fine sandy loam, the only soil in this unit, is poorly drained or somewhat poorly drained and is nearly level. It has a surface layer of fine sandy loam. The underlying material is loamy fine sand.

Permeability is rapid, and available water capacity is low or moderate. Spring planting and tillage commonly are delayed by wetness caused by the high water table. Wetness is the main limitation in the use of this soil, but controlling soil blowing also is an important management concern.

This soil is suited to corn, soybeans, small grains, flax, and alfalfa. During wet years, late-planted crops such as millet and sudangrass are better suited than most others.

Drainage that controls the level of the water table helps to avoid excessive wetness. Stubble mulching or keeping crop residue on the soils, wind stripcropping, growing cover crops, and using field windbreaks help to control soil blowing. Growing grasses and legumes in the cropping system helps to maintain fertility and content of organic matter.

CAPABILITY UNIT IIIs–1

This unit consists mainly of deep, moderately well drained to somewhat excessively drained, nearly level soils. These soils have a surface layer of fine sandy loam or sandy loam and a subsoil of sandy loam, fine sandy loam, loamy sand, or loamy fine sand.

These soils take in water readily, but permeability of the underlying material is moderate or slow. Available water capacity is low, moderate, or high. These soils blow easily and are somewhat droughty during extended dry periods. Controlling soil blowing and conserving moisture are the main concerns of management, but maintaining fertility and content of organic matter also is a concern. Improving drainage is a concern of management in small areas of poorly drained soils.

These soils are used for corn, soybeans, small grains, flax, and alfalfa. Early-maturing crops are better suited in most areas, but late-planted crops such as millet and sudangrass are better suited in the more poorly drained areas during wet years.

Stubble mulching or keeping crop residue on the soils, wind stripcropping, growing cover crops, and using minimum tillage and field windbreaks help to control soil blowing and conserve moisture. Growing grasses and legumes in the cropping system helps to maintain fertility and content of organic matter.

CAPABILITY UNIT IIIs–2

This unit consists of well-drained, gently sloping and gently undulating, loamy soils. These soils have a subsoil of loam or gravelly loam. Most are underlain by sand and gravel at a moderate depth; however, some are underlain by a thin layer of sand and gravel, which in turn is underlain by glacial till.

These soils are easy to work. Fertility is mainly medium, but the soils are somewhat droughty in most places. Runoff is medium. Areas where gravel is near the surface are low in fertility and are droughty. Conserving moisture, controlling erosion and soil blowing, and maintaining or improving fertility and content of organic matter are management concerns.

These soils are used for corn, oats, flax, rye, wheat, barley, and alfalfa. Early-maturing crops are better suited to these soils than most others.

Stubble mulching or keeping crop residue on the soils, contour farming, stripcropping, and using field windbreaks and minimum tillage help to conserve moisture and control erosion and soil blowing. Growing grasses and legumes in the cropping system helps to maintain or to improve fertility and content of organic matter.

CAPABILITY UNIT IIIs–3

Renshaw loam, 0 to 3 percent slopes, is the only soil in this unit. The surface layer and subsoil are loam. Sand and gravel are at a depth of 10 to 20 inches.

This soil is easy to work, but it is low in fertility and is droughty. Permeability is moderately rapid in the subsoil and is rapid in the underlying sand and gravel. Runoff is slow. Conserving moisture, controlling soil blowing, and improving fertility and content of organic matter are management concerns.

This soil is used for corn, small grains, flax, and alfalfa. Small grains and flax are better suited to it than corn.

Keeping crop residue on the soils, wind stripcropping, and using minimum tillage help to conserve moisture and control soil blowing. Growing grasses and legumes in the cropping system help to improve fertility and content of organic matter.

CAPABILITY UNIT IIIs–4

Only the mapping unit Divide-Marysland loams is in this unit. It consists of nearly level, calcareous, loamy soils. These soils are underlain by sand and gravel at a moderate depth. They are moderately well drained or somewhat poorly drained and poorly drained.

Available water capacity is low or moderate. Most areas are droughty during extended dry periods. The high content of lime affects the availability of plant nutrients and also causes the soils to blow easily. Wetness, caused by a high water table, delays farming in some years. Conserving moisture, controlling soil blowing, maintaining or improving fertility, and improving drainage are management concerns.

Corn, small grains, flax, and alfalfa are suited to most areas of these soils. If adequately drained, the soils in wetter areas are suited to corn, barley, and flax.

Stubble mulching or keeping crop residue on the soils, wind stripcropping, and using field windbreaks help to conserve moisture and to control soil blowing. Growing grasses in the cropping system and using green-manure crops help to maintain the content of organic matter and to maintain fertility. Crops grown on these soils respond well to nitrogen and phosphorus fertilizers.

CAPABILITY UNIT IIIs–5

Ulen sandy loam, the only soil in this unit, is deep, somewhat poorly drained, nearly level, and calcareous. It has a surface layer of sandy loam and underlying material of sandy loam, loamy sand, and sand.

Fertility is medium or low, and the content of organic matter is moderate or moderately low. This soil is droughty during extended dry periods, and it blows easily. Controlling soil blowing, conserving moisture, and maintaining or improving fertility and content of organic matter are management concerns.

This soil is used for corn, soybeans, small grains, and alfalfa.

Stubble mulching or keeping crop residue on the soils, wind stripcropping, growing cover crops, and using field windbreaks and minimum tillage help to control soil blowing and conserve moisture. Growing grasses and legumes in the cropping system and planting green-manure crops help to maintain or to improve fertility and content of organic matter.

CAPABILITY UNIT IVe-1

This unit consists of deep, well-drained, undulating and rolling soils. These soils have a surface layer of loam and a subsoil of clay loam. Some areas are moderately or severly eroded.

Fertility is mainly medium or high but is low in some small areas. Available water capacity is high. Runoff is medium or rapid. Controlling erosion and maintaining or improving content of organic matter and fertility are concerns of management.

Cultivated areas are better suited to small grains, flax, alfalfa, and tame grasses than to other crops. Row crops are not so well suited because of the hazard of erosion.

Stubble mulching or keeping crop residue on the soils, growing close-sown crops and cover crops in the cropping system, and using grassed waterways help to control erosion. Contour stripcropping and terraces also help to control erosion, but slopes are too irregular in most areas for these management practices. Growing grasses and legumes in the cropping system and using green-manure crops and animal manure help to improve fertility and content of organic matter in eroded areas.

CAPABILITY UNIT IVe-5

Hattie clay loam, 9 to 15 percent slopes, is the only soil in this unit. It is deep, well-drained, and rolling. It has a surface layer of clay loam and a subsoil of clay.

Fertility is medium. Available water capacity is moderate, but this soil takes in water slowly and releases moisture to plants slowly. This soil is difficult to work, and good tilth is difficult to maintain in cultivated areas. Runoff is medium. Controlling erosion, maintaining tilth, improving water intake, and controlling soil blowing are management concerns.

This soil is suited to small grains, flax, alfalfa, and tame grasses. Row crops are not so well suited because of the hazard of erosion.

Stubble mulching or keeping crop residue on the soils; growing grasses, legumes, and close-sown crops in the cropping system; and using grassed waterways help to achieve the objectives of management. Slopes commonly are too irregular for terraces and contour farming. If the soil is plowed in the fall, leaving the surface layer rough helps to reduce the hazard of soil blowing.

CAPABILITY UNIT IVw-2

This unit consists of deep, poorly drained, nearly level soils. These soils have a surface layer of loam, silt loam, or silty clay loam and a subsoil or underlying material of silty clay loam or clay.

Fertility is medium or high. Available water capacity is high. Permeability ranges from moderately rapid in some areas to very slow in other areas. Runoff is slow or very slow, or the surface is ponded. The soils are subject to flooding in spring and have a high water table. Drainage has not been installed, and it is not practical to install it in many areas. Wetness limits crop growth and the choice of crops.

Cultivated areas are used for small grains, flax, and tame grasses. Late-planted crops such as millet, flax, and sudangrass are better suited than small grain during wet years.

Practices that help to reduce runoff from adjacent soils also help to improve drainage. Keeping crop residue on the soils, growing green-manure crops, and using timely tillage help to maintain fertility and tilth.

CAPABILITY UNIT IVs-1

This unit consists of deep, moderately well drained and well drained, nearly level to gently undulating soils. These soils have a surface layer of loamy fine sand and underlying material of loamy fine sand and fine sand.

Fertility is medium or low. Available water capacity is low or moderate, and permeability is moderately rapid or rapid. Runoff is slow. These soils blow easily and are droughty during dry periods. Controlling soil blowing, conserving moisture, and maintaining fertility and content of organic matter are management concerns. Areas of more poorly drained soils require improved drainage.

These soils are used for corn, oats, soybeans, rye, flax, alfalfa, and tame grasses. Trees grow well in these soils.

Stubble mulching or keeping crop residue on the soils, wind stripcropping, growing cover crops, and using minimum tillage and field windbreaks help to control soil blowing and conserve moisture. Growing grasses and legumes in the cropping system, using animal manures, and growing green-manure crops help to maintain fertility and content of organic matter.

CAPABILITY UNIT IVs-2

This unit consists of somewhat excessively drained, gently sloping to undulating soils. These soils have a surface layer and subsoil of loam. They are shallow or very shallow over sand and gravel.

These soils are easy to work, but they are droughty and fertility is low. Runoff is medium, and the soils are subject to erosion and soil blowing. Conserving moisture, controlling erosion and soil blowing, and maintaining fertility and content of organic matter are management concerns. Areas of soils that are very shallow to sand and gravel are too droughty to be cultivated.

Cultivated areas are best suited to small grains, flax, alfalfa, and tame grasses. Corn is poorly suited to these areas, however, and it is better that the very shallow soil remain in, or be seeded to, native grasses.

Stubble mulching or keeping crop residue on the soils, contour farming, stripcropping, growing cover crops, and using grassed waterways help to conserve moisture and to control erosion and soil blowing. Growing grasses and legumes in the cropping system and using green-manure crops help to maintain or improve fertility and content of organic matter.

CAPABILITY UNIT Vw-1

This unit consists of moderately deep, poorly drained and very poorly drained, nearly level soils. These soils have a surface layer of silt loam or mucky silt loam and underlying material of silt loam, loam, or sand and gravel.

Permeability is moderate or moderately rapid in the upper part of these soils, but it is rapid to moderately slow in the lower part. Runoff is slow, very slow, or ponded, and these soils are subject to flooding. The water table is at or near the surface during the growing season. These soils are too wet to be cultivated.

Most areas remain in native vegetation and are used for grazing, for growing hay, and as wildlife habitat. Tame grasses have been seeded or inter-seeded in some areas.

Drainage generally is not feasible, but drainage can be improved by practices that reduce runoff from adjacent soils.

CAPABILITY UNIT Vw-2

This unit consists of deep, poorly drained or very poorly drained soils. These soils have a surface layer of silt loam or silty clay loam and a subsoil or underlying material of silty clay loam or clay. Salts are in some areas.

Runoff is very slow or ponded, and permeability is moderately slow or slow. The water table is at or near the surface during much of the growing season. Drainage has not been installed and is not feasible in most areas of these soils.

These soils are too wet to be cultivated or seeded to tame grasses. They remain in native vegetation used for hay, for grazing, and for wildlife habitat, and they are better suited to these uses than to others. More than 50 percent of the vegetation is suited to grazing.

Proper range use helps to maintain a desirable vegetative cover.

CAPABILITY UNIT VIe-1

This unit consists of deep, well-drained, hilly soils and rolling, eroded soils. These soils have a surface layer of loam and a subsoil or underlying material of clay loam.

Available water capacity is high. Fertility is medium or high. The hilly soils are too steep and erodible to be cultivated, and the rolling soils are too eroded to remain cultivated. Controlling erosion is the main management concern. Improving fertility and content of organic matter is a management concern in cultivated areas of eroded soils.

Most of the hilly soils are in native grass and are used for grazing and for growing hay. The rolling, eroded soils are used for small grains, flax, and alfalfa.

Range and pasture practices that maintain a good vegetative cover help to control erosion. Keeping crop residue on the soils, growing close-sown crops and cover crops in the cropping system, and using grassed waterways help to control erosion in cultivated areas until the areas are seeded to permanent grasses.

CAPABILITY UNIT VIe-3

This unit consists of shallow and deep, well-drained, strongly sloping to steep soils. These soils have a surface layer of loam, silt loam, or clay loam and are calcareous at or near the surface.

Permeability ranges from moderate to slow. Fertility is low or medium. Runoff is medium or rapid. These soils are too erodible to be cultivated.

Most areas remain in native grass and are used for grazing or for growing hay. A good cover of vegetation on these soils helps to control erosion.

CAPABILITY UNIT VIe-6

Only the mapping unit Renshaw-Sioux loams, 9 to 20 percent slopes, is in this unit. It has a surface layer and subsoil of loam and is shallow to sand and gravel. In some areas sand and gravel are at very shallow depths.

These soils are droughty. Fertility is low. Runoff is medium, and in areas where vegetative cover is lacking, the soils are subject to erosion and soil blowing.

These soils are not suited to cultivated crops. It is better to let them remain in native grasses than to use them for other purposes. Maintaining a good cover of grasses helps to control erosion and soil blowing.

CAPABILITY UNIT VIw-2

This unit consists of poorly drained, mixed soils and soil materials on bottom lands along streams and on flats adjacent to lakes.

These soils are subject to flooding, and the water table commonly fluctuates. They are too wet to be cultivated. Some areas are cut into small tracts by meandering channels. These tracts are so small that it is impractical to cultivate them. Shore areas that lack vegetation and gently undulating beach ridges are present in some areas.

It is better to keep these soils in their native vegetation and use them for grazing or wildlife habitat than to use them for most other purposes.

In some areas channel improvement and grade-stabilization structures help to control streambank erosion.

CAPABILITY UNIT VIs-1

Maddock loamy fine sand, 6 to 25 percent slopes, is the only soil in this unit. This well-drained, undulating to hilly soil has a surface layer of loamy fine sand and underlying material of fine sand.

This soil is droughty, and the material blows easily. Fertility is medium or low, and content of organic matter is moderately low. Conserving moisture, controlling soil blowing, and improving fertility and content of organic matter are management concerns.

Most areas remain in native grass and are used for grazing or for growing hay. A few areas are cultivated.

Proper range and pasture use help to conserve moisture and control soil blowing. Keeping crop residue on the soils, growing cover crops, and wind stripcropping help to control erosion in cultivated areas until it is practical to seed them to grass.

CAPABILITY UNIT VIIe-1

This unit consists of deep, well-drained, hilly to steep soils. These soils have a surface layer of loam and a subsoil and underlying material of clay loam or loam.

Available water capacity is high or moderate, but runoff is rapid and these soils erode easily. Also, fertility is mainly low or medium, and the content of organic matter is mainly moderately low or low.

These soils are too steep and erodible to be cultivated. Most areas are in native vegetation and are used for grazing or for wildlife habitat. Some areas are in native trees and are well suited to wildlife and recreation uses.

Using range and pasture properly and maintaining a good cover of vegetation in other areas help to control erosion.

CAPABILITY UNIT VIIs-1

This unit consists of nearly level to steep stony soils. These soils have a surface layer of loam or stony loam. Mapped areas contain stony areas that are as large as 15 acres. Soils in some areas are shallow and very shallow to sand and gravel.

All these soils are too stony to be cultivated and are too stony for harvesting hay. Clearing out the stones is not practical in most areas.

All these areas are in native grass and are used for grazing. Proper range use helps to control erosion and conserve moisture.

CAPABILITY UNIT VIIIw-1

This unit consists only of Marsh. The water table is at or near the surface, and areas are covered with water much of the time.

These areas are too wet for pasture plants. The dominant vegetation is cattails, rushes, and sedges. They are better suited to wildlife habitat than to other uses.

Estimated yields

Table 2 lists the predicted yields for the principal crops grown in the county for each soil that is suitable for crops. The yields shown are for dry-farmed soils under two levels of management. They are based on information from farmers and on observations made by farming specialists in state and Federal agencies.

The estimated yields in column A are those that can be expected under management that was commonly practiced in 1967. Under that kind of management, the cropping system consisted of 27 percent row crops, 52 percent small grains, and 21 percent tame grasses and legumes. The grasses and legumes were grown in a long-period cropping system and generally remained in a field until the stand failed or became unproductive. Grain stubble was plowed under or incorporated into the surface layer, but green-manure crops were seldom grown. Commercial fertilizer was used for most crops but was not applied in kinds and sufficient amounts as determined by soil tests and field trials. Barnyard manure was applied where available in areas that were conveniently located. Practices that conserve soil and water commonly were not used.

Yields in column B are those that can be expected under a high level of management. At this level appropriate practices to conserve soil and water are applied. The cropping system is designed to maintain fertility and tilth. Seeds used in the system are clean and of high quality. They are treated seeds that are resistant to disease and are adapted to the soils and to the environment. All crop residue is returned to the soil and is incorporated in the surface layer. Green-manure crops are grown, and animal manure is applied to improve fertility and increase the content of organic matter. Laboratory tests and field trials are used as a basis for selecting kinds and amounts of chemical fertilizers. Weeds are controlled. Wet areas are adequately drained for the kinds of crops grown.

Use of the Soils for Pasture [4]

Tame pastures are an important alternative in the intensively farmed parts of Roberts County. They also supplement the grazing provided by native pastures in other parts of the county. Many of these pastures have been closely grazed and have poor stands of grass.

Properly managed tame pastures provide more forage for grazing than do overgrazed pastures. Also, they help to control erosion and soil blowing. Proper management includes controlled and deferred grazing. Other practices that help realize the production potential of a tame pasture are using fertilizers in recommended kinds and amounts, controlling weeds, rotating grazing, and clipping to encourage uniform grazing. Interseeding or reseeding adapted grasses increases production of pastures that have a poor stand of grass. The use of sudan hybrids for temporary pasture permits permanent pastures to regain their vigor while being rested.

In the following paragraphs the pasture groups of Roberts County are described, and the species of grasses and legumes are listed. Only those soils suitable for tame pasture are placed in pasture groups. The names of the series represented are mentioned, but this does not mean that all the soils in a given series are in that group. To find the pasture group of a given soil, refer to that soil in the "Guide to Mapping Units" at the back of this survey.

PASTURE GROUP A

In this group are moderately well drained to poorly drained, loamy and clayey soils of the Divide, Doran, Dovray, and Hamar series and drained areas of poorly drained, silty and loamy soils of the Borup, Lamoure, Ludden, Parnell, Tonka, and Vallers series. The moisture condition in these soils is above average because of permanent water tables, flooding from streams, or runoff from adjacent soils. Drainage is adequate or has been improved. Moisture supplies are sufficient to produce two to three times the amount of forage produced on well-drained soils.

Suitable grasses and legumes are alfalfa, big bluestem, creeping foxtail, indiangrass, intermediate wheatgrass, reed canarygrass, smooth bromegrass, and switchgrass.

PASTURE GROUP B

In this group are poorly drained and very poorly drained, silty and loamy soils of the Colvin and Marysland series and undrained areas of poorly drained, silty and loamy soils of the Borup, Lamoure, Ludden, Parnell, Tonka, and Vallers series. Drained areas of these soils are in Pasture Group A. The water table is high, and some of these soils are flooded. Water is ponded long enough to limit the kinds of adapted grasses.

Suitable pasture species are creeping foxtail, reed canarygrass, and western wheatgrass.

PASTURE GROUP C

The Cavour soil in the Peever-Cavour complex, 0 to 3 percent slopes, is the only soil in this group. It has a surface layer of loam and a claypan subsoil. The dense, clayey subsoil takes in water very slowly and releases moisture slowly to plants.

Suitable grasses and legumes are alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and western wheatgrass.

PASTURE GROUP D

In this group are somewhat excessively drained and well-drained, nearly level to hilly, loamy soils of the Fordville and Renshaw series. Fordville soils are moderately deep and Renshaw soils are shallow to sand and gravel. Available water capacity is low or moderate. These soils are droughty.

Suitable grasses and legumes are crested wheatgrass and pubescent wheatgrass. Alfalfa, intermediate wheatgrass, and smooth bromegrass also are suited to Fordville soils.

PASTURE GROUP E

In this group are well-drained, nearly level to steep, loamy soils of the Hattie and Peever series. These soils have

[4] By PAUL BODEN, conservation agronomist, Soil Conservation Service.

a clayey subsoil that takes in water slowly and releases moisture slowly to plants.

Suitable grasses and legumes are alfalfa, big bluestem, green needlegrass, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP F

In this group are well-drained, nearly level to hilly, silty and loamy soils of the Eckman, Forman, Heimdal, Poinsett, Rentill, and Vienna series. Fertility is medium or high. Available water capacity is high or moderate. These soils have few or no limitations for pasture plants.

Suitable grasses and legumes are alfalfa, big bluestem, green needlegrass, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP G

In this group are well-drained, gently undulating to hilly and moderately steep, loamy and silty soils of the Buse, Kloten, Sisseton, and Zell series. Fertility is low or medium. All soils but the Kloten soil are calcareous. Runoff is rapid, and these soils erode easily.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, and smooth bromegrass.

PASTURE GROUP H

In this group are somewhat poorly drained to somewhat excessively drained, nearly level to hilly, loamy and sandy soils of the Dickey, Embden, Hecla, Maddock, Sverdrup, Towner, and Ulen series. These soils trap most of the water that falls on them, but available water capacity is low or moderate in all but the Dickey and Towner soils. These soils blow easily if they lack a grass cover.

Suitable grasses and legumes are alfalfa, big bluestem, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP I

In this group are well-drained, nearly level and gently sloping, clayey soils of the Sinai series. Fertility is high, but these soils take in water slowly. They are hard when dry, and they swell when wet.

Suitable grasses and legumes are alfalfa, green needlegrass, intermediate wheatgrass, and smooth bromegrass.

PASTURE GROUP J

Playmoor silty clay loam is the only soil in this group. This poorly drained soil has a high water table and accumulations of salt in the upper part of the soil.

Only tall wheatgrass and western wheatgrass are suitable because they are tolerant of salt and wetness.

PASTURE GROUP K

In this group are moderately well drained to poorly drained, loamy and silty soils of the Aastad, Antler, Bearden, Gardena, Glyndon, Hamerly, LaDelle, Svea, and Waubay series. Fertility is high or medium. Available water capacity is high in most of these soils. They receive runoff from adjacent soils. Some of the soils have a seasonal water table.

Suitable grasses and legumes are alfalfa, big bluestem, creeping foxtail, indiangrass, intermediate wheatgrass, reed canarygrass, smooth bromegrass, and switchgrass.

Use of the Soils for Range [5]

Prior to settlement most of Roberts County was covered with prairie vegetation. Except for some bur oak groves in the western part of the county and scattered trees along streams and around lakes, the vegetation was dominantly grass.

As the county was settled, much of this grassland was broken and farmed. Generally the soils that had the least hazard of erosion were selected for cultivation. Because of this, the soils that remain in native vegetation are, for the most part, steep, shallow, stony, wet, or for other reasons not well suited to cultivation.

Approximately 139,000 acres, or 20 percent of the land area in Roberts County, remains in native grass. Much of this is in the Sisseton Hills in the western part of the county. The steep slopes and stoniness of the Buse and Forman soils in this area cause them to be poorly suited to cultivation.

Much of the rangeland in Roberts County has been heavily grazed for a long time. This long period of heavy use has brought about changes in the plant cover making appraisal of the productive potential of the land difficult unless the range site and range condition techniques are used.

Range sites and condition classes

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. It is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical site deterioration it supports a plant community that differs from that of other range sites in kind and proportion of range plants, or in total annual yield. Boundaries of range sites can be determined directly from the soil maps in this survey.

Range condition is the present state of vegetation in relation to the climax plant community for that site (*2*). The terms "climax" and "natural potential" are considered to be synonymous.

Range condition classes are an expression of the degree to which the present composition, expressed in percentages, has departed from that of the climax plant community of a range site.

Four range condition classes are recognized: *excellent*, *good*, *fair*, and *poor*. A range is in *excellent* condition if 76 to 100 percent of the vegetation is that of the climax vegetation for that site. It is in *good* condition if the percentage is 51 through 75; in *fair* condition if the percentage is 26 through 50; and in *poor* condition if the percentage is 25 or less.

The determination of range condition provides a basis for predicting the nature and direction of plant community changes that can be expected from management and treatment measures.

The range condition of a range site is determined by comparing present vegetation with the climax plant community as indicated by the range condition guide for the site. To facilitate this process, components of the plant community are grouped according to their response to grazing use on specific range sites. These groups, or categories, are *increaser*, *decreaser*, and *invader* plants.

Decreaser plants are species in the climax plant community that decrease in relative abundance when such a com-

[5] By C. M. SCHUMACHER, range conservationist, Soil Conservation Service.

TABLE 2.—*Estimated average yields*

[Yields in columns A can be expected under average management; those in columns B can be expected under a high level of management. complexes are given a yield on

Soil	Corn		Soybeans		Oats
	A	B	A	B	A
	Bu	*Bu*	*Bu*	*Bu*	*Bu*
Aastad loam	48	68	14	22	50
Antler-Colvin silt loams	34	50	10	17	42
Antler-Tonka silt loams	34	50	12	19	40
Antler and Hamerly soils, 0 to 2 percent slopes:					
Antler soil	34	55	11	16	42
Hamerly soil	36	56	11	16	44
Bearden silty clay loam	38	56	10	16	44
Borup silt loam	30	42	8	14	35
Dickey fine sandy loam, 0 to 2 percent slopes	28	40	9	14	28
Dickey fine sandy loam, 2 to 6 percent slopes	26	36	8	12	26
Divide-Marysland loams	18	30	6	10	25
Doran loam	40	65	16	25	42
Dovray clay	35	55	12	17	40
Eckman loam, 0 to 2 percent slopes	38	58	13	19	44
Eckman loam, 2 to 6 percent slopes	37	57	11	18	42
Eckman-Zell complex, 6 to 9 percent slopes	27	41	8	12	32
Embden-Hamar fine sandy loams	35	54	11	17	34
Fordville loam, 0 to 3 percent slopes	32	42	12	16	34
Fordville-Renshaw loams, 3 to 6 percent slopes	25	36	8	12	27
Forman-Aastad loams, 0 to 2 percent slopes	42	64	13	20	46
Forman-Aastad loams, 2 to 6 percent slopes	40	60	12	18	43
Forman-Aastad loams, 6 to 9 percent slopes	34	52	----------	----------	36
Forman-Aastad loams, 9 to 15 percent slopes	25	44	----------	----------	27
Forman-Buse loams, 6 to 9 percent slopes, eroded	25	38	6	10	29
Forman-Buse loams, 9 to 15 percent slopes, eroded	18	28	----------	----------	22
Gardena silt loam	42	62	17	22	48
Glyndon silt loam, 0 to 3 percent slopes	40	59	14	18	44
Hamar fine sandy loam	29	43	10	15	28
Hamerly-Tonka complex, 0 to 3 percent slopes	37	55	12	17	42
Hamerly-Vallers loams, 0 to 2 percent slopes	37	54	9	14	41
Hamerly-Vallers loams, 2 to 4 percent slopes	35	52	9	14	40
Hattie clay loam, 9 to 15 percent slopes	----------	----------	----------	----------	30
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	32	48	9	13	29
Heimdal-Sisseton loams, 2 to 6 percent slopes	38	54	11	18	41
Heimdal-Sisseton loams, 6 to 9 percent slopes	27	39	7	11	33
Heimdal-Svea loams, 0 to 2 percent slopes	44	65	14	22	46
Heimdal-Svea loams, 2 to 6 percent slopes	42	60	13	20	45
LaDelle silt loam	53	77	17	25	48
Lamoure silty clay loam	39	58	15	23	44
Ludden clay	24	35	----------	----------	26
Maddock loamy fine sand, 0 to 6 percent slopes	23	36	5	7	22
Parnell silty clay loam	37	55	12	17	43
Peever clay loam, 0 to 2 percent slopes	40	55	12	18	42
Peever clay loam, 2 to 6 percent slopes	38	52	11	16	38
Peever clay loam, 6 to 9 percent slopes	33	45	8	12	31
Peever-Cavour complex, 0 to 3 percent slopes	32	44	10	16	36
Peever-Tonka complex	37	52	12	19	40
Playmoor silty clay loam	24	35	----------	----------	30
Poinsett silt loam, 0 to 2 percent slopes	44	65	14	24	46
Poinsett silt loam, 2 to 6 percent slopes	42	62	13	22	45
Renshaw loam, 0 to 3 percent slopes	16	28	6	9	18
Renshaw loam, 3 to 9 percent slopes	12	20	4	7	16
Renshaw-Sioux loams, 3 to 9 percent slopes	10	16	----------	----------	13
Rentill loam, 0 to 2 percent slopes	36	45	8	12	38
Rentill loam, 2 to 6 percent slopes	30	42	7	11	35
Sinai silty clay, 0 to 2 percent slopes	40	55	14	19	45
Sinai silty clay, 2 to 6 percent slopes	38	52	13	18	43
Svea loam, 5 to 9 percent slopes	42	60	14	22	46
Sverdrup sandy loam, 0 to 3 percent slopes	26	42	7	10	26
Sverdrup sandy loam, 3 to 9 percent slopes	22	36	5	8	24
Tonka silt loam	35	54	13	20	38
Towner fine sandy loam	32	46	11	17	36
Ulen sandy loam	25	35	13	17	40
Vallers-Hamerly loams, 0 to 2 percent slopes	35	51	8	12	37
Vienna silt loam, 0 to 2 percent slopes	44	58	14	22	46
Vienna silt loam, 2 to 6 percent slopes	42	55	13	20	45
Vienna silt loam, 6 to 9 percent slopes	35	46	11	17	41
Waubay silty clay loam	47	68	16	24	50

per acre of principal crops grown

Absence of a yield figure indicates that the soil is not suited to the crop specified, or that the crop is not commonly grown on the soil. Soil the composition of soils in the complex]

Oats—Cont.	Spring wheat		Flax		Rye		Alfalfa	
B	A	B	A	B	A	B	A	B
Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*
74	24	36	14	22	24	40	2.4	3.3
60	15	23	10	14	14	22	1.5	2.4
60	15	23	10	15	14	22	1.7	2.6
62	15	23	10	15	14	22	1.5	2.4
64	17	26	9	14	16	24	1.8	2.7
64	22	32	10	15	20	32	1.9	2.8
53	12	20	8	12	12	18	1.8	2.6
40	14	25	7	11	16	28	1.3	2.0
38	12	23	6	10	14	25	1.2	1.9
40	13	18	8	13	12	20	1.0	2.3
68	17	28	10	16	20	36	1.9	2.9
60	15	24	10	15	15	25	2.0	3.1
63	18	27	11	18	20	32	1.8	2.7
60	17	26	10	17	18	30	1.8	2.6
48	12	21	7	11	10	19	1.4	2.2
55	16	26	10	16	16	27	1.7	2.5
49	16	24	9	14	16	30	1.5	1.9
39	12	19	7	11	13	22	1.1	1.6
70	19	29	12	19	20	36	2.1	2.9
67	18	28	11	18	18	34	2.0	2.7
62	15	24	9	15	13	23	1.9	2.6
45	12	20	7	11	10	17	1.7	2.4
50	11	20	7	12	12	20	1.3	2.1
35	9	15	5	9	10	17	1.2	1.9
70	23	35	12	18	20	32	2.0	2.8
64	21	31	10	15	18	30	1.9	2.7
48	16	24	9	13	14	24	1.7	2.6
61	16	25	9	14	15	23	1.8	2.7
60	16	25	9	14	14	22	1.8	2.7
57	15	24	8	13	13	21	1.7	2.6
45	10	16	7	11	10	17	1.5	2.0
44	13	20	9	14	13	21	1.5	2.4
57	15	23	11	16	17	26	1.5	2.4
43	13	18	8	13	14	21	1.4	2.1
65	19	29	14	19	22	32	2.0	3.0
63	17	26	13	18	20	30	1.9	2.8
74	19	29	13	20	22	34	2.5	3.4
63	17	28	11	17	20	30	2.0	3.0
35	10	18	7	11	10	18	1.2	2.0
34	10	15	6	10	10	16	1.0	1.6
60	16	24	10	15	14	25	2.0	2.8
63	19	27	11	17	20	35	1.8	2.8
60	18	26	10	16	18	32	1.6	2.7
50	15	24	8	12	15	27	1.4	2.3
54	16	23	9	15	17	30	1.5	2.2
60	17	25	11	16	18	30	1.9	2.8
42	10	16	6	11	13	22	1.5	2.2
70	20	28	13	19	22	35	2.1	3.0
68	18	25	12	18	20	32	2.0	2.9
30	9	14	6	10	10	15	.8	1.1
27	8	13	4	8	9	13	.5	.9
19	6	10	----------	----------	8	11	.5	.7
52	17	23	9	14	18	28	1.8	2.0
49	15	20	8	12	16	26	1.4	1.8
68	19	25	14	20	20	27	2.1	3.0
65	17	23	12	18	18	25	2.0	2.8
68	18	28	12	19	20	32	2.2	3.1
39	12	18	7	12	15	24	1.3	1.9
37	9	14	6	10	13	20	1.0	1.7
52	16	21	10	15	14	24	2.1	2.8
52	15	22	10	17	20	32	1.6	2.0
50	14	19	9	12	18	28	1.6	2.5
53	15	23	8	12	13	22	1.8	2.6
68	20	28	13	18	22	34	2.1	2.9
65	18	25	12	17	20	32	2.0	2.7
58	14	22	10	15	16	24	1.8	2.4
75	22	32	14	22	24	36	2.5	3.4

munity is subject to continued excessive grazing use. *Increaser* plants are species in the climax plant community that increase in relative abundance when the range site is subject to continued excessive grazing use. *Invader* plants are not members of the climax plant community for the site. They invade the community as a result of various kinds of disturbances.

Descriptions of range sites

The range sites of Roberts County are described in the following paragraphs. The descriptions give the important characteristics and properties of the soils in each site, the principal plants in the plant community, and estimates of forage yield. The yield estimates are for sites in excellent condition and are for the entire annual growth. Of this total annual yield, 70 to 90 percent are of grass species that provide the major source of forage for cattle.

The name of the soil series represented are given in each site, but this does not mean that all the soils in a given series are in that site. To find the range site in which a soil is placed and the page on which it is described, refer to that soil in the section "Descriptions of the Soils" or in the "Guide to Mapping Units" at the back of this survey.

WETLAND RANGE SITE

This site consists of poorly drained and very poorly drained soils of the Colvin, Marysland, Parnell, Rauville, and Tonka series. These soils have a water table at a shallow depth for much of the growing season. Wetness and poor aeration limit the growth of grass. The soils are too wet and too poorly aerated to permit the growth of bluestem, but this site has potential for producing luxuriant stands of water-tolerant grasses.

Prairie cordgrass, reedgrass, reed canarygrass, and rivergrass are the main species. In places sedges make up about 25 percent of the existing vegetation. Shrubs and trees such as indigobush amorpha and willows are in some areas.

Under continued overuse the stand of climax grasses loses vigor and thins out, and sedges, rushes, Kentucky bluegrass, and inland saltgrass increase in abundance. Because these species are either shorter or less palatable than the climax species, production of the site declines.

Mechanical treatment to improve this site is not feasible. Range seeding is very difficult because of wetness.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 7,000 pounds per acre in favorable years to 6,000 pounds per acre in unfavorable years.

SUBIRRIGATED RANGE SITE

This site consists of poorly drained and somewhat poorly drained soils of the Borup, Hamar, Lamoure, Marysland, Playmoor, and Vallers series. Also in this site is the land type Sandy lake beaches. The soils in this site have a water table at a depth of less than 5 feet for much of the growing season. They are not too wet and are aerated enough to permit the growth of big bluestem. This site has potential for producing luxuriant stands of tall prairie grasses.

Big bluestem is the dominant grass on this site and makes up 75 to 90 percent of the existing vegetation in some areas. Other tall grasses in lesser amounts are switchgrass, indiangrass, Canada wildrye, and prairie cordgrass. Western wheatgrass and inland saltgrass are increasers that are present in small amounts. Also present are Kentucky bluegrass, sedges, and forbs. Indigobush amorpha is a conspicuous shrub in places.

Under continued overuse the stand of climax grasses loses vigor and thins out, and western wheatgrass, inland saltgrass, and Kentucky bluegrass increase in abundance. If overuse continues, Kentucky bluegrass or inland saltgrass and an overstory of unpalatable weeds become dominant.

Mechanical treatment, such as contour furrowing and pitting, is not feasible on this site.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 6,400 pounds per acre in favorable years to 5,000 pounds per acre in unfavorable years.

OVERFLOW RANGE SITE

This site consists of deep, moderately well drained to poorly drained soils of the Aastad, LaDelle, Ludden, and Svea series. Also in this site is Loamy Fluvaquents. The soils in this site regularly receive additional moisture because they are flooded by stream overflow or because they receive runoff from adjacent, sloping soils. Because this site receives additional moisture, it has potential of producing dense stands of tall grasses.

Big bluestem is the dominant grass in the climax plant cover and in places makes up 65 to 85 percent of the existing vegetation. In a few places green needlegrass and porcupinegrass are abundant, but they do not dominate the site. Indiangrass, switchgrass, Canada wildrye, and little bluestem are other decreasers. The principal increasers are western wheatgrass and side-oats grama. Also present in the understory are Kentucky bluegrass, sedges, and forbs. Scattered leadplant amorpha is conspicuous in some areas.

Under continued overuse the stand of climax grasses loses vigor and thins out, and western wheatgrass and Kentucky bluegrass increase in abundance. If overuse continues, Kentucky bluegrass becomes dominant.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 5,200 pounds per acre in favorable years to 4,000 pounds per acre in unfavorable years.

SANDS RANGE SITE

This site consists of deep, moderately well drained and well drained, sandy soils of the Hecla and Maddock series. The upper part of these soils is loamy fine sand, and the underlying material is fine sand. These soils readily absorb all precipitation that falls on the site.

The climax plant cover is mainly a mixture of tall, warm-season grasses. Sand bluestem, big bluestem, and little bluestem collectively dominate the site in some areas, but a single species seldom does. Other warm-season decreasers are indiangrass and switchgrass. Canada wildrye and prairie junegrass are cool-season decreasers that are present in small amounts. Prairie sandreed is the principal increaser. Forbs and woody plants are significant in some areas.

Under continued overuse bluestems decrease and are replaced by prairie sandreed. If prairie sandreed is overgrazed, bare areas become common, and soil blowing is a serious concern.

Mechanical treatment, such as contour furrowing and pitting, is not feasible on this site.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,000 pounds per acre in favorable years to 2,800 pounds per acre in unfavorable years.

SANDY RANGE SITE

This site consists of somewhat excessively drained to somewhat poorly drained soils of the Dickey, Embden, Sverdrup, Towner, and Ulen series. The surface layer of these soils is fine sandy loam or sandy loam, and the subsoil and underlying material range from loam to sand. Permeability is moderately rapid or rapid in the upper part of these soils.

The climax plant cover is mainly a mixture of mid and tall warm-season grasses. Little bluestem, sand bluestem, and big bluestem are the main species. Canada wildrye and prairie junegrass are cool-season decreasers that are present in small amounts. Prairie sandreed is the principal increaser, and needleandthread and western wheatgrass are cool-season increasers. Small amounts of blue grama, side-oats grama, and forbs are also present.

Under continued overuse bluestems decrease and are replaced by prairie sandreed, needleandthread, western wheatgrass, and side-oats grama. If overuse continues, Kentucky bluegrass and blue grama become dominant.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,800 pounds per acre in favorable years to 2,600 pounds per acre in unfavorable years.

SILTY RANGE SITE

This site consists of loamy and silty soils of the Aastad, Antler, Barnes, Bearden, Divide, Eckman, Fordville, Forman, Gardena, Glyndon, Hamerly, Heimdal, Poinsett, Rentill, Svea, Vienna, and Waubay series. Fertility is medium or high. Available water capacity is mainly moderate or high, but it is low or moderate in the Divide and Fordville soils. Permeability of the subsoil ranges from moderately slow to moderately rapid.

The climax plant cover is a mixture of tall and mid grasses. This mixture is characteristic of areas that are in transition from true prairie to mixed prairie. Big bluestem and little bluestem are important warm-season decreasers. Green needlegrass and western wheatgrass are important but do not dominate the site. Significant amounts of blue grama and side-oats grama are present. Forbs and such woody plants as leadplant amorpha generally are not abundant but are an important part of climax vegetation.

Under continued overuse bluestems decrease and are replaced by western wheatgrass and needleandthread. If overuse continues, blue grama replaces western wheatgrass.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,000 pounds per acre in favorable years to 2,800 pounds per acre in unfavorable years.

CLAYEY RANGE SITE

This site consists of deep, loamy and clayey soils of the Doran, Dovray, Hattie, Peever, and Sinai series. These soils have a subsoil of clay, silty clay, or heavy clay loam. Permeability is slow or very slow. The clayey subsoil releases moisture slowly to plants and is somewhat restrictive to the development of plant roots.

The climax plant cover is a mixture of tall, mid, and short grasses. Western wheatgrass and green needlegrass are the dominant grasses. Big bluestem and little bluestem are warm-season decreasers that are present in lesser amounts. An understory of short grasses also is present in the climax plant cover. Forbs and woody plants are of little importance.

If the site is overused continuously, green needlegrass and bluestems are replaced by western wheatgrass. If overuse continues, short grasses replace western wheatgrass.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 4,000 pounds per acre in favorable years to 2,800 pounds per acre in unfavorable years.

THIN UPLAND RANGE SITE

This site consists of well-drained, loamy and silty soils of the Buse, Kloten, Sisseton, and Zell series. Buse, Sisseton, and Zell soils are calcareous at or near the surface. The Kloten soil is shallow over bedded shale. Available water capacity is high or moderate in Buse, Sisseton, and Zell soils. Fertility is low or medium.

Little bluestem is the most important plant in the climax plant cover. Other important decreasers are big bluestem and green needlegrass. Side-oats grama, western wheatgrass, needleandthread, and blue grama are important increasers. Forbs and such shrubs as leadplant amorpha, are important in places.

If the site is overused continuously, the bluestem species and green needlegrass are replaced by needleandthread and side-oats grama. If overuse continues, blue grama becomes dominant.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,600 pounds per acre in favorable years to 2,600 pounds per acre in unfavorable years.

CLAYPAN RANGE SITE

This site consists of moderately well drained, claypan soils of the Cavour series. The surface layer is loam and the subsoil is clay. Salts are common in the lower part of the subsoil. Available water capacity is moderate or high, but the claypan subsoil takes in water very slowly and releases it slowly to plants.

The climax plant cover is a mixture of water-tolerant and drought-tolerant grasses. Switchgrass, green needlegrass, and prairie cordgrass are significant in the plant community, but they do not grow so well on this site as they do on others. Western wheatgrass, blue grama, inland saltgrass, and sedges are an important part of the plant cover.

If this site is overused continuously, the tall grasses are replaced by western wheatgrass and short grasses. Short grasses then dominate the site during dry periods and are overtopped by weeds during wet periods.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 3,000 pounds per acre in favorable years to 2,200 pounds per acre in unfavorable years.

SHALLOW TO GRAVEL RANGE SITE

This site consists of somewhat excessively drained, loamy soils of the Renshaw series. These soils are shallow over sand and gravel. Available water capacity is low, and the soils are droughty.

The climax plant cover is a mixture of mid and short grasses. Needleandthread is dominant. Blue grama, hairy grama, and threadleaf sedge are important short plants. Forbs, such as black samson, are common.

If the site is continuously overused, the short grasses and an overstory of a few unpalatable weeds become dominant.

Mechanical treatment, such as contour furrowing and pitting, is not feasible on this site.

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

VERY SHALLOW RANGE SITE

This site consists of excessively drained, loamy soils of the Sioux series. These soils are very shallow over sand and gravel. Available water capacity is very low or low, and the soils are very droughty.

The climax plant cover is a mixture of mid and short grasses. Needleandthread, side-oats grama, and little bluestem are important mid grasses. Blue grama and threadleaf sedge are important short-growing plants.

If this site is overused, it rapidly deteriorates to a stand of blue grama and threadleaf sedge. Further overuse thins the plant cover, and bare areas of the soil are subject to erosion.

Mechanical treatment is not feasible on this site. Range seeding is not feasible where soils are steep, and the chance of success when seeding areas of less steep soils is very poor.

If this site is in excellent condition, the total annual yield of air-dry herbage ranges from 2,200 pounds per acre in favorable years to 1,500 pounds in unfavorable years.

Use of the Soils for Woodland and Windbreaks [6]

Roberts County has approximately 12,000 acres of native woodland. The most dense and most productive stands of trees grow on Sieche soils, which are on the steep sides of draws or ravines on the eastern edge of the Sisseton Hills. Some areas of trees and shrubs are along the lower reaches of the Little Minnesota River. Trees and shrubs also are scattered singly or in clumps along other streams and around lakes, sloughs, and wet areas throughout the county.

Tree species present in these areas of native woodland include American elm, aspen, basswood, boxelder, bur oak, cottonwood, green ash, hackberry, and willow. Principal shrubs are American plum, buckbrush, chokecherry, and sumac. Except in the more inaccessible, steeper areas, young growth is very limited because of grazing by livestock.

The native woodland in the county has little commercial value and is valued primarily for esthetic, recreation, watershed, and wildlife uses.

Windbreaks have been planted in the county since the days of the early settlers. Most early windbreaks were planted for the protection of farmsteads and livestock. A need for windbreaks still exists, and many present ones need supplemental plantings. In most recent years, field windbreaks have been planted to help control soil blowing in cultivated fields (fig. 18). Thousands of acres in the county still need some form of protection to help control soil blowing.

Windbreaks return many benefits to the landowner. They prevent snow from drifting into the farmstead and protect the home and livestock from cold winds. They protect field crops, gardens, and orchards from damaging winds; reduce evaporation of moisture; help control soil blowing and erosion; provide habitat for birds and wildlife; and enhance the beauty of the rural home and its surroundings.

Poorly designed windbreaks can cause many problems. When planning a windbreak the purpose of the windbreak, its location, and the suitability of soils in the site need to be considered.

After the site is selected, the establishment of a windbreak depends upon suitable site preparation. Grasses and weeds need to be eliminated before the trees are planted, and adapted trees and shrubs need to be selected. After the windbreak is established, the desirable growth of the trees and shrubs depends on adequate maintenance. Regrowth of ground cover needs to be controlled during the life of the windbreak. Some replanting may be necessary especially in the first and second years.

Windbreak suitability groups

The soils of Roberts County are grouped according to their suitability for windbreak plantings. Table 3 lists most of the trees and shrubs used in windbreak plantings and their probable performance in each windbreak suitability group. The table gives the actual or estimated average height growth and the vigor of each species at 20 years of age. All height measurements and vigor ratings are based on plantings that have been given adequate care. The vigor ratings are based on density of foliage, extent of damage from insects or disease, and the general appearance of the tree or shrub. They are defined in the following paragraphs.

Vigor is *good* if one or more of the following conditions are present: leaves or needles are normal in color and growth; small amounts of deadwood (tops, branches, twigs) are within the live crowns; evidence of disease, insect, or climatic damage is limited; slight evidence of suppression or stagnation in places.

Vigor is *fair* if one or more of the following conditions are present: leaves or needles are abnormal in color and growth; substantial amounts of deadwood (tops, branches, twigs) are within the live crowns; evidence of moderate disease, insect, or climatic damage is obvious; definite suppression or stagnation exists; current year's growth obviously is less than normal.

Vigor is *poor* if one or more of the following conditions are present: leaves or needles are very abnormal in color and growth; very large amounts of deadwood (tops, branches, twigs) are within the live crowns; evidence of extensive disease, insect, or climatic damage is obvious; plants show effects of severe stagnation, suppression, or decadence; current year's growth is negligible. Plants with this rating are not recommended for farmstead, feedlot, or field windbreaks, but they may be satisfactory for wildlife and beautification plantings.

The windbreak suitability groups are described in the following paragraphs. Except for group 10, the names of the soil series are mentioned in the description of each group, but this does not mean that all the soils of a series are in that group. To find the windbreak group of a given soil, refer to that soil in the section "Descriptions of the Soils" or in the "Guide to Mapping Units" at the back of this survey.

WINDBREAK SUITABILITY GROUP 1

In this group are deep, moderately well drained to poorly drained, loamy and silty soils of the Aastad, Antler, Bearden, Embden, Gardena, Glyndon, Hamerly, Hecla,

[6] By DAVID L. HINTZ, forester, and KARL F. ZIEGLER, district conservationist, Soil Conservation Service.

Figure 18.—**Single-row field windbreak on Doran loam.**

LaDelle, Svea, Towner, and Waubay series. The surface layer of these soils ranges from fine sandy loam to silty clay loam. Permeability ranges from rapid to slow. Available water capacity is high or moderate. Areas of these soils regularly receive additional moisture in the form of runoff from adjacent soils or from stream overflow. Some soils have a water table within reach of tree roots. The moisture regime is the most favorable one in the county for the planting and survival of trees.

Soils of this group are well suited to the planting of trees and shrubs for the protection of fields, farmsteads, and feedlots. They also are well suited as sites for recreation, beautification, and wildlife plantings.

WINDBREAK SUITABILITY GROUP 2

In this group are moderately well drained to poorly drained soils of the Borup, Divide, Dovray, Hamar, Lamoure, Marysland, Ulen, and Vallers series. The surface layer of these soils ranges from loamy fine sand to clay. Permeability ranges from moderately rapid to very slow. These soils have a high water table that limits the growth and development of roots. The high water table also limits the selection of trees and shrubs to those that tolerate wetness. Some of these soils are subject to soil blowing.

Soils of this group are well suited to the planting of trees and shrubs for the protection of fields, farmsteads, and feedlots. They also are suited as sites for wildlife, beautification, and recreation plantings. Drainage on some of these soils improves growth conditions for some trees and shrubs.

WINDBREAK SUITABILITY GROUP 3

In this group are deep, well-drained, nearly level to strongly sloping and rolling, loamy and silty soils of the Eckman, Forman, Heimdal, Poinsett, Rentill, and Vienna series. Permeability is moderate or moderately rapid. Available water capacity is mainly high but is moderate or high in the Rentill soils.

Soils of this group are well suited to all kinds of tree and shrub plantings. Contour plantings in areas of sloping soils help to conserve moisture.

WINDBREAK SUITABILITY GROUP 4

In this group are deep, nearly level to rolling, loamy and clayey soils of the Doran, Hattie, Peever, and Sinai series. Doran soils are somewhat poorly drained, but the others are well drained. The subsoil of these soils is heavy clay loam, clay, or silty clay. Available water capacity is moderate or high, but permeability is slow in the subsoil. These soils take in water slowly, and the clayey subsoil limits the development of tree roots. The hazard of erosion is moderate in areas of sloping soils.

Soils of this group are moderately suited to windbreak

TABLE 3.—*Estimated height and vigor of trees and*

[*Estimates of height not*

Woodland species	Group 1		Group 2		Group 3		Group 4	
	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
		Feet		*Feet*		*Feet*		*Feet*
American elm	Good	24–28	Good	22–26	Good	20–22	Fair	24–28
Black Hills spruce, blue spruce	Good	24–30	Good	20–24	Good	24–28	Poor	----------
Boxelder	Good	20–22	Fair	18–20	Fair	20–22	Poor	----------
Buffaloberry	Good	8–10	Fair	6–8	Good	7–9	Good	7–9
Caragana	Good	9–11	Fair	7–9	Good	9–10	Fair	7–8
Chokecherry	Good	12–14	Fair	9–11	Good	9–12	Good	10–12
Cotoneaster	Good	6–7	Fair	5–6	Good	5–6	Good	6–7
Cottonwood	Fair or good.	35–40	Fair or good.	32–36	Poor	----------	Poor	----------
Crabapple	Good	18–20	Good	16–18	Good	15–17	Fair	13–15
Eastern redcedar, Rocky Mountain juniper	Good	15–18	Good	14–16	Good	13–15	Good	15–17
Green ash	Good	23–27	Good	20–24	Good	20–24	Fair	21–26
Hackberry	Good	23–27	Good	22–26	Good	20–24	Good	22–24
Harbin pear	Good	16–18	Good	14–16	Good	15–17	Fair	13–15
Honeylocust	Good	30–34	Good	30–34	Fair	26–30	Fair	24–26
Honeysuckle	Good	8–10	Good	6–8	Good	7–9	Good	8–10
Lilac	Good	7–8	Good	5–6	Good	6–7	Fair	4–5
Nanking cherry	Good	5–6	Fair	4–5	Fair	5–6	Fair	4–5
Plum	Good	8–9	Good	5–6	Good	8–9	Good	8–9
Ponderosa pine	Good	24–30	Good	20–22	Good	22–26	Good	17–23
Russian olive	Fair	16–20	Fair	14–16	Fair	15–18	Fair	16–22
Siberian elm, dropmore elm, chinkota elm	Good	32–36	Good	24–28	Good	30–32	Good	36–40
White willow, golden willow	Good	32–35	Good	30–34	Poor	----------	Poor	----------

plantings for the protection of fields, farmsteads, and feedlots. They also are moderately suited as sites for recreation, beautification, and wildlife plantings.

WINDBREAK SUITABILITY GROUP 5

In this group are deep, somewhat excessively drained soils of the Dickey and Sverdrup series. The surface layer of these soils is fine sandy loam or sandy loam, and the subsoil is loamy sand or sandy loam. Permeability is moderately rapid. Available water capacity ranges from low to high, and the underlying sandy material releases water readily to tree roots. These soils are subject to soil blowing.

Soils of this group are well suited to tree plantings of all kinds. Soil blowing can be controlled if site preparation and planting are carefully done.

WINDBREAK SUITABILITY GROUP 6

This group consists of well-drained, loamy soils of the Fordville series. These soils are moderately deep to sand and gravel. Available water capacity is low or moderate, and the soils are somewhat droughty. Root system development is shallow because the sand and gravel lack moisture.

This soil is poorly suited to windbreak plantings. They are suited to other plantings if optimum growth is not critical. Plantings on the contour help to conserve needed moisture.

WINDBREAK SUITABILITY GROUP 7

Maddock loamy fine sand, 0 to 6 percent slopes, is the only soil in this group. This is a deep, well-drained, sandy soil. Permeability is rapid, and available water capacity is low. Fertility is low or medium, and the hazard of soil blowing is high.

This soil is poorly suited to windbreak plantings, but it can be used as sites for recreation, wildlife, and beautification plantings if special care is taken. Special site preparation and management practices generally are needed to control soil blowing.

WINDBREAK SUITABILITY GROUP 8

In this group are deep, well-drained, calcareous, loamy and silty soils of the Sisseton and Zell series. Permeability is moderate, and available water capacity is moderate or high. The high content of lime affects the availability of plant nutrients, and the soils are subject to soil blowing and erosion.

Soils of this group are moderately suited to windbreak plantings. Management that controls erosion and soil blowing is needed during site preparation and after planting. Plantings on the contour help to conserve moisture and control erosion.

WINDBREAK SUITABILITY GROUP 9

The Cavour soil in the Peever-Cavour complex, 0 to 3 percent slopes, is the only soil in this group. It is a moderately well drained, claypan soil. The surface layer is loam, and the subsoil is clay. Salts are common in the lower part of the subsoil and in the underlying material. Permeability is very slow. The claypan subsoil restricts the development of root systems, and the presence of salts is unfavorable for many species.

This soil is poorly suited to windbreak plantings. It can be used for other types of plantings where optimum growth and vigor are not required.

shrubs at 20 years of age by windbreak suitability groups

given for species rated poor]

Group 5		Group 6		Group 7		Group 8		Group 9	
Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
	Feet		*Feet*		*Feet*		*Feet*		*Feet*
Fair	20–24	Fair or poor.	10–12	Poor		Fair	14–16	Poor	
Poor		Poor		Poor		Poor		Poor	
Poor		Poor		Poor		Poor		Poor	
Fair	6–8	Fair	5–6	Poor		Fair	4–5	Fair	3–4
Good	8–10	Fair	6–7	Poor		Fair	7–8	Fair	5–6
Fair	9–11	Poor		Poor		Poor		Poor	
Good	6–7	Fair	4–5	Poor		Fair	5–6	Poor	
Poor		Poor		Poor		Poor		Poor	
Good	17–19	Fair	12–14	Poor		Poor		Poor	
Good	13–15	Fair	9–11	Fair	9–11	Fair	9–11	Fair	6–8
Good	22–26	Fair	12–14	Poor		Fair	14–16	Fair	10–12
Good	21–25	Fair	10–12	Poor		Fair	14–16	Poor	
Good	15–17	Fair	11–12	Poor		Fair	7–9	Fair	5–7
Fair	28–32	Fair or poor.	15–17	Poor		Fair	17–20	Poor	
Good	6–7	Fair	5–7	Poor		Fair	6–8	Poor	
Good	6–7	Fair	4–5	Poor		Fair	5–6	Fair	3–4
Fair	4–5	Poor		Poor		Poor		Poor	
Good	6–7	Poor		Poor		Fair	5–6	Poor	
Good	20–24	Fair	13–15	Fair	14–16	Fair	14–16	Fair	10–12
Fair	14–18	Fair	9–12	Poor		Fair	14–16	Fair	8–10
Good	30–34	Fair	16–20	Poor		Fair	18–22	Fair	12–14
Poor		Poor		Poor		Poor		Poor	

WINDBREAK SUITABILITY GROUP 10

This group consists of soils that are too stony, too steep, or too wet for the machinery used in planting trees. Some of the soils are too shallow, too saline, or too wet for most species used in windbreaks.

Some of the soils in this group can be used as sites for recreation, beautification, and wildlife plantings if the trees and shrubs are hand planted and are given special care. The trees and shrubs which are selected for special plantings need to be tolerant of the soil conditions at each site.

Use of the Soils for Wildlife Habitat [7]

Habitat for wildlife is a product of soil just as are crops, trees, and forage for domestic animals. The production of adapted wildlife is dependent on a balanced habitat that provides food, cover, and other requirements essential for a given wildlife species. Wildlife habitat is provided by introduced as well as native plants and is dependent on the suitability of the soil for growing these plants. Several kinds of soil can be required to produce all the habitat needs of a given wildlife species. The wildlife potential of soils in Roberts County, therefore, can be best related to the soil associations described in this survey. In the following paragraphs, the soil associations of Roberts County are grouped into nine wildlife suitability areas, and the wildlife potential of each area is discussed.

WILDLIFE SUITABILITY AREA 1

This area consists of nearly level to steep, loamy soils of the Heimdal-Svea-Sisseton association. Slopes are mostly nearly level to undulating, but some steeper slopes are in areas adjacent to Big Stone Lake, along large drainageways, and around sloughs and potholes. Most of these soils are cultivated, but many small, mostly tame pastures are scattered throughout the area. Some of the steeper spots, such as those bordering Big Stone Lake, are in native grass. Stands of native trees border Big Stone Lake, and stringers of native trees are along some of the larger drainageways. Many farm windbreaks and a few field windbreaks are present.

Game in this association consists of white-tail deer, mourning doves, pheasants, and ducks. Deer are present throughout the area, but they are more plentiful in spots bordering Big Stone Lake and on the edges of the area where habitat is balanced by that of wildlife suitability area 8. Small sloughs and potholes provide limited habitat for ducks.

Habitat for pheasants can be improved by additional tree plantings for winter storm protection and by additional herbaceous plantings for nesting cover. Both mourning doves and pheasants can benefit from more field windbreaks and from proper grazing use of tame and native pastures.

Big Stone Lake is a natural lake that is used for sport fishing and other forms of recreation. It also provides an annual commercial harvest of rough fish, mostly European carp, to improve sport fishing. Progressive eutrophication of Big Stone Lake, however, has resulted in excessive summer growths of algae. This lessens the value of the lake for recreation, and increases the probability of winterkill of fish. Action programs are under consideration for improving conditions on this lake.

Some of the stockwater ponds in the areas of native grass near Big Stone Lake are suitable for pond fisheries and waterfowl habitat.

[7] By JOHN B. FARLEY, biologist, Soil Conservation Service.

WILDLIFE SUITABILITY AREA 2

This area consists of gently undulating to steep, loamy soils of the Forman-Aastad-Buse association. Some of the less steep soils are cultivated, but extensive areas are in native grass and are used as range. Stringers of native trees are along drainageways and around lakes, and dense stands of native trees are on the sides of entrenched drainageways or coulees. Numerous natural lakes, sloughs, and potholes are throughout this area. Windbreaks are around some farmsteads.

The only big game in this association is white-tail deer. Their principal habitat is the wooded coulees, but they range over the entire area. Other wildlife are beaver, bobcat, coyote, and red fox. Songbirds inhabit the wooded coulees and adjacent grassland.

Because natural wetlands (fig. 19) are numerous, this wildlife area is rated high for wetland wildlife in a rating scale used by the Bureau of Sport Fisheries and Wildlife. These wetlands provide excellent habitat for waterfowl, shore birds, and furbearers. Gadwall ducks are the most numerous, but many other species are also present. These wetlands also have populations of mink, muskrat, raccoon, weasel, and skunk.

Mourning doves are the most plentiful among the upland bird species. The pheasant population is low, and the presence of gray partridge and sharp-tailed grouse is rare.

The many natural lakes on soils in this wildlife area have an average depth of less than 10 feet. Although the lakes are managed for sport fishing, the fish population frequently is affected by winterkill. All the lakes have good populations of black bullheads and some northern pike. One Road Lake (fig. 20) at times provides good catches of yellow perch. These lakes are used as resting habitat for waterfowl. Dry Wood Lake has a cormorant rookery.

The wooded coulees in this area are a potential habitat for wild turkey. Some of the wooded coulees are too small to support enough turkeys for hunting purposes, but if wild turkeys are successfully introduced they add to the diversity of wildlife.

WILDLIFE SUITABILITY AREA 3

This area consists of soils in the southern part of the Peever association extending from an area northwest of the town of Sisseton to the county line to the south. Most of these soils are cultivated, but stringers of trees and shrubs are along entrenched drainageways that cut across this area. Natural wetlands, relatively rare in this area, are on narrow bottom lands along the larger drainageways and in a few potholes.

White-tail deer, pheasants, and mourning doves are the principal wildlife. The potential is highest for deer because the soils in this area have wooded drainageways, and they are close to the soils in wildlife suitability areas 2 and 8. The

Figure 19.—**Marshland that has small, open bodies of water in the Forman-Aastad-Buse association.**

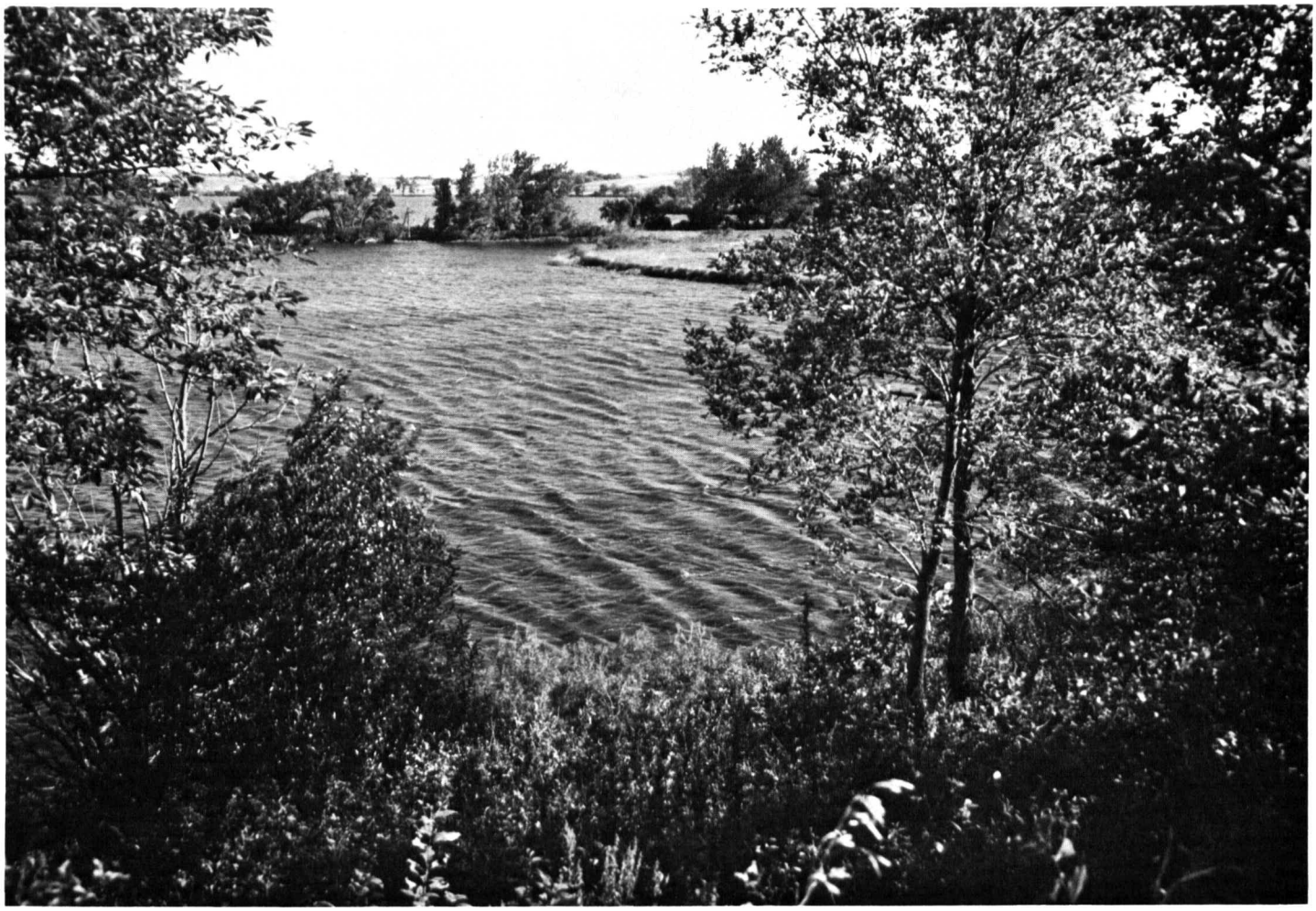

Figure 20.—**One Road Lake is one of the many small lakes in the Forman-Aastad-Buse association.**

potential habitat for pheasant and mourning dove is favorable.

WILDLIFE SUITABILITY AREA 4

This area consists of the soils in the Forman-Aastad and Peever-Tonka associations and in the northern part of the Peever association. Most of these soils are cultivated, but natural wetlands are significant. A few small lakes and sloughs and many small potholes or depressions are throughout the area, and some areas of Marsh are in the Forman-Aastad association. Windbreaks are around many of the farmsteads, but field windbreaks are rare.

This area has good potential for waterfowl habitat and moderate potential for cottontail rabbit, mourning doves, gray partridge, and pheasant habitat. Favorable populations of white-tail deer are in this area, and they benefit from the emergent aquatic vegetation in the areas of Marsh.

The potential for waterfowl habitat depends on preservation of the existing areas of wetlands. The development of the shallow-water areas in some wetlands could enhance this potential and that of other aquatic wildlife. The preservation of the natural wetlands is also important to upland wildlife. Other management practices that affect the wildlife potential of this area are exclusion of livestock grazing from windbreaks, accelerated use of field windbreaks, proper use of tame and native pastures, and conservation management of crops.

WILDLIFE SUITABILITY AREA 5

This area consists of the soils in the Doran, Glyndon-Gardena, and Poinsett-Eckman-Heimdal associations. Most of these soils are cultivated and are intensively farmed and planted to corn, soybeans, flax, and small grains. Small depressions or potholes are scattered throughout the associations, but many are farmed and the rest are used as small pastures. Windbreaks are around most of the farmsteads and around some fields.

Big Slough and the northern part of Cottonwood Slough have excellent habitat for waterfowl, and in these areas ducks and geese are plentiful for hunting. These natural wetlands provide habitat for other aquatic animals and also provide winter cover for deer and pheasant. Natural wetlands are not significant in this area except for these important ones near Victor.

Pheasants, mourning dove, cottontail rabbits, and deer are throughout this area. Deer generally are more plentiful on soils in the eastern side of this area, because wildlife suitability area 6 is nearby.

The intensive farming in this area limits the potential for wildlife, but habitat can be improved by adding border rows

of shrubs to many existing farmstead and field windbreaks. Use of wildlife plantings on field borders and odd areas also enhances the habitat for farm game.

WILDLIFE SUITABILITY AREA 6

This area consists of sloughs, open water, potholes, and flats of the Marsh-Antler-Hamerly association. Some of the Antler and Hamerly soils in this association are cultivated, but other areas remain in native vegetation and are used for pasture and hay. About 50 percent of the area is Marsh.

Marsh provides excellent habitat for waterfowl and aquatic animals. It is particularly good habitat for furbearers, ducks, shore birds, and songbirds. Clumps of cottonwood and willow and emergent aquatic plants provide excellent habitat for deer and also provide very good winter habitat for pheasant.

This area has an exceptional wildlife potential although some of the farm drainage activities have lessened its potential. Because much of this area is Marsh, public ownership and management by a wildlife agency is one means of realizing the full potential for wildlife.

WILDLIFE SUITABILITY AREA 7

This area consists of loamy and silty soils of the Renshaw-Fordville association and the Vienna association. The Renshaw and Fordville soils are underlain by sand and gravel and are somewhat droughty. Slopes are mostly nearly level and gently sloping, but they range from nearly level to steep. Most of the soils in the Vienna association are cultivated, but about half of the area of the Renshaw-Fordville association is in native grass. Windbreaks are around some farmsteads, but the potential for additional plantings on the droughty Renshaw and Fordville soils is limited.

Sloughs, potholes, and lakes in this area provide favorable habitat for waterfowl and furbearers, but their extent is limited. Hurricane Lake provides a bullhead-northern pike fishery, but susceptibility to winterkill is high because the lake is not very deep.

Pheasants, deer, mourning dove, waterfowl, furbearers, and songbirds are in this wildlife area, but it has the lowest potential of all the wildlife areas in the county.

WILDLIFE SUITABILITY AREA 8

This area consists of the Dovray-Ludden-Lamoure, Hamerly-Vallers, and LaDelle-Playmoor-Lamoure associations. The soils of these associations formed in alluvium and are on bottom lands and adjacent flats along the major streams and on flats along Lake Traverse. Some of the better drained soils are cultivated, but many of the poorly drained soils are used for grazing, for growing hay, and as wildlife habitat. Many areas of bottom land are heavily wooded with native trees and shrubs.

The poorly drained soils and Marsh in this area provide excellent habitat for waterfowl, and ducks and geese are plentiful for hunting. They also provide habitat for other aquatic animals and winter habitat for deer and pheasant. Live streams in the area provide considerable habitat for mink and beaver.

The live streams in the area have little potential as sport fisheries, but some minnow are harvested from the North Fork of the Whetstone River. Lake Traverse is the main sport fishery in this area and a number of fishing resorts are on its shores.

WILDLIFE SUITABILITY AREA 9

This area consists of nearly level, loamy and sandy soils of the Towner-Hecla-Hamar association. Most of the soils in this association are cultivated. Scattered small, tame and native pastures provide summer grazing for livestock. Trees grow well on these soils, and many farmstead and field windbreaks are in this area. The field windbreaks help to control soil blowing on the sandy soils.

This area currently has the highest population of farm game in the county. Populations of pheasant are very high, and gray partridges are relatively abundant. Habitat for mourning doves and cottontail rabbits is excellent.

Engineering Uses of the Soils [8]

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

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

Information in this section 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 sand, gravel, clay, and roadfill material.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil elsewhere.
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 4, 5, 6, and 7, which show respectively, several estimated soil properties significant to engineering laboratory tests on soil samples, including samples taken along proposed highway routes. This information along with the soil map and other parts of this survey, can be used to make interpretations other than those given in table 5.

This information, however, does not eliminate need for further investigation at sites selected for engineering works, especially those that involve heavy loads or that

[8] ALFRED H. CHRISTENSON, agricultural engineer, Soil Conservation Service, assisted in the preparation of this section.

require excavation to a depth more than those shown in table 4. Also, inspection of sites commonly is needed because many areas of a given mapping unit contain small areas of other kinds of soil that have contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used by soil scientists have special meaning to soil scientists and may be unfamiliar to engineers. The Glossary at the back of this soil survey defines many of these terms.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system used by SCS engineers, the Department of Defense, and others and the AASHO system adopted by the American Association of State Highway Officials.

In the Unified system (*9*) soils are classified according to particle-size distribution, plasticity, liquid limit, and content of organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of five-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes, for example, CL–ML.

The AASHO system (*1*) is used in classifying soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in A–7, are clay soils that have low strength when wet and are the poorest mineral soils for subgrade. If laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. The engineering value of a soil material also 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 AASHO classification for tested soils, with group index numbers in parentheses, is shown in tables 6 and 7. The estimated classification, without group index numbers, is given in table 4 for all soils mapped in Roberts County.

Engineering properties of the soils

Table 4 lists the soil series and mapping units in Roberts County and provides estimates of some of the soil properties important to engineering. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and detailed experience with the individual kind of soil in the county. Depth to bedrock is not shown, because most soils in Roberts County are deep to bedrock. In soils of the Kloten series, however, depth to shale is 9 to 20 inches.

USDA texture is determined by the relative proportions of sand, silt, and clay in soil material less than 2.0 millimeters in diameter. "Sand," "silt," "clay," and some of the other terms used in the USDA textural classification are defined in the Glossary.

The percentage of material passing the number 4, 10, 40, and 200 sieves reflects the normal range listed in table 4, but it should not be assumed that all the soils in a given series do.

Permeability, as used in table 4, relates to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on structure and porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the capacity of soils to store water available for use by plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. In table 4 it is expressed as inches of water per inch of soil.

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

Salinity of the soil is based on the electrical conductivity of the saturated soil extract, as expressed in millimhos per centimeter at 25° C. The salinity rating and salinity as millimhos per centimeter are listed below.

Salinity rating	*Salinity as millimhos per centimeter*
None	Less than 2.0
Low	2.0 to 4.0
Moderate	4.0 to 8.0
High	8.0 to 16.0
Very high	More than 16.0

Shrink-swell potential is the relative change in volume of the soil material to be expected as moisture content changes. The shrinking and swelling of soils causes much damage to foundations of buildings, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures constructed in, on, or with material having this rating.

Corrosivity, as used in table 4, indicates the potential danger to uncoated steel or concrete structures through chemical action that dissolves or weakens the structural material. Structural materials do corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than it does in others. Extensive installations of uncoated steel that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Engineering interpretations

The interpretations in table 5 are based on the estimated properties of soils shown in table 4, on test data for soils in this county or from adjacent or nearby counties, and on the experience of engineers and soil scientists with the soils of Roberts County. In table 5, ratings are given to indicate limitations or suitability for all listed uses of the soils other than for drainage of cropland and pasture, irrigation, pond reservoirs, embankments, terraces and diversions, and grassed waterways. For those particular uses, table 5 lists soil features that need to be considered in planning, installation, and maintenance.

Soil suitability is rated by the terms *good, fair,* and *poor.* These terms approximately parallel the terms *slight, moderate,* and *severe* described in the following paragraph, but they express degree of suitability rather than limitations.

Soil limitations are indicated by the ratings *slight, moderate,* and *severe. Slight* means soil properties are favorable for the rated use and that the limitations are minor or 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 and special design. The limit-

TABLE 4.—*Estimated soil*

[An asterisk in the first column indicates that this mapping unit is made up of two or more kinds of soil. The soils in such mapping units may that appear in the first column of this table. The

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		No. 4 (4.7 mm)
				Unified	AASHO	
	Feet	*Inches*				
Aastad: AaA	>5	0–18	Loam	ML or CL	A–6 or A–7	100
		18–30	Clay loam	ML or CL	A–6 or A–7	100
		30–60	Loam	ML or CL	A–6 or A–7	100
*Antler: Ac, At, AvA For Colvin part of Ac, see Colvin series. For Tonka part of At, see Tonka series. For Hamerly part of AvA, see Hamerly series.	1–4	0–8	Silt loam	CL–ML or ML	A–6 or A–7	100
		8–18	Silt loam	CL–ML or ML	A–6 or A–7	100
		18–60	Loam	CL	A–6 or A–7	95–100
*Barnes: BbE For Buse part of BbE, see Buse series.	>5	0–9	Loam	ML or CL	A–6	95–100
		9–17	Loam	ML or CL	A–6	95–100
		17–60	Clay loam	CL	A–6 or A–7	95–100
Bearden: Be	3–5	0–8	Silty clay loam	CL–ML or CL	A–6 or A–7	100
		8–60	Silty clay loam	CL–ML or CL	A–6 or A–7	100
Borup: Bo	1–3	0–8	Silt loam	ML	A–4	100
		8–19	Silt loam	ML	A–4	100
		19–60	Silt loam	ML	A–4	100
*Buse: BpF For Forman part of BpF, see Forman series.	>5	0–8	Loam	CL–ML or CL	A–4 or A–6	90–100
		8–60	Clay loam	CL–ML or CL	A–6 or A–7	90–100
Cavour Mapped only in a complex with Peever soils.	>5	0–8	Loam	ML	A–6 or A–7	100
		8–24	Clay	CH	A–7	100
		24–60	Clay loam	CL	A–6 or A–7	100
Colvin: Co	1–4	0–13	Silt loam	ML	A–4	100
		13–36	Silty clay loam	CL	A–7 or A–6	100
		36–60	Silt loam	ML	A–4 or A–6	100
Dickey: DcA, DcB	>5	0–16	Fine sandy loam	SM	A–4	100
		16–28	Loamy sand	SM	A–2 or A–4	100
		28–60	Loam	ML	A–6	100
*Divide: Dm For Marysland part, see Marysland series.	3–5	0–12	Loam	ML	A–4	100
		12–22	Loam	ML or CL	A–4 or A–6	100
		22–60	Sand and gravel	GM, SM, GW–GM, or SW–SM	A–1 or A–2	25–75
Doran: Do	>4	0–6	Loam	ML–CL or CL	A–4 or A–6	100
		6–11	Clay loam	CL	A–6 or A–7	100
		11–60	Clay loam	CL	A–6 or A–7	100
Dovray: Dv	>3	0–31	Clay	CH	A–7	100
		31–60	Clay	CH	A–7	100
*Eckman: EcA, EcB, EeC For Zell part of EeC, see Zell series.	>5	0–12	Loam	ML	A–4	100
		12–27	Silt loam	ML or CL–ML	A–4	100
		27–60	Silt loam	ML or CL–ML	A–4	100
*Embden: Eh For Hamar part, see Hamar series.	>5	0–33	Fine sandy loam	ML or SM	A–4	100
		33–60	Loamy fine sand	SM	A–2 or A–4	100
*Fordville: FdA, FeB For Renshaw part of FeB, see Renshaw series.	>5	0–22	Loam	ML or CL–ML	A–4 or A–6	100
		22–60	Sand and gravel	SM, GM, GW–GM, or SW–SM	A–1 or A–2	25–75
*Forman: FoA, FoB, FoC, FoD, FsB, FuC, FuD, FuE, FvE.	>5	0–6	Loam	ML or CL	A–6 or A–7	100

significant in engineering

have different properties and limitations, and for this reason it is necessary to follow carefully the directions for referring to other series symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete
			Inches per hour	*Inch per inch of soil*	*pH*	*Millimhos per centimeter*			
95–100	85–95	60–75	0.6–2.0	0.18–0.20	6.1–7.3	<2	Moderate	Moderate	Low.
95–100	85–95	65–80	0.6–2.0	0.17–0.20	6.6–7.8	<2	Moderate or high.	High	Low.
95–100	80–95	60–80	0.2–0.6	0.16–0.18	7.9–8.4	<2	Moderate or high.	High	Moderate.
100	85–100	70–90	0.6–2.0	0.19–0.22	7.3–8.4	2–4	Moderate	Moderate	Low.
100	85–100	70–90	0.6–2.0	0.14–0.17	7.9–8.4	2–8	Moderate	High	Low.
90–100	85–95	60–80	0.2–0.6	0.13–0.15	7.9–8.4	2–8	Moderate	High	Moderate.
90–100	70–95	50–70	0.6–2.0	0.18–0.20	6.6–7.3	<2	Moderate	Low	Low.
90–100	70–95	50–70	0.6–2.0	0.16–0.18	6.6–7.8	<2	Moderate	Low	Low.
90–100	60–95	50–80	0.2–0.6	0.17–0.20	7.9–8.4	<2	Moderate	Moderate	Moderate.
100	95–100	85–95	0.6–2.0	0.19–0.22	7.9–8.4	<2	Moderate or high.	High	Low.
100	95–100	85–95	0.06–0.2	0.14–0.17	7.9–8.4	2–8	Moderate or high.	High	Moderate.
100	90–100	70–90	0.6–2.0	0.19–0.22	7.4–8.4	<2	Low	High	Low.
100	90–100	70–90	2.0–6.0	0.14–0.17	7.9–8.4	2–4	Low	High	Low.
100	90–95	70–90	2.0–6.0	0.17–0.20	7.9–8.4	2–4	Low	High	Low.
85–100	75–95	60–80	0.6–2.0	0.18–0.20	7.4–7.8	<2	Moderate	Low	Low.
85–100	80–95	60–80	0.2–0.6	0.16–0.18	7.9–8.4	0–4	Moderate	Moderate	Moderate.
100	90–100	60–80	0.6–2.0	0.18–0.20	6.6–7.8	<2	Low	Low	Low.
100	90–100	75–95	<0.06	0.10–0.15	7.9–9.0	8–16	High	High	High.
100	90–100	70–90	0.2–0.6	0.14–0.17	7.9–8.4	8–16	High	High	High.
100	90–100	70–90	0.6–2.0	0.19–0.22	7.9–8.4	<2	Moderate	High	Low.
100	95–100	80–95	0.2–0.6	0.14–0.17	8.5–9.0	4–8	Moderate	High	Moderate.
100	90–100	70–95	0.2–0.6	0.17–0.20	7.9–9.0	4–8	Moderate	High	Moderate.
95–100	55–85	35–50	2.0–6.0	0.14–0.17	6.1–7.3	<2	Low	Low	Low.
95–100	50–75	25–50	2.0–6.0	0.08–0.10	6.6–7.3	<2	Low	Low	Low.
85–100	80–95	65–90	0.6–2.0	0.16–0.18	6.6–8.4	<2	Moderate	Low	Low.
100	85–95	60–75	2.0–6.0	0.18–0.20	7.9–8.4	<2	Low or moderate.	Low	Low.
100	85–95	60–75	2.0–6.0	0.16–0.18	7.9–8.4	<2	Low or moderate.	High	Low.
15–50	10–40	5–25	6.0–20.0	0.03–0.06	7.9–8.4	<2	Low	High	Low.
95–100	85–95	60–80	0.2–0.6	0.18–0.20	6.6–7.3	<2	Moderate	Moderate	Low.
95–100	90–100	70–85	0.06–0.2	0.19–0.22	6.6–7.8	<2	Moderate or high.	High	Low.
95–100	85–100	60–80	0.06–0.2	0.17–0.20	7.9–8.4	2–4	Moderate or high.	High	Moderate.
100	90–100	70–95	<0.06	0.10–0.14	7.4–8.4	<2	High	High	Low.
100	90–100	75–95	<0.06	0.08–0.12	7.9–8.4	<2	High	High	Moderate.
100	85–100	50–80	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
100	90–100	70–90	0.6–2.0	0.17–0.20	6.6–7.3	<2	Low	Low	Low.
100	90–100	70–90	0.6–2.0	0.17–0.20	7.4–8.4	<2	Low	Low	Low.
90–100	70–100	40–55	0.6–2.0	0.14–0.17	6.6–7.3	<2	Low	Low	Low.
100	60–100	25–50	2.0–6.0	0.08–0.10	6.6–7.3	<2	Low	Low	Low.
85–100	80–95	50–80	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
15–65	15–40	0–25	6.0–20.0	0.03–0.06	7.4–8.4	<2	Low	Low	Low.
85–100	80–100	60–85	0.6–2.0	0.18–0.20	6.6–7.3	<2	Low or moderate.	Low	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		No. 4 (4.7 mm)
				Unified	AASHO	
	Feet	*Inches*				
For Aastad part of FoA, FoB, FoC, FoD, and FsB, see Aastad series. For Buse part of FuC, FuD, FuE, and FvE, see Buse series.		6–19	Clay loam	CL–ML or CL	A–7 or A–6	95–100
		19–60	Clay loam	CL or ML	A–6 or A–7	95–100
Gardena: Ga	>5	0–18	Silt loam	ML	A–4	100
		18–60	Silt loam	ML	A–4	100
Glyndon: GyA	2–5	0–8	Silt loam	ML	A–4	100
		8–22	Silt loam	ML	A–4	100
		22–60	Silt loam	ML	A–4	100
Hamar: Ha	1–3	0–8	Fine sandy loam	SM or ML	A–4	100
		8–16	Loamy fine sand	SM	A–2 or A–4	100
		16–60	Loamy fine sand	SM	A–2 or A–4	100
*Hamerly: HbA, HcA, HcB	3–4	0–11	Loam	ML or CL	A–4 or A–6	100
For Tonka part of HbA, see Tonka series. For Vallers part of HcA and HcB, see Vallers series.		11–29	Loam	ML or CL	A–4 or A–6	100
		29–60	Loam	ML or CL	A–4 or A–6	100
*Hattie: HdD, HdE, HkD	>5	0–8	Clay loam	CL or CH	A–6 or A–7	100
For Kloten part of HkD, see Kloten series.		8–18	Clay	CH or CL	A–7	100
		18–36	Clay	CH	A–7	100
		36–60	Clay loam	CL or CH	A–6 or A–7	100
*Hecla: HmA	4–10	0–32	Loamy fine sand	SM	A–2 or A–4	100
For Hamar part, see Hamar series.		32–43	Loamy fine sand	SM	A–2 or A–4	100
		43–60	Fine sand	SM	A–2	100
*Heimdal: HsB, HsC, HvA, HvB	>5	0–11	Loam	ML or CL	A–4 or A–6	95–100
For Sisseton part of HsB, and HsC, see Sisseton series. For Svea part of HvA and HvB, see Svea series.		11–17	Loam	ML or CL	A–4 or A–6	95–100
		17–60	Loam	ML or CL	A–4 or A–6	95–100
Kloten	>5	0–6	Clay loam	CL	A–6 or A–7	100
Mapped only in complex with the Hattie soils.		6–16	Silty clay loam	CL or CH	A–7	100
		16–60	Shale.			
LaDelle: La	>4	0–60	Silt loam	CL–ML or CL	A–4 or A–6	100
Lamoure: Lm	2–5	0–27	Silty clay loam	CL–ML or MH	A–6 or A–7	100
		27–60	Silty clay loam	CL–ML or MH	A–6 or A–7	100
Loamy Fluvaquents: Lt. Estimates not made.						
Ludden: Lu	2–3	0–34	Clay	CH	A–7	100
		34–60	Clay	CH	A–7	100
Maddock: MaB, MaD	>5	0–22	Loamy fine sand	SM	A–2 or A–4	100
		22–60	Fine sand	SM	A–2	100
Marsh: Mr. Estimates not made.						
Marysland: Mw	1–4	0–12	Loam	ML	A–4	100
		12–35	Loam	ML	A–4	100
		35–60	Sand and gravel	GM, SW, or SM	A–1 or A–2	25–75
Parnell: Pa	0–4	0–18	Silty clay loam	CL or ML	A–7 or A–6	100
		18–43	Clay	CL or CH	A–7	100
		43–60	Clay loam	CL	A–6 or A–7	100
*Peever: PeA, PeB, PeC, PhA, Pk	>5	0–7	Clay loam	CL, CH, or MH	A–6 or A–7	90–100
For Cavour part of PhA, see Cavour series. For Tonka part of Pk, see Tonka series.		7–39	Clay	CL, CH, or MH	A–6 or A–7	90–100
		39–60	Clay loam	CL, CH, or MH	A–6 or A–7	90–100

significant in engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete
			Inches per hour	*Inch per inch of soil*	*pH*	*Millimhos per centimeter*			
85–100	80–100	60–90	0.6–2.0	0.17–0.20	6.6–7.8	<2	Moderate or high.	Moderate	Low.
65–100	70–100	60–80	0.2–0.6	0.17–0.20	7.9–8.4	<2	Moderate	Moderate	Moderate.
100	90–100	70–90	0.6–2.0	0.19–0.22	6.6–7.8	<2	Low	Moderate	Low.
100	90–100	70–90	0.6–2.0	0.17–0.20	7.4–8.4	<2	Low	Moderate	Low.
100	90–100	70–90	0.6–2.0	0.19–0.22	7.9–8.4	<2	Low	Moderate	Low.
100	90–100	70–90	0.6–2.0	0.14–0.17	7.9–8.4	2–4	Low	Moderate or high.	Low.
100	90–100	70–90	0.6–2.0	0.17–0.20	7.9–8.4	4–8	Low	Moderate or high.	Moderate.
100	70–90	40–55	2.0–6.0	0.14–0.17	6.6–7.3	<2	Low	Low	Low.
100	50–90	20–45	6.0–20.0	0.10–0.12	6.6–7.3	<2	Low	High	Low.
100	50–90	20–45	6.0–20.0	0.08–0.10	7.4–8.4	<2	Low	High	Low.
90–100	85–95	60–75	0.6–2.0	0.18–0.20	7.4–7.8	<2	Low	Moderate	Low.
90–100	85–95	60–75	0.6–2.0	0.13–0.15	7.9–8.4	2–4	Moderate	High	Low.
90–100	85–95	60–75	0.2–0.6	0.16–0.18	7.9–8.4	4–8	Moderate	High	Moderate.
95–100	70–100	70–85	0.2–0.6	0.16–0.19	7.4–8.4	<2	High	Moderate	Low.
95–100	85–100	75–95	0.06–0.2	0.13–0.18	7.9–8.4	<2	High	High	Low.
95–100	85–100	75–95	0.06–0.2	0.08–0.12	7.9–8.4	<2	High	High	Low.
95–100	70–100	70–85	0.2–0.6	0.14–0.17	7.9–8.4	<2	High	High	Moderate.
100	70–85	25–45	2.0–6.0	0.10–0.12	6.6–7.3	<2	Low	Low	Low.
100	70–85	25–45	2.0–6.0	0.08–0.10	6.6–7.3	<2	Low	Low	Low.
100	65–85	20–35	6.0–20.0	0.06–0.08	6.6–7.3	<2	Low	Low	Low.
90–100	75–95	50–75	2.0–6.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
90–100	75–95	50–75	2.0–6.0	0.16–0.18	6.6–7.8	<2	Low	Low	Low.
90–100	75–95	50–75	2.0–6.0	0.16–0.18	7.9–8.4	<2	Low	Low	Low.
100	90–100	70–80	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	Moderate	Low.
100	90–100	80–95	0.6–2.0	0.17–0.20	6.6–7.3	<2	Moderate	Moderate	Low.
100	90–100	70–95	0.6–2.0	0.19–0.22	7.9–8.4	0–4	Low or moderate.	High	Low.
95–100	85–100	80–95	0.6–2.0	0.19–0.22	7.9–8.4	2–4	Moderate or high.	High	Low.
95–100	85–100	80–95	0.6–2.0	0.17–0.20	7.9–8.4	2–8	Moderate or high.	High	Low.
100	90–100	75–95	<0.06	0.10–0.14	7.9–8.4	2–4	High	High	Moderate.
100	90–100	75–95	<0.06	0.08–0.12	7.9–8.4	4–8	High	High	Moderate.
100	70–85	25–45	6.0–20.0	0.10–0.12	6.6–7.3	<2	Low	Low	Low.
100	65–80	20–35	6.0–20.0	0.06–0.08	6.6–7.3	<2	Low	Low	Low.
100	85–95	60–75	0.6–2.0	0.18–0.20	7.9–8.4	<2	Low	Moderate	Low.
100	85–95	60–75	2.0–6.0	0.13–0.15	7.9–8.4	<2	Low	High	Low.
15–50	10–40	0–25	6.0–20.0	0.03–0.06	7.9–8.4	<2	Low	High	Low.
100	95–100	60–95	0.2–0.6	0.16–0.19	6.6–7.3	<2	Moderate or high.	High	Low.
100	90–100	70–95	0.06–0.2	0.13–0.18	6.6–7.8	<2	High	High	Low.
95–100	75–100	60–80	0.06–0.2	0.17–0.20	7.4–7.8	<2	Moderate or high.	High	Low.
90–100	85–95	70–90	0.2–0.6	0.16–0.19	6.6–7.3	<2	Moderate or high.	Moderate	Low.
90–100	80–95	70–95	0.06–0.2	0.11–0.16	6.6–8.4	<2	High	High	Low.
90–100	85–95	70–95	0.2–0.6	0.14–0.17	7.9–8.4	<2	Moderate or high.	High	Moderate.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		No. 4 (4.7 mm)
				Unified	AASHO	
	Feet	*Inches*				
Playmoor: Pm	1–3	0–38	Silty clay loam	CL–ML or MH	A–6 or A–7	100
		38–60	Silty clay loam	CL–ML or MH	A–6 or A–7	100
Poinsett: PoA, PoB	>5	0–6	Silt loam	ML or CL	A–6 or A–4	100
		6–25	Silty clay loam	CL–ML or CL	A–6 or A–7	100
		25–60	Silt loam	ML or CL	A–6 or A–4	100
Rauville: Ra	0–4	0–27	Mucky silt loam	OL or ML	A–4	100
		27–60	Silt loam	CL–ML or ML	A–4	100
*Renshaw: ReA, ReB, RhB, RhD, RsE For Sioux part of RhB, RhD, and RsE, see Sioux series.	>5	0–15	Loam	ML	A–4	100
		15–60	Sand and gravel	GM, SM, GW–GM, or SW–SM	A–1 or A–2	30–70
Rentill: RtA, RtB	>5	0–12	Loam	ML or CL	A–4 or A–6	90–100
		12–21	Sand and gravel	GM, SM, GP, or SP	A–1 or A–2	25–75
		21–37	Clay	CL or CH	A–7 or A–6	90–100
		37–60	Clay loam	CL or CH	A–7 or A–6	90–100
Sandy lake beaches: Sb. Estimates not made.						
Sieche: ScF	>5	0–9	Loam	ML or CL	A–4 or A–6	100
		9–24	Clay loam	CL or CH	A–6 or A–7	100
		24–60	Clay loam	CL or CH	A–6 or A–7	100
Siani: SnA, SnB	>5	0–17	Silty clay	MH or CH	A–7	100
		17–44	Silty clay	MH or CH	A–7	100
		44–60	Clay	CL or CH	A–7	100
Sioux Mapped only in a complex with the Renshaw soils.	>5	0–7	Loam	ML or CL	A–4 or A–6	100
		7–60	Sand and gravel	GM, GP, SM, or SP	A–1 or A–2	25–75
*Sisseton: SsF, StD For Heimdal part of StD, see Heimdal series.	>5	0–36	Loam	CL–ML or CL	A–4	90–100
		36–60	Silt loam	CL–ML or CL	A–4	90–100
Svea: SvC	>5	0–25	Loam	ML or CL	A–4 or A–6	95–100
		25–60	Loam	CL–ML or CL	A–4 or A–6	95–100
Sverdrup: SwA, SwB	>5	0–14	Sandy loam	SM	A–2 or A–4	100
		14–22	Sandy loam	SM	A–2 or A–4	100
		22–60	Sand	SP–SM or SM	A–3, A–2, or A–4	100
Tonka: Tk	0–4	0–18	Silt loam	ML or CL	A–4 or A–6	100
		18–39	Clay	CL or CH	A–7	100
		39–48	Clay	CH	A–7	100
		48–60	Clay loam	CL or CH	A–6 or A–7	100
Towner: To	2–3	0–8	Fine sandy loam	SM	A–4	100
		8–25	Loamy fine sand	SM	A–2 or A–4	100
		25–35	Loam	ML or CL	A–4 or A–6	100
		35–60	Loam	ML or CL	A–4 or A–6	100
Ulen: Un	2–4	0–7	Sandy loam	SM	A–4 or A–2	100
		7–20	Sandy loam	SM	A–4 or A–2	100
		20–35	Loamy sand	SM	A–2	100
		35–60	Sand	SM	A–2	100
*Vallers: VhA For Hamerly part, see Hamerly series.	2–4	0–9	Loam	ML or CL	A–4 or A–6	100

significant in engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete
			Inches per hour	*Inch per inch of soil*	*pH*	*Millimhos per centimeter*			
100	90–100	70–95	0.2–0.6	0.19–0.22	7.9–8.4	4–8	Moderate or high.	High	Moderate.
100	90–100	70–95	0.2–0.6	0.17–0.20	7.9–8.4	8–16	Moderate or high.	High	Moderate.
100	90–100	70–90	0.6–2.0	0.19–0.22	6.6–7.3	<2	Low or moderate.	Low	Low.
100	90–100	70–95	0.6–2.0	0.17–0.20	6.6–8.4	<2	Moderate	Moderate	Low.
90–100	85–100	60–90	0.6–2.0	0.17–0.20	7.9–8.4	<2	Moderate	Moderate	Low.
100	90–100	70–90	0.6–2.0	0.19–0.22	7.4–8.4	2–4	Moderate	High	Low.
100	90–100	70–90	0.2–0.6	0.17–0.20	7.4–8.4	2–4	Moderate	High	Low.
90–100	85–95	60–75	2.0–6.0	0.18–0.20	6.6–7.3	<2	Low	Low	Low.
15–50	15–50	0–30	6.0–20.0	0.03–0.06	7.4–8.4	<2	Low	Low	Low.
90–100	85–95	60–75	0.6–2.0	0.18–0.20	6.6–7.8	<2	Low	Low	Low.
15–50	10–40	0–25	6.0–20.0	0.03–0.06	7.9–8.4	<2	Low	Low	Low.
90–100	85–95	70–95	0.06–0.6	0.11–0.16	7.9–8.4	<2	High	High	Low.
90–100	85–95	70–95	0.06–0.6	0.14–0.17	7.9–8.4	<2	Moderate or high.	Moderate	Low.
100	85–95	60–75	0.6–2.0	0.18–0.20	6.1–7.3	<2	Low or moderate.	Low	Low.
100	85–95	70–95	0.6–2.0	0.16–0.19	6.1–7.3	<2	Moderate or high.	Moderate	Low.
100	90–100	70–95	0.2–0.6	0.17–0.20	7.9–8.4	<2	Moderate or high.	Moderate	Moderate.
95–100	85–100	80–95	0.06–0.2	0.13–0.18	6.6–7.3	<2	High	High	Low.
95–100	85–100	80–95	0.06–0.2	0.11–0.16	7.4–8.4	<2	High	High	Low.
100	90–100	70–95	0.06–0.2	0.11–0.16	7.9–8.4	<2	High	High	Low.
100	85–95	60–75	2.0–6.0	0.18–0.20	6.6–7.8	<2	Low	Low	Low.
20–50	8–35	0–25	0.6–20.0	0.03–0.06	7.9–8.4	<2	Low	Low	Low.
85–100	80–90	60–90	0.6–2.0	0.13–0.15	7.9–8.4	<2	Low or moderate.	Low	Low.
85–100	80–90	60–90	0.6–2.0	0.14–0.17	7.9–8.4	<2	Low or moderate.	Low	Low.
90–100	85–95	60–75	0.6–2.0	0.18–0.20	6.6–7.8	<2	Low	Moderate	Low.
90–100	85–100	60–80	0.06–0.2	0.16–0.18	7.9–8.4	<2	Moderate	Moderate	Low.
100	60–100	25–50	2.0–6.0	0.11–0.15	6.6–7.3	<2	Low	Low	Low.
100	65–100	25–50	2.0–6.0	0.09–0.13	6.6–7.3	<2	Low	Low	Low.
70–100	50–80	5–50	2.0–6.0	0.06–0.08	7.4–8.4	<2	Low	Low	Low.
100	90–100	70–90	0.6–2.0	0.19–0.22	6.6–7.3	<2	Low	Low	Low.
100	85–100	70–95	0.06–0.2	0.13–0.18	6.6–7.3	<2	High	High	Low.
100	85–100	70–95	0.06–0.2	0.11–0.16	6.6–7.3	<2	High	High	Low.
100	85–100	70–90	0.2–0.6	0.17–0.20	6.6–7.8	<2	Moderate or high.	High	Low.
100	50–75	35–50	2.0–6.0	0.14–0.17	6.6–7.3	<2	Low	Low	Low.
100	50–75	15–40	6.0–20.0	0.10–0.12	6.6–7.3	<2	Low	Low	Low.
100	85–95	60–75	0.06–0.2	0.16–0.18	6.6–7.3	2–4	Low or moderate.	Moderate	Low.
100	85–95	60–75	0.06–0.2	0.16–0.18	7.9–8.4	2–4	Moderate	Moderate	Low.
100	70–85	25–45	2.0–6.0	0.11–0.15	7.4–7.8	<2	Low	Low	Low.
100	70–85	25–45	2.0–6.0	0.09–0.13	7.9–8.4	<2	Low	Moderate	Low.
100	50–75	15–30	6.0–20.0	0.08–0.10	7.9–8.4	<2	Low	Moderate	Low.
90–100	50–75	10–30	6.0–20.0	0.06–0.08	7.9–8.4	<2	Low	Moderate	Low.
95–100	85–95	60–75	0.6–2.0	0.18–0.20	7.9–8.4	2–4	Low or moderate.	High	Low.

TABLE 4.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		No. 4 (4.7 mm)
				Unified	AASHTO	
Vallers (Continued)	*Feet*	*Inches*				
		9–27	Loam	ML or CL	A–4 or A–6	100
		27–60	Loam	ML or CL	A–4 or A–6	100
Vienna: VnA, VnB, VnC	>5	0–11	Silt loam	CL–ML or ML	A–4 or A–6	100
		11–21	Loam	ML or CL	A–4 or A–6	100
		21–60	Clay loam	CL–ML or CL	A–6 or A–7	100
Waubay: Wa	>5	0–18	Silty clay loam	CL–ML or CL	A–6 or A–7	100
		18–47	Silty clay loam	CL	A–6 or A–7	100
		47–60	Silty clay	CL or CH	A–7	100
*Zell: ZeD	>5	0–6	Silt loam	ML	A–4	100
For Eckman part, see Eckman series.		6–60	Silt loam	ML	A–4	100

TABLE 5.—*Interpretations of*

[An asterisk in the first column indicates that this mapping unit is made up of two or more kinds of soil. The soils in such mapping units may have the first column

Soil series and map symbols	Degree and kinds of limitations for—						Road fill
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	
Aastad: AaA	Severe: moderately slow permeability in substratum.	Slight if slopes are 0 to 2 percent. Moderate if slopes are 2 to 6 percent. Severe if slopes are greater than 6 percent.	Moderate: clay loam subsoil; moderately well drained.	Moderate or severe: moderate or high shrink-swell potential.	Moderate: loam and clay loam; moderately well drained.	Moderate or severe: moderate or high shrink-swell potential.	Fair to poor: moderate or high shrink-swell potential.
*Antler: Ac, At, Ava For Colvin part of Ac, see Colvin series. For Tonka part of At, see Tonka series. For Hamerly part of AvA, See Hamerly series.	Severe: moderately slow permeability; seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: somewhat poorly drained or poorly drained; seasonal high water table.	Severe: somewhat poorly drained; high susceptibility to frost heave.	Poor: somewhat poorly drained or poorly drained; high susceptibility to frost action.
*Barnes: BbE For Buse part, see Buse series.	Severe: moderately slow permeability in substratum.	Severe: slopes are more than 9 percent.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Moderate: moderate shrink-swell potential. Severe if slopes are more than 15 percent.	Slight or moderate: loam and clay loam. Moderate if slopes are more than 15 percent.	Moderate: moderate shrink-swell potential. Severe if slopes are more than 15 percent.	Fair: moderate shrink-swell potential.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						Uncoated steel	Concrete
			Inches per hour	*Inch per inch of soil*	*pH*	*Millimhos per centimeter*			
95–100	85–95	60–75	0.2–0.6	0.13–0.15	7.9–8.4	4–8	Low or moderate.	High	Moderate.
95–100	85–100	60–80	0.2–0.6	0.16–0.18	7.9–8.4	4–8	Moderate	High	Moderate.
100	90–100	70–90	0.6–2.0	0.19–0.22	6.6–7.3	<2	Low or moderate.	Low	Low.
95–100	85–100	60–90	0.6–2.0	0.16–0.18	7.4–7.8	<2	Low or moderate.	Low	Low.
95–100	80–100	60–80	0.2–0.6	0.17–0.20	7.9–8.4	<2	Moderate	Moderate	Low.
100	90–100	70–95	0.6–2.0	0.19–0.22	6.6–7.8	<2	Moderate	High	Low.
100	90–100	70–95	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate or high.	High	Low.
100	90–100	90–95	0.2–0.6	0.11–0.16	7.9–8.4	<2	High	High	Low.
100	90–100	70–90	0.6–2.0	0.19–0.22	7.9–8.4	<2	Low	Low	Low.
100	90–100	70–90	0.6–2.0	0.17–0.20	7.9–8.4	<2	Low	Low	Low.

engineering properties of the soils

different properties and limitations, and for this reason it is necessary to follow carefully the directions for referring to other series that appear in of this table]

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuitable	Good	Moderate permeability in subsoil; moderately slow permeability in substratum.	Fair to good compaction characteristics; low permeability when compacted; medium to high compressibility.	Moderately well drained; moderately slow permeability in substratum.	Moderately slow intake rate; high available water capacity.	Moderate permeability in subsoil; loam and clay loam.	High available water capacity; moderately well drained; moderate permeability in subsoil.
Unsuitable	Fair or poor: somewhat poorly drained or poorly drained.	Moderately slow permeability; seasonal high water table.	Fair to good stability and compaction characteristics; medium compressibility; good resistance to seepage and piping.	Seasonal high water table; moderately slow permeability.	Moderate or high available water capacity; seasonal high water table at a depth of 1 foot to 4 feet.	Structure is generally not needed because soils are level.	Generally not needed because soils are level.
Unsuitable	Fair if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Moderately slow permeability in substratum; steep slopes; low storage capacity.	Fair to good stability and compaction characteristics; medium to high compressibility, good resistance to piping.	Well drained; steep slopes.	Moderately slow intake rate; high available water capacity; steep slopes.	Short steep slopes; moderate permeability in subsoil.	Erosion hazard on the steep slopes.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						Road fill
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	
Bearden: Be	Severe: slow permeability; seasonal water table.	Moderate or severe: seasonal high water table at a depth of 3 to 5 feet.	Severe: seasonal water table.	Severe: somewhat poorly drained; moderate or high shrink-swell potential.	Severe: seasonal water table.	Severe: somewhat poorly drained; moderate or high shrink-swell potential; high susceptibility to frost action.	Fair or poor: moderate or high shrink-swell potential.
Borup: Bo	Severe: seasonal high water table.	Severe: seasonal high water table; possible pollution hazard.	Severe: seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; moderately rapid permeability; possible pollution hazard.	Severe: poorly drained; high susceptibility to frost action.	Poor: poorly drained; high susceptibility to frost action.
*Buse: BpF For Forman part, see Forman series.	Severe: moderately slow permeability in substratum.	Severe: slopes are more than 6 percent.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Moderate: moderate shrink-swell potential. Severe if slopes are more than 15 percent.	Slight if slopes are less than 15 percent. Moderate if slopes are 15 to 25 percent. Severe if slopes are more than 25 percent.	Moderate: moderate shrink-swell potential. Severe if slopes are more than 15 percent.	Fair: moderate shrink-swell potential. Poor if slopes are more than 25 percent.
Cavour Mapped only in a complex with the Peever soils.	Severe: very slow permeability.	Slight	Moderate or severe: clay and clay loam; moderately well drained.	Severe: high shrink-swell potential.	Moderate or severe: clay loam and clay.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Colvin: Co	Severe: seasonal high water table; subject to flooding.	Severe: high water table; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; seasonal high water table; subject to flooding.	Severe: poorly drained; seasonal high water table; subject to flooding.	Severe: poorly drained; high potential frost action.	Poor: poorly drained.
Dickey: DcA, DcB	Moderate: moderate permeability at a depth of 28 inches.	Moderate: moderate permeability at a depth of 28 inches.	Slight	Moderate: moderate shrink-swell potential.	Slight	Moderate: moderate shrink-swell potential.	Good to fair: moderate shrink-swell potential below a depth of 28 inches.
*Divide: Dm For Marysland part, see Marysland series.	Severe: high water table; possible pollution hazard.	Severe: high water table; moderately rapid permeability; possible pollution hazard.	Severe: seasonal high water table.	Moderate or severe: seasonal high water table.	Severe: moderately rapid permeability; possible pollution hazard; seasonal high water table.	Moderate: somewhat poorly drained.	Fair: somewhat poorly drained; moderate susceptibility to frost action.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Fair: silty clay loam.	Slow permeability; seasonal water table.	Fair to good stability and compaction characteristics; low seepage; medium to high compressibility.	Slow permeability; seasonal water table.	Moderately slow intake rate; moderate or high available water capacity; seasonal water table.	Slow permeability; clayey; moderately alkaline.	Somewhat poorly drained; slow permeability.
Unsuited	Poor: poorly drained.	Seasonal high water table; moderately rapid permeability.	Fair to poor stability and compaction characteristics; medium compressibility.	Poorly drained; high water table.	High available water capacity; high water table; poorly drained.	Structure is generally not needed because soils are level.	Structure is generally not needed because soils are level.
Unsuited	Poor: thin topsoil; slopes are more than 15 percent in places.	Steep slopes; low storage potential; moderately slow permeability in substratum.	Fair to good stability and compaction characteristics; good resistance to piping; medium to high compressibility.	Rapid surface runoff on steep slopes; well drained.	Moderately slow intake rate; high available water capacity; steep slopes.	Steep slopes; erosion hazard on outlet; moderately slow permeability in substratum.	Erosion hazard on the steep slopes; moderate permeability.
Unsuited	Fair in upper 8 inches; poor below that depth.	Very slow permeability.	Fair to poor stability and compaction characteristics; medium to high compressibility; low seepage; good resistance to piping.	Very slow permeability.	Unsuited	Very slow permeability	Claypan subsoil at shallow depths; moderate to high available water capacity; moderately well drained.
Unsuited	Poor: poorly drained.	Moderately slow permeability; seasonal high water table.	Fair stability and compaction characteristics; medium compressibility; moderate to low permeability when compacted.	Poorly drained: seasonal high water table; subject to flooding.	Poorly drained; seasonal high water table.	Not applicable	Not applicable.
Unsuited	Good in upper 16 inches; poor below that depth.	Somewhat excessively drained; moderate permeability below a depth of 28 inches.	Fair to good stability and compaction characteristics; low to moderate permeability when compacted.	Somewhat excessively drained.	Moderate or high available water capacity; moderate intake rate; hazard of soil blowing.	Susceptible to soil blowing; somewhat excessively drained.	Subject to water erosion; somewhat excessively drained.
Poor: high water table; excessive fines.	Good	Seasonal high water table; rapid permeability in sand and gravel.	Fair to good stability and compaction characteristics; slight to medium compressibility; poor to good resistance to piping.	Seasonal high water table at a depth of 3 to 5 feet; moderately well drained to somewhat poorly drained; rapid permeability in substratum.	Moderately slow intake rate; seasonal high water table; low or moderate available water capacity.	Not applicable	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						Road fill
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	
Doran: Do	Severe: slow permeability.	Slight	Moderate: seasonal water table below a depth of 4 feet.	Moderate or severe: moderate or high shrink-swell potential; moderate potential frost action.	Moderate: clay loam; somewhat poorly drained.	Moderate or severe: moderate or high shrink-swell potential; moderate susceptibility to frost action.	Fair or poor: moderate or high shrink-swell potential; moderate susceptibility to frost action.
Dovray: Dv	Severe: very slow permeability.	Slight	Severe: clay; poorly drained.	Severe: high shrink-swell potential; poorly drained.	Severe: clay; poorly drained.	Severe: high shrink-swell potential; poorly drained.	Poor: high shrink-swell potential; poorly drained.
*Eckman: EcA, EcB, EeC. For Zell part of EeC, see Zell series.	Slight to moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Slight	Slight	Moderate: ML material that has plasticity index of less than 15.	Fair: ML material that has plasticity index of less than 15.
*Embden: Eh For Hamar part, see Hamar series.	Slight	Severe: moderately rapid permeability; possible pollution hazard.	Moderate: moderately well drained.	Slight or moderate: moderately well drained.	Severe: moderately rapid permeability; possible pollution hazard.	Slight or moderate: moderate if fines of more than 30 percent.	Good or fair: fair if fines of more than 30 percent.
*Fordville: FdA, FeB. For Renshaw part of FeB, see Renshaw series.	Slight: possible pollution hazard.	Severe: rapid permeability in substratum; pollution hazard.	Severe: sand and gravel below a depth of 20 inches.	Slight	Severe: rapid permeability in sand and gravel; pollution hazard.	Slight	Good below a depth of 20 inches; fair above.
*Forman: FoA, FoB, FoC, FoD, FsB, FuC, FuD, FuE, FvE. For Aastad part of FoA, FoB, FoC, FoD, and FsB, see Aastad series. For Buse part of FuC, FuD, FuE, and FvE, see Buse series.	Severe: moderately slow permeability in the underlying material.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 6 percent. Severe if slopes are more than 6 percent.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Moderate or severe: moderate or high shrink-swell potential. Severe if slopes are more than 15 percent.	Moderate: loam and clay loam. Severe if slopes are more than 25 percent.	Moderate or severe: moderate or high shrink-swell potential. Severe if slopes are more than 15 percent.	Fair or poor: moderate or high shrink-swell potential. Poor if AASHO group index is more than 8.
Gardena: Ga	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: moderately well drained.	Moderate: moderately well drained.	Slight	Severe: high susceptibility to frost action.	Poor: high susceptibility to frost action.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Good to a depth of 6 inches; fair at a depth of 6 to 11 inches.	Slow permeability; seasonal water table below a depth of 4 feet.	Fair to good stability and compaction characteristics; medium compressibility; low seepage rate.	Slow permeability; somewhat poorly drained; water table below a depth of 4 feet.	Moderately slow intake rate; high available water capacity.	Not applicable	Not applicable.
Unsuited	Poor: poorly drained; clay.	Very slow permeability; seasonal water table.	Poor stability and compaction characteristics; high compressibility; good resistance to piping; low seepage.	Poorly drained; water table below a depth of 4 feet; clay; very slow permeability.	Very slow intake rate; low or moderate available water capacity.	Not applicable	Not applicable.
Unsuited	Good	Moderate permeability.	Fair to poor stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Moderate permeability; well drained.	Moderate intake rate; high available water capacity.	Subject to erosion and soil blowing; channels subject to siltation.	Slopes subject to water erosion; high available water capacity.
Unsuited	Good	Moderately rapid permeability; possible pollution hazard.	Fair to poor stability and compaction characteristics; medium compressibility; poor resistance to piping.	Moderately well drained; moderately rapid permeability.	Moderately rapid intake rate; moderate available water capacity.	Subject to soil blowing; moderately rapid permeability.	Moderate available water capacity; moderately rapid permeability.
Good to fair below a depth of 20 inches, depending on amount of fines.	Good	Rapid permeability in sand and gravel.	Fair stability and compaction characteristics; slight to medium compressibility; poor resistance to piping.	Well drained; sand and gravel below a depth of 20 inches.	Low or moderate available water capacity; moderate intake rate; sand and gravel below a depth of 20 inches.	Underlain with sand and gravel; rapid permeability below a depth of 20 inches.	Low or moderate available water capacity.
Unsuited	Good in upper 6 inches; fair below that depth.	Moderate permeability in subsoil; moderately slow in substratum.	Fair to good stability and compaction characteristics; medium compressibility; good resistance to piping.	Well drained	Slow intake rate; high available water capacity; erosion hazard if sloping.	Short irregular slopes; moderate permeability in subsoil.	Well drained; high available water capacity; erosion hazard if sloping.
Unsuited	Good	Moderate permeability; water table at a depth of 5 feet.	Fair to poor stability and compaction characteristics; medium compressibility; fair to poor resistance to piping.	Moderately well drained; moderate permeability.	Moderately slow intake rate; high available water capacity.	Not applicable	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	Road fill
Glyndon: GyA	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Moderate or severe: moderately well drained or somewhat poorly drained; high water table; high potential frost action.	Severe: seasonal high water table.	Severe: severe susceptibility to frost action; somewhat poorly drained or moderately well drained.	Poor: high susceptibility to frost action.
Hamar: Ha	Severe: high water table.	Severe: high water table; rapid permeability; pollution hazard.	Severe: somewhat poorly drained or poorly drained; seasonal high water table; sandy.	Severe: somewhat poorly drained or poorly drained; seasonal high water table.	Severe: rapid permeability; seasonal high water table.	Moderate or severe: somewhat poorly drained or poorly drained; moderately susceptible to frost action.	Fair or poor: somewhat poorly drained or poorly drained; moderately susceptible to frost action.
*Hamerly: HbA, HcA, HcB. For Tonka part of HbA, see Tonka series. For Vallers part of HcA, and HcB, see Vallers series.	Severe: seasonal water table; moderately slow permeability in substratum.	Moderate or severe: seasonal water table.	Moderate or severe: moderately well drained or somewhat poorly drained; seasonal water table at a depth of 3 to 4 feet.	Moderate or severe: moderately well drained or somewhat poorly drained.	Severe: seasonal water table.	Severe: high susceptibility to frost action; seasonal water table.	Fair: moderate shrink-swell potential.
*Hattie: HdD, HdE, HkD. For Kloten part of HkD, see Kloten series.	Severe: slow permeability.	Severe: slopes are more than 6 percent.	Severe: clayey.	Severe: high shrink-swell potential.	Severe: clay and clay loam.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Hecla: HmA. For Hamar part, see Hamar series.	Slight: possible pollution hazard.	Severe: moderately rapid permeability; pollution hazard.	Severe: sandy.	Slight or moderate: moderately well drained; water table below a depth of 4 feet.	Severe: moderately rapid permeability; possible pollution hazard.	Slight or moderate: moderate if fines are more than 30 percent.	Good or fair: fair if fines are more than 30 percent.
*Heimdal: HsB, HsC, HvA, HvB. For Sisseton part of HsB and HsC, see Sisseton series. For Svea part of HvA and HvB, see Svea series.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Severe: moderately rapid permeability.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Severe: moderately rapid permeability.	Moderate: ML or CL material that has plasticity index of less than 15; severe if slopes are more than 15 percent.	Fair: ML or CL material that has plasticity index of less than 15.
Kloten. Mapped only in a complex with the Hattie soils.	Severe: steep slopes; shale at a depth of 16 inches.	Severe: steep slopes.	Severe: steep slopes; shale at a depth of 16 inches.	Severe: shale at a depth of 16 inches.	Severe: steep slopes; shale at a depth of 16 inches.	Severe: shale at a depth of 16 inches.	Poor: shale at a depth of 16 inches.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Good	Moderate permeability; high water table.	Fair to poor stability and compaction characteristics; medium compressibility; fair to poor resistance to piping.	Moderately well drained or somewhat poorly drained; seasonal high water table; moderate permeability.	Moderately slow intake rate; high available water capacity; water table at a depth of 2 to 5 feet.	Not applicable	Not applicable.
Unsuited	Good in upper 8 inches; poor below that depth; sandy.	High water table; rapid permeability; sandy.	Fair to good stability and compaction characteristics; susceptible to seepage and piping.	Somewhat poorly drained or poorly drained; seasonal high water table.	Low or moderate available water capacity; moderately rapid intake rate; seasonal high water table.	Not applicable	Not applicable.
Unsuited	Fair in upper 11 inches.	Moderate permeability in subsoil; seasonal water table.	Fair to good stability and compaction characteristics; medium compressibility; poor to good resistance to piping.	Moderately well drained or somewhat poorly drained; seasonal water table at a depth of 3 to 4 feet.	High available water capacity; moderately slow intake rate; seasonal water table at a depth of 3 to 4 feet.	Short, irregular slopes; high lime content; moderate permeability in subsoil.	High available water capacity; high lime content; moderately well drained or somewhat poorly drained.
Unsuited	Fair in upper 8 inches if slopes are less than 15 percent; poor if more than 15 percent.	Slow permeability; steep slopes.	Fair to poor stability and compaction characteristics; medium to high compressibility; good resistance to piping.	Well drained	Slow intake rate; moderate available water capacity; steep slopes.	Clayey subsoil; slow permeability; erosion hazard.	Clayey subsoil; erosion hazard; moderate available water capacity.
Unsuited	Poor: sandy	Moderately rapid permeability; water table at a depth of 4 to 10 feet.	Fair to good stability and compaction characteristics; susceptibility to seepage and piping.	Moderately well drained; sandy; water table at a depth of 4 to 10 feet.	Low or moderate available water capacity; very rapid intake rate.	Sandy; moderately rapid permeability; soil blowing hazard.	Sandy; low or moderate available water capacity; subject to soil blowing.
Unsuited	Good	Moderately rapid permeability; possible seepage.	Fair stability and compaction characteristics; medium compressibility; poor to good resistance to piping.	Well drained; moderately rapid permeability.	Moderate intake rate; high available water capacity.	Short irregular slopes; moderately rapid permeability.	Erosion hazard on slopes; high available water capacity; situation hazard.
Unsuited	Poor: steep slopes.	Shallow to shale; seepage may be excessive in fractured shale.	Shale at a depth of 16 inches; may be subject to slippage.	Well drained	Not applicable	Shale at a depth of 16 inches; steep slopes	Erosion hazard where shale is exposed on steep slopes.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						Road fill
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	
LaDelle: La-----	Severe: seasonal water table at a depth of 4 feet; subject to flooding.	Severe: moderate permeability; subject to flooding.	Severe: seasonal water table; subject to flooding.	Severe: subject to occasional flooding.	Severe: seasonal water table; subject to occasional flooding.	Severe: high susceptibility to frost action; subject to flooding.	Poor: high susceptibility to frost action.
Lamoure: Lm ---	Severe: high water table; subject to flooding.	Severe: high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Poor: poorly drained; moderate or high shrink-swell potential; high susceptibility to frost action.
Loamy Fluvaquents: Lt. Interpretations not made.							
Ludden: Lu-----	Severe: very slow permeability; high water table.	Severe: subject to flooding.	Severe: poorly drained; subject to flooding; high water table.	Severe: poorly drained; high shrink-swell potential.	Severe: flooding hazard; high water table.	Severe: poorly drained; subject to flooding; high shrink-swell potential.	Poor: high shrink-swell potential.
Maddock: MaB, MaD.	Slight if slopes are less than 9 percent. Moderate if slopes are more than 9 percent. Severe if slopes are more than 15 percent.	Severe: rapid permeability; pollution hazard.	Severe: sandy.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Severe: rapid permeability; pollution hazard.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Good if slopes are less than 15 percent. Fair if slopes are more than 15 percent.
Marsh: Mr. Interpretations not made.							
Marysland: Mw -	Severe: seasonal high water table; pollution hazard.	Severe: high water table; pollution hazard.	Severe: high water table; poorly drained.	Severe: poorly drained; high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high water table; high susceptibility to frost action.	Poor: poorly drained.
Parnell: Pa -----	Severe: ponded; slow permeability.	Severe: subject to ponding; high water table. Slight if water is not likely to enter or damage lagoon.	Severe: poorly drained or very poorly drained; subject to ponding.	Severe: poorly drained or very poorly drained; high shrink-swell potential; subject to ponding.	Severe: poorly drained or very poorly drained; subject to ponding.	Severe: poorly drained or very poorly drained; high shrink-swell potential; high susceptibility to frost action.	Poor: high shrink-swell potential; poorly drained or very poorly drained.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Good	Moderate permeability; seasonal water table below a depth of 4 feet.	Fair stability and compaction characteristics; medium compressibility; poor to good resistance to seepage and piping.	Subject to occasional flooding; seasonal water table at a depth of more than 4 feet; moderately well drained; moderate permeability.	High available water capacity; moderately slow water intake rate; seasonal water table below a depth of 4 feet.	Structure is generally not needed.	Generally not needed.
Unsuited	Poor: poorly drained.	High water table; moderate permeability.	Fair to poor stability and compaction characteristics; medium to high compressibility; good resistance to seepage and piping.	Poorly drained; water table at a depth of 2 to 5 feet; subject to flooding.	Slow intake rate; subject to flooding; high available water capacity.	Structure is generally not needed.	Generally not needed.
Unsuited	Poor: poorly drained.	High water table; very slow permeability.	Poor stability and compaction characteristics; good resistance to piping.	Poorly drained; very slow permeability; subject to flooding.	Very slow intake rate; low or moderate available water capacity; subject to flooding.	Not applicable	Not applicable.
Fair to poor for sand; excessive fines.	Poor: loamy sand.	Rapid permeability.	Fair to good stability and compaction characteristics; poor resistance to piping; low compressibility.	Well drained; rapid permeability; sandy.	Low available water capacity; rapid intake rate.	Sandy; rapid permeability; soil blowing hazard.	Low available water capacity; soil blowing hazard; difficult to vegetate.
Poor: high water table; may have excessive fines.	Poor: poorly drained.	Rapid permeability in underlying sand and gravel; high water table.	Poor stability and compaction characteristics; medium compressibility; poor resistance to piping.	Poorly drained; high water table; rapid permeability in underlying sand and gravel.	Poorly drained; moderately slow intake rate; high water table.	Not applicable	Not applicable.
Unsuited	Poor: poorly drained or very poorly drained.	Slow permeability; high water table; subject to ponding.	Fair to poor stability and compaction characteristics; good resistance to seepage and piping.	Poorly drained or very poorly drained; depressions; slow permeability.	Slow intake rate; subject to ponding; high available water capacity.	Not applicable	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	Road fill
*Peever: PeA, PeB, PeC, PhA, Pk. For Cavour part of PhA, see Cavour series. For Tonka part of Pk, see Tonka series.	Severe: slow permeability.	Slight in nearly level areas. Moderate if slopes are 2 to 6 percent. Severe if slopes are more than 6 percent.	Moderate or severe: clay or clay loam.	Severe: high shrink-swell potential.	Moderate or severe: clay loam or clay.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Playmoor: Pm	Severe: seasonal high water table.	Severe: high water table; subject to flooding.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; subject to flooding; high water table.	Severe: poorly drained; subject to flooding; high water table.	Severe: poorly drained; moderate or high shrink-swell potential; subject to flooding.	Poor: poorly drained; moderate or high shrink-swell potential; high susceptibility to frost action.
Poinsett: PoA, PoB.	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Slight	Severe: AASHO group index more than 8.	Poor: AASHO group index more than 8.
Rauville: Ra	Severe: high water table.	Severe: high water table; very poorly drained.	Severe: very poorly drained; high water table.	Severe: very poorly drained; high water table.	Severe: very poorly drained.	Severe: very poorly drained; high water table; high susceptibility to frost action.	Poor: very poorly drained; high susceptibility to frost action.
*Renshaw: ReA, ReB, RhB, RhD, Rse. For Sioux part of RhB, RhD, and RsE, see Sioux series.	Slight: possible pollution hazard.	Severe: rapid permeability in sand and gravel; pollution hazard.	Moderate or severe: sand and gravel substratum.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Severe: rapid permeability in sand and gravel; possible pollution hazard.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Good below a depth of 15 inches. Fair if slopes are 15 to 25 percent. Poor if slopes are more than 25 percent.
Rentill: RtA, RtB.	Severe: moderately slow permeability or slow permeability below a depth 21 inches.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 6 percent.	Moderate or severe: clay loam and clay in substratum.	Severe: high shrink-swell potential.	Moderate or severe: clay loam and clay in substratum.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential below a depth of of 21 inches.
Sandy lake beaches: Sb. Interpretations not made.							
Sieche: ScF	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Severe: slopes are more than 15 percent.	Moderate if slopes are 15 to 25 percent. Severe if slopes are more than 25 percent.	Severe: slopes are more than 15 percent.	Fair or poor: moderate or high shrink-swell potential; poor if slopes are more than 25 cent.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Fair to a depth of 7 inches; clay loam; poor below that depth.	Slow permeability; low seepage.	Fair to poor stability and compaction characteristics; good resistance to seepage and piping.	Well drained; nearly level to sloping; slow permeability.	Slow intake rate; moderate or high available water capacity.	Slow permeability; clayey.	Erosion hazard on slopes; clayey; moderate or high available water capacity.
Unsuited	Poor: poorly drained; salinity.	Moderately slow permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; high compressibility; good resistance to seepage and piping.	Poorly drained; moderately slow permeability; subject to flooding.	High salinity; subject to flooding; poorly drained.	Not applicable	Not applicable.
Unsuited	Good to a depth of 6 inches; fair below that depth; silty clay loam.	Moderate permeability; subject to seepage in substratum.	Fair to poor stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Well drained; nearly level to gently sloping; moderate permeability.	Moderately slow intake rate; high available water capacity.	Nearly level to gently sloping; moderate permeability.	Slight erosion hazard; high available water capacity; nearly level to gently sloping.
Unsuited	Poor: very poorly drained.	Very poorly drained; high water table.	Fair to poor compaction characteristics; medium compressibility.	Very poorly drained; high water table.	Very poorly drained.	Not applicable	Not applicable.
Fair to poor: excessive fines.	Poor: sand and gravel to a depth of 15 inches.	Rapid permeability in sand and gravel; high seepage.	Good stability and compaction characteristics; susceptibility to seepage and piping.	Somewhat excessively drained; nearly level to steep; rapid permeability in substratum.	Low available water capacity; rapid intake rate; erosion hazard on the steep slopes.	Shallow to sand and gravel.	Subject to erosion; low available water capacity.
Unsuited	Good to a depth of 12 inches; gravelly below that depth.	Slow permeability below a depth of 20 inches; gravelly in upper part.	Fair to good stability; medium to high compressibility.	Well drained; thin gravel; moderately slow permeability or slow permeability in substratum.	Moderate or high available water capacity; thin gravel; moderately rapid intake rate.	Gravelly; moderately slow permeability or slow permeability in underlying material.	Gravelly; moderately slow permeability or slow permeability in underlying material; moderate or high available water capacity.
Unsuited	Poor; slopes are more than 15 percent.	Steep	Fair to poor stability and compaction characteristics; good resistance to seepage and piping.	Well drained; hilly to steep.	Not applicable	Not applicable	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	Road fill
Sinai: SnA, SnB.	Severe: slow permeability.	Slight if slopes are less than 2 percent. Moderate if slopes are more than 2 percent.	Severe: silty clay.	Severe: high shrink-swell potential.	Severe: silty clay.	Severe: high shrink-swell potential.	Poor: high shrink-swell potential.
Sioux. Mapped only in a complex with the Renshaw soils.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent. Pollution hazard potential.	Severe: rapid permeability.	Severe: sand and gravel below a depth of 7 inches.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Severe: rapid permeability; pollution hazard.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Good below a depth of 7 inches. Fair if slopes are 15 to 25 percent. Poor if slopes are more than 25 percent.
*Sisseton: SsF, StD. For Heimdal part of StD, see Heimdal series.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Moderate if slopes are 2 to 6 percent. Severe if slopes are more than 6 percent.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Slight or moderate: low or moderate shrink-swell potential. Severe if slopes are more than 15 percent.	Slight if slopes are less than 15 percent. Moderate if slopes are 15 to 25 percent. Severe if slopes are more than 25 percent.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent.	Fair if slopes are less than 25 percent. ML material that has plasticity index of less than 15.
Svea: SvC.	Severe: moderately slow permeability in substratum.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 7 percent. Severe if slopes are more than 7 percent.	Moderate: moderately well drained.	Moderate: moderate shrink-swell potential. Severe if not protected from run-in water from adjacent slopes.	Slight if protected from run-in water from adjacent slopes.	Severe: high susceptibility to frost action.	Fair: moderate shrink-swell potential.
Sverdrup: SwA, SwB.	Slight: possible pollution hazard.	Severe: moderately rapid permeability; pollution hazard.	Severe: sandy; low sidewall stability.	Slight	Severe: moderately rapid permeability; possible pollution hazard.	Slight to moderate: fines range from 5 to 50 percent.	Good to fair: fines range from 5 to 50 percent.
Tonka: Tk	Severe: slow permeability; subject to ponding.	Slight	Severe: poorly drained; subject to ponding.	Severe: poorly drained; high shrink-swell potential; high potential frost action.	Severe: poorly drained.	Severe: poorly drained; high shrink-swell potential; high susceptibility to frost action.	Poor: poorly drained; high shrink-swell potential; high susceptibility to frost action.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Poor: silty clay.	Slow permeability; low seepage.	Fair to poor stability and compaction characteristics; good resistance to seepage and piping; high compressibility.	Well drained; nearly level to gently sloping uplands; slow permeability.	Very slow intake rate; moderate or high available water capacity.	Long, smooth slopes; silty clay; slow permeability.	Moderate or high available water capacity; silty clay; gentle slopes; subject to erosion.
Good or fair, depending on content of fines.	Poor: thin surface layer.	Rapid permeability; high seepage.	Good stability and compaction characteristics; susceptibility to seepage and piping.	Excessively drained; rapid permeability.	Very low or low available water capacity; very rapid intake rate.	Very shallow to sand and gravel.	Very low or low available water capacity; erosion hazard on the steep slopes; very shallow to sand and gravel.
Unsuited	Poor: thin surface layer.	Moderate permeability; steep slopes in places.	Fair stability and compaction characteristics; medium compressibility; fair resistance to seepage; susceptible to piping.	Well drained; undulating to rolling and steep uplands; moderate permeability.	Moderate or high available water capacity; moderate intake rate; slopes subject to erosion.	Gently undulating to steep, erodible slopes; moderate permeability.	Erosion hazard; moderate or high available water capacity; low fertility.
Unsuited	Good	Moderate permeability.	Fair to good stability and compaction characteristics; medium compressibility; good resistance to seepage and piping.	Moderately well drained; toe slopes and swales; moderate permeability.	Moderately slow intake rate; high available water capacity.	Slow permeability below a depth of 25 inches.	High available water capacity; high fertility; erosion hazard in sloping areas.
Good to poor for sand below a depth of 2 feet, depending on fines.	Good	Moderately rapid permeability; susceptibility to seepage.	Fair to good stability and compaction characteristics; slight compressibility; susceptibility to seepage and piping.	Somewhat excessively drained; nearly level to sloping uplands; moderately rapid permeability.	Low or moderate available water capacity; rapid intake rate.	Sandy substratum within a depth of 2 feet; susceptibility to soil blowing.	Erosion hazard in sloping areas; low or moderate available water capacity; soil blowing hazard.
Unsuited	Poor: poorly drained; good in drained areas.	Slow permeability; subject to ponding.	Fair to poor stability and compaction characteristics; medium to high compressibility; low seepage.	Slow permeability; subject ponding.	Subject to ponding; clayey subsoil at a depth of 18 inches; high available water capacity.	Not applicable	Not applicable.

TABLE 5.—*Interpretations of engineering*

Soil series and map symbols	Degree and kinds of limitations for—						
	Septic-tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets	Road fill
Towner: To	Severe: slow permeability in substratum.	Severe: seasonal water table.	Severe: seasonal water table.	Severe: seasonal water table; moderate potential frost action.	Severe: seasonal water table.	Moderate: low or moderate shrink-swell potential; moderate susceptibility to frost action.	Fair: low or moderate shrink-swell potential; ML or CL material below a depth of 25 inches.
Ulen: Un	Severe: high water table; pollution hazard.	Severe: high water table; rapid permeability; pollution hazard.	Severe: high water table.	Severe: high water table.	Severe: high water table; pollution hazard.	Moderate: somewhat poorly drained; moderate susceptibility to frost action.	Fair: somewhat poorly drained; moderate susceptibility to frost action.
*Vallers: VhA For Hamerly part, see Hamerly series.	Severe: moderately slow permeability; high water table.	Severe: seasonal high water table; slight if drained.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table; high potential frost action.	Severe: poorly drained.	Severe: poorly drained; moderate shrink-swell potential; high susceptibility to frost action.	Poor: poorly drained; moderate shrink-swell potential; high susceptibility to frost action.
Vienna: VnA, VnB, VnC.	Severe: moderately slow permeability below a depth of 21 inches.	Slight if slopes are less than 2 percent. Moderate if slopes are 2 to 6 percent. Severe if slopes are more than 6 percent.	Slight	Moderate: moderate shrink-swell potential.	Moderate: clay loam below a depth of 21 inches.	Severe: AASHO group index is more than 8.	Poor: AASHO group index is more than 8.
Waubay: Wa	Moderate or severe: moderate permeability in subsoil; moderately slow below a depth of 47 inches.	Moderate: moderate permeability.	Moderate: moderately well drained.	Moderate: moderate shrink-swell potential; moderately well drained. Severe in areas that receive runoff from adjacent slopes.	Moderate: silty clay loam.	Severe: AASHO group index is more than 8; plasticity index is more than 15.	Poor: AASHO group index is more than 8; plasticity index is more than 15.
*Zell: ZeD For Eckman part, see Eckman series.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Severe: slopes.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Slight if slopes are less than 15 percent. Moderate if slopes more than 15 percent.	Moderate if slopes are less than 15 percent. Severe if slopes are more than 15 percent; ML material that has plasticity index of less than 15.	Fair: ML material that has plasticity index of less than 15.

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

properties of the soils—Continued

Suitability as source of—		Soil features affecting—					
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Unsuited	Good to a depth of 8 inches; poor below that depth.	Seasonal water table; slow permeability in substratum; sandy in upper 25 inches.	Fair to good stability and compaction characteristics in upper 25 inches; fair to poor stability and compaction characteristics in substratum; low to medium compressibility.	Moderately well drained; rapid permeability in upper 25 inches; slow permeability in substratum; seasonal water table.	Rapid intake rate; moderate or high available water capacity.	Not applicable	Not applicable.
Unsuited	Good	Seasonal high water table; rapid permeability.	Fair stability; fair to good compaction characteristics; low compressibility; poor resistance to piping.	Rapid permeability; seasonal high water table.	Very rapid intake rate; seasonal high water table; low available water capacity.	Structure is generally not needed because soils are nearly level.	Generally not needed because soils are nearly level.
Unsuited	Poor: poorly drained.	Moderately slow permeability; seasonal high water table.	Poor to good stability and compaction characteristics; medium to high compressibility; poor to good resistance to piping.	Moderately slow permeability; seasonal high water table.	High available water capacity; seasonal high water table; moderately slow intake rate.	Structure is generally not needed because soils are nearly level.	Generally not needed because soils are nearly level.
Unsuited	Good	Moderate permeability in subsoil; moderately slow in underlying material.	Fair to good stability and compaction characteristics; medium compressibility; good resistance to seepage and piping.	Well drained; moderately slow permeability in substratum.	High available water capacity; moderately slow intake rate; erosion hazard in sloping areas.	Moderately slow permeability below a depth of 21 inches; long, smooth slopes.	Sloping areas subject to erosion; high available water capacity.
Unsuited	Fair: silty clay loam.	Moderate: permeability; low seepage.	Fair to poor stability and compaction characteristics; medium to high compressibility; fair to good resistance to seepage and piping.	Moderately well drained; silty clay loam; moderate permeability in subsoil.	High available water capacity; moderately slow intake rate; moderately well drained.	Structure is generally not needed because soils are nearly level.	High available water capacity; moderately well drained; high fertility.
Unsuited	Good to a depth of 6 inches if slopes are less than 9 percent. Fair if slopes are 9 to 15 percent. Severe if slopes are more than 15 percent.	Moderate permeability.	Poor stability and compaction characteristics; medium compressibility; poor resistance to seepage and piping.	Moderate permeability; sloping to moderately steep.	Moderate intake rate; erosion hazard; high available water capacity.	Erosion hazard at outlets; short, steep slopes.	Erosion hazard; high available water capacity; thin surface layer.

TABLE 6.—

[Tests performed by the South Dakota Department of Highways in accordance with

Soil name and location	Parent material	Depth	Moisture-density [1]	
			Maximum dry density	Optimum moisture
		Inches	*Percent*	*Percent*
Forman loam:				
0.35 mile north and 120 feet west of southeast corner of sec. 19, T. 126 N., R. 52 W. (Modal)	Glacial till.	8–21	103	18
		21–37	109	16
		37–62	109	18
Heimdal loam:				
2,175 feet west and 85 feet south of northeast corner of sec. 6, T. 126 N., R. 51 W. (Modal)	Silty and loamy glacial drift.	10–19	110	16
		19–33	116	15
		33–64	119	13
Peever clay loam:				
0.23 mile west and 140 feet south of northeast corner of sec. 26, T. 128 N., R. 52 W. (Modal)	Glacial till.	7–22	94	23
		22–38	102	21
		38–64	100	23
Playmoor silty clay loam:				
1,848 feet north and 2,478 feet west of southeast corner of sec. 31, T. 123 N., R. 49 W. (Modal)	Saline, clayey alluvium.	5–16	90	28
		16–35	104	20
		35–54	94	26
Sisseton loam:				
2,112 feet east and 132 feet north of southwest corner of sec. 4, T. 124 N., R. 50 W. (Modal)	Silty and loamy glacial drift.	8–18	111	17
		18–36	112	15
		36–64	112	17
Sverdrup sandy loam:				
585 feet east and 180 feet south of northwest corner of sec. 36, T. 129 N., R. 50 W. (Modal)	Lacustrine and eolian sands.	13–26	114	13
		38–54	110	13
		54–66	108	15

[1] Based on AASHO Designation T 99, Method A (*1*).

[2] Mechanical analyses according to AASHO Designation T 88 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO 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

TABLE 7.—*Engineering test data for soil samples taken along proposed*

[Tests made by the South Dakota Department of Highways.

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm)		No. 40 (0.42 mm)		No. 200 (0.074 mm)	
			Range	Average	Range	Average	Range	Average
Aastad	A	4	96–99	98	89–94	92	57–77	68
	B	6	97–99	99	90–96	92	65–82	73
	C	8	97–100	98	89–97	92	71–89	76
Buse	AC	6	79–100	93	71–93	81	43–70	55
	C	34	82–100	95	66–100	86	28–94	62
Dovray	A	2	98–100	99	91–98	95	69–75	72
	B	3	97–100	99	94–99	97	81–94	87
	C	4	98–100	99	92–99	96	79–92	86
Eckman	A	11	97–100	99	93–98	96	27–78	58
	B	12	96–100	99	69–100	96	30–78	63
	C	69	89–100	98	71–100	94	13–98	72
Embden	B	2	94–100	97	70–98	84	28–37	33
	C	6	100–100	100	98–100	100	28–55	43

Engineering test data

standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than 0.005 mm			AASHO [3]	Unified [4]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
99	97	89	67	35	42	14	A–7–6(8)	ML
99	95	87	68	36	37	15	A–6(9)	CL
97	93	86	67	35	36	15	A–6(8)	CL
98	96	84	54	17	33	9	A–4(4)	CL–ML
97	92	81	58	27	27	9	A–4(5)	CL
96	92	79	54	14	23	8	A–4(4)	CL
100	98	94	86	49	53	23	A–7–5(16)	MH–CH
99	95	91	80	46	49	25	A–7–6(16)	CL
98	94	90	82	47	52	25	A–7–6(16)	MH–CH
---	100	97	83	34	58	24	A–7–5(17)	MH
---	100	99	75	28	37	13	A–6(9)	CL–ML
---	100	99	85	40	52	19	A–7–5(14)	MH
92	89	82	63	23	30	9	A–4(6)	CL–ML
100	97	88	66	21	27	8	A–4(6)	CL
98	95	87	68	22	26	7	A–4(7)	CL–ML
---	100	97	31	8	19	2	A–2–4(0)	SM
---	100	99	25	6	21	2	A–2–4(0)	SM
---	100	99	48	10	21	2	A–4(2)	SM

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

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 8): AASHO Designation M 145–49 (*1*).

[4] Based on the Unified classification system (*9*).

highway routes in Roberts County and surrounding counties.

Dashed lines indicate soil area not tested for property indicated]

Liquid limit [2]		Plasticity index [3]		Classification			Estimated California bearing ratio [4]
Range	Average	Range	Average	AASHO [5] (Old index)	AASHO [6] (New index)	Unified [7]	
39–53	49	14–20	18	A–7–5(11)	A–7–5(12)	ML	3
38–55	48	17–32	25	A–7–6(15)	A–7–6(18)	CL	4
35–51	44	16–31	24	A–7–6(14)	A–7–6(17)	CL	4
36–66	46	9–17	13	A–7–5(6)	A–7–5(6)	ML	4
0–56	34	0–32	15	A–6(7)	A–6(7)	CL	7
41–47	44	13–17	15	A–7–6(10)	A–7–6(11)	ML	4
51–73	65	26–50	42	A–7–6(20)	A–7–6(40)	CH	2
37–64	56	15–40	32	A–7–6(19)	A–7–6(30	CH	3
0–42	32	0–14	8	A–4(5)	A–4(3)	CL–ML	8
22–45	35	2–19	10	A–4(6)	A–4(5)	CL–ML	6
0–40	30	0–19	9	A–4(7)	A–4(5)	CL–ML	8
25–26	26	5–6	6	A–2–4(0)	A–2–4(0)	SM–SC	[8]
21–25	23	2–5	4	A–4(2)	A–4(0)	SM–SC	13

TABLE 7.—*Engineering test data for soil samples taken along proposed*

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm)		No. 40 (0.42 mm)		No. 200 (0.074 mm)	
			Range	Average	Range	Average	Range	Average
Fordville	A	2	----------	98	89–91	90	58–69	64
	B	5	86–100	93	68–97	82	45–77	58
Forman	A	45	86–100	97	81–97	92	51–81	69
	B	39	86–100	98	77–99	92	42–89	70
	C	174	66–100	96	50–100	90	28–100	72
Glyndon	C	3	99–100	100	93–98	96	48–88	66
Hamar	AC	1	----------	95	----------	88	----------	22
	C	2	98–98	98	89–93	91	39–64	52
Hamerly	A	3	98–99	98	90–96	93	60–76	68
	C1	5	91–100	97	85–98	91	50–79	60
	C2	27	58–100	95	48–97	87	37–87	64
Heimdal	A	18	89–100	96	80–96	89	53–82	64
	B	21	94–100	98	85–97	91	43–81	67
	C	59	82–100	94	63–100	86	36–96	63
LaDelle	A	1	----------	99	----------	88	----------	58
	C	6	86–100	96	53–99	82	35–95	62
Lamoure	A	3	100–100	100	95–98	97	60–75	68
	B	2	94–100	97	86–98	92	65–86	76
	C	7	93–100	98	69–99	89	40–92	66
	2C	1	----------	72	----------	30	----------	17
Parnell	B	4	91–99	96	78–97	89	61–76	68
	C	7	93–99	96	83–95	90	67–86	75
Peever	A	33	84–100	97	66–98	91	43–84	70
	B	40	87–100	98	79–99	92	62–89	76
	C	107	60–100	98	36–100	93	16–97	78
Playmoor	C1	2	99–100	100	92–100	96	69–93	81
	C2	4	98–100	99	77–98	91	47–80	67
Renshaw	A	9	87–99	96	64–90	80	22–58	43
	2C	21	43–65	49	8–37	19	4–17	9
Sinai	A	3	94–99	97	88–94	91	70–74	72
	B	2	99–100	100	92–93	93	68–73	71
Sioux	C	1	----------	52	----------	24	----------	16
Sisseton	A	1	----------	100	----------	92	----------	52
	C1	9	63–99	88	50–94	75	25–72	47
	C2	29	66–100	92	39–100	82	19–89	52
Sverdrup	A	3	----------	100	88–97	93	33–49	41
	B	4	97–100	99	56–99	85	23–42	33
	C	15	64–100	93	38–100	79	8–33	18
Tonka	A	7	96–100	99	90–97	94	54–83	75
	B	13	91–100	97	83–99	93	71–96	83
	C	4	97–100	99	90–98	95	74–94	85
Ulen	C1	3	98–100	99	84–93	90	32–40	35
	C2	6	83–100	96	26–100	75	10–35	20
Vallers	C	2	98–98	98	90–97	94	71–78	75
Vienna	B	1	----------	92	----------	81	----------	60
	C	1	----------	95	----------	84	----------	63

highway routes in Roberts County and surrounding counties—Continued

Liquid limit [2]		Plasticity index [3]		Classification			Estimated California bearing ratio [4]
Range	Average	Range	Average	AASHO [5] (Old index)	AASHO [6] (New index)	Unified [7]	
33–38	36	8–13	11	A–6(6)	A–6(5)	CL–ML	6
35–44	39	12–20	17	A–6(7)	A–6(7)	CL	5
35–58	44	11–26	15	A–7–6(9)	A–7–6(10)	ML	4
28–50	43	9–28	19	A–7–6(11)	A–7–6(13)	CL–ML	4
0–54	38	0–33	17	A–6(10)	A–6(11)	CL	6
28–46	35	5–15	9	A–4(6)	A–4(5)	CL–ML	6
----------	----------	----------	----------	A–2(4)	A–2(4)	SM	([8])
26–36	31	8–11	10	A–4(3)	A–4(2)	CL–ML	8
36–46	40	12–18	15	A–6(9)	A–6(9)	CL–ML	5
36–42	39	14–17	15	A–6(7)	A–6(7)	CL–ML	5
17–55	36	4–26	15	A–6(8)	A–6(8)	CL	6
30–53	40	6–25	14	A–6(7)	A–6(8)	CL–ML	5
26–49	38	5–22	15	A–6(8)	A–6(9)	CL–ML	6
19–44	31	0–25	13	A–6(7)	A–6(6)	CL	8
----------	42	----------	16	A–7–6(7)	A–7–6(7)	CL–ML	5
26–55	37	12–30	17	A–6(8)	A–6(8)	CL	6
37–51	45	12–22	18	A–7–6(11)	A–7–6(11)	CL–ML	4
47–65	56	28–30	29	A–7–6(19)	A–7–6(23)	MH–CH	3
31–44	37	11–23	16	A–6(9)	A–6(9)	CL	6
----------	30	----------	8	A–2–4(0)	A–2–4(0)	SM–SC	([8])
32–53	45	11–24	20	A–7–6(11)	A–7–6(13)	CL–ML	4
29–53	44	3–28	21	A–7–6(13)	A–7–6(16)	CL	4
34–63	46	8–33	16	A–7–5(10)	A–7–5(11)	ML	4
32–65	50	13–38	25	A–7–6(16)	A–7–6(19)	CL	3
18–97	51	11–78	28	A–7–6(17)	A–7–6(22)	CH	3
58–76	67	16–35	26	A–7–5(18)	A–7–5(26)	MH	2
38–61	48	15–25	20	A–7–6(12)	A–7–6(13)	CL–ML	4
23–61	36	2–13	8	A–4(2)	A–4(1)	SM	6
21–34	26	2–12	6	A–1–A(0)	A–1–A(0)	SM–SC	([8])
52–57	54	8–25	18	A–7–5(13)	A–7–5(14)	MH	3
51–51	51	19–20	20	A–7–5(13)	A–7–5(14)	MH	3
----------	36	----------	12	A–2–6(0)	A–2–6(0)	SM–SC	([8])
----------	32	----------	10	A–4(3)	A–4(3)	CL–ML	8
18–43	34	2–15	8	A–4(2)	A–4(1)	SM–SC	7
0–44	25	0–30	9	A–4(3)	A–4(2)	CL	11
28–44	35	4–9	7	A–4(1)	A–4(0)	SM	6
20–30	25	3–11	6	A–2–4(0)	A–2–4(0)	SM–SC	([8])
0–26	10	0–4	1	A–2–4(0)	A–2–4(0)	SM	([8])
36–56	47	11–31	19	A–7–6(13)	A–7–6(15)	CL–ML	4
44–64	53	19–41	30	A–7–6(19)	A–7–6(27)	CH	3
42–64	55	19–36	29	A–7–6(19)	A–7–6(27)	CH	3
25–30	28	4–6	5	A–2–4(0)	A–2–4(0)	SM–SC	([8])
0–27	12	0–7	2	A–2–4(0)	A–2–4(0)	SM	([8])
36–43	40	14–18	16	A–6(10)	A–6(11)	CL–ML	5
----------	33	----------	12	A–6(6)	A–6(5)	CL	7
----------	34	----------	17	A–6(8)	A–6(8)	CL	7

TABLE 7.—*Engineering test data for soil samples taken along proposed*

[Tests made by the South Dakota Department of Highways.

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm)		No. 40 (0.42 mm)		No. 200 (0.074 mm)	
			Range	Average	Range	Average	Range	Average
Zell	A	2	99–99	99	93–96	95	60–69	65
	C2	10	96–100	99	65–100	91	5–95	59

[1] Mechanical analyses according to AASHO Designation T 88 (*1*). Results by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO 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 data used in this table are not suitable for use in naming textural classes for soils.

[2] Based on the AASHO Designation T 89–60 (*1*).

ing soil property is given for those soils with moderate and severe ratings.

The following are explanations of some of the columns in table 5.

Septic-tank absorption fields are affected mainly by soil permeability, depth to water table or bedrock, susceptibility to flooding, and slope. The soil material from a depth of 18 inches to 5 feet or more is evaluated.

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. Properties or features that affect sewage lagoons are soil permeability, depth to water table or bedrock, content of organic matter, slope, and susceptibility to flooding.

Shallow excavations are those as much as 6 feet deep for basements, ditches, graves, sewer lines, and underground cables and pipelines. Limitations are based on texture, depth to water table or bedrock, stoniness, slope, and susceptibility to flooding.

Ratings for dwellings are for those not more than three stories high and are supported by foundation footings placed in undisturbed soil. Items that affect the rating of a soil for such dwellings are depth to water table or bedrock, shrink-swell potential, texture, plasticity, potential frost action, slope, and susceptibility to flooding.

Sanitary land fill is a method of disposing of refuse in dug trenches by spreading the wastes in thin layers, compacting it to the smallest volume, and covering the wastes each day in a manner than provides maximum protection of the environment. Some soil properties that affect suitability for land fill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are easy to excavate. Every site should be investigated for limitations of material at a depth of more than 6 feet.

Road fill is soil material used in embankments for roads. The ratings reflect the predicted performance of soil after it has been placed in a properly compacted embankment and the relative ease of excavating the material from borrow areas.

The ratings in table 5 for sand and gravel provide guidance on where to look for these materials. The ratings do not take into account the thickness of the overburden, depth to water table, or other factors that affect mining of the materials.

Topsoil is used for topdressing an area where vegetaion is to be established and maintained. Texture of the surface layer, thickness of suitable layers of soil, natural fertility, response to fertilizer, and absence of substances toxic to plants affect the rating.

Ratings for roads and streets in table 5 are for those that have an all-weather surface expected to carry automobile traffic all year, but not for fast-moving, heavy trucks. The AASHO and Unified classifications of the soil, wetness and flooding, shrink-swell potential, potential frost action, and depth to bedrock are items that affect the ratings.

Pond reservoir areas are affected by seepage loss of water which is related to soil permeability and depth to bedrock or other permeable material.

Dikes, levees, and other embankments for retention of water require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility.

Drainage for crops and pasture is affected by soil permeability, texture, and structure; depth to claypan, bedrock, or water table; slope; stability of ditchbanks; susceptibility to flooding; salinity or alkalinity; and availability of outlets.

Irrigation is influenced by soil features such as water intake rate, permeability, available water capacity, depth of rooting zone, salinity, stoniness, slope, and susceptibility to flooding.

Terraces and diversions are affected by those features and qualities of soils that affect their stability, hinder layout and construction, cause sedimentation in channels, and cause difficulties in establishing and maintaining vegetative cover.

Grassed waterways are affected by those features and qualities of soils that affect the establishment, growth, and maintenance of plants and the layout and construction of the waterway.

highway routes in Roberts County and surrounding counties.

Dashed lines indicate soil area not tested for property indicated]

Liquid limit [2]		Plasticity index [3]		Classification			Estimated California bearing ratio [4]
Range	Average	Range	Average	AASHO [5] (Old index)	AASHO [6] (New index)	Unified [7]	
37–38	38	8–10	9	A–4(6)	A–4(5)	ML	6
0–37	22	0–13	6	A–4(5)	A–4(1)	CL–ML	14

[3] Based on the AASHO Designation T 90–61 (*1*).
[4] Estimated values based on relationships between California bearing ratio and liquid limit.
[5] Based on AASHO Designation M 145–49 (*1*).
[6] Based on AASHO Designation M 145–66I (*1*).
[7] Based on the Unified classification system (*9*).
[8] California bearing ratio and liquid limit relationship is not applicable to granular (A–1, A–2, A–3) and subgroups of those classifications.

Engineering test data

Tables 6 and 7 contain results of engineering tests performed by the South Dakota Department of Highways on soils in Roberts County. Table 6 contains the results of tests on selected horizons of 6 soils at specific locations in Roberts County. Table 7 gives the results of tests on soil samples taken along proposed highway routes in Roberts County and adjacent counties.

In table 7 the horizon column indicates the major horizons from which samples were taken. The samples were taken at depths that indicated distinct changes in color and texture, and they therefore may include material from more than one major horizon. The number of samples taken for each horizon also are listed. The actual range and average value for each of the several properties are given, but because of the method of sampling the range in properties given in table 7 is not necessarily the same as that given in table 4. Some of the columns in tables 6 and 7 are explained in the following paragraphs.

Maximum dry density is the maximum unit dry weight of a soil when it has been compacted to optimum moisture by the prescribed method of compaction. The moisture content that gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

Mechanical analyses show the percentages, by weight, of soil particles that would pass sieves of specified sizes. Sand and other coarser materials do not pass through the 200 sieve, but silt and clay do. The percentage smaller than the 200 sieve openings was determined by the hydrometer method rather than pipette method used by most soil scientists when determining the clay content of soil samples.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a solid 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 passes from solid to plastic. The liquid limit is the moisture content at which material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and plastic limit. It indicates the range of moisture content within which a soil material is plastic.

The estimated California bearing ratio in table 7 is the load-supporting capacity of a soil compared to that of standard crushed limestone. Expressed as a ratio, it was first standardized in California and abbreviated CBR. A soil having a CBR of 16 will support 16 percent of the load that would be supported by the standard crushed limestone per unit area, and it will do it with the same degree of distortion.

Town and Country Planning

Soil information is an important factor in planning the use or development of lands for nonfarm purposes. Land appraisers, realtors, city planners, builders, and others need facts to help them determine what soils are suitable for homes and other buildings and what soils are best suited to other purposes. This information is obtained by using the soil maps to identify the soils and then referring to the sections describing the soils and their use for tree plantings, engineering, and recreation. It is still important to make detailed sampling and testing at the exact site of proposed buildings, roads, and streets.

Soil properties have an important effect on the suitability of a site, a subdivision, or an individual home. Table 4 in the section "Engineering Uses of the Soils" gives information on texture, permeability, shrink-swell potential, and corrosivity of the soils, and lists the Unified soil classification of material in the different layers. The Unified classification system groups soils according to their performance as foundation materials. Information on soil features affecting dwellings with basements is given in table 5.

Subdivisions that have sloping areas denuded because of construction are susceptible to severe erosion. Exposed cuts and compaction of soil material greatly increase runoff that results in flooding and deposition of sediment in streams and low areas. Subdivisions and individual homes and industrial sites outside the limits of municipalities frequently have to be provided with facilities for sewage and garbage disposal and with new roads and streets. Informa-

tion on the suitability of the soils of the county for septic-tank absorption fields, sewage lagoons, sanitary land fill, and local roads and streets is presented in table 5 in the section "Engineering Uses of the Soils." This information is useful to help ensure that facilities function properly and pollution of ground and surface water is avoided. Driveways, sidewalks, streets, and roads shift and crack when built on high shrink-swell soils. This is an important consideration in locating these facilities.

Table 5 also provides information on the suitability of each soil as a source of topsoil. This information is helpful in establishing vegetation cover on borrow pits and cut banks of new roads as an erosion control measure.

Recreation

Roberts County offers many forms of outdoor recreation to residents and visitors. The hilly and undulating relief in the southwest part of the county offers considerable potential for winter sports and hunting and fishing.

Lake Traverse and Big Stone Lake form the eastern boundary of the county and offer excellent fishing and waterfowl hunting. Smaller lakes scattered throughout the county offer additional recreation. Swimming, boating, and water-skiing are popular water sports. Ice fishing and snowmobiling (fig. 21) are popular winter sports.

Summer cottages have been constructed on the shoreline of many of the larger lakes. Most of the soils are suited to this type of summer home, but careful onsite investigation is needed to determine whether septic tanks and sewage disposal systems will function properly and whether the soil is suited to building foundations. Pollution of ground water supplies and lakes is a hazard in developments near lakes.

La Coteau ski area, located near Sisseton, is one of the few in eastern South Dakota. Skiing, tobogganing, and snowmobiling are offered. It has a 110 foot vertical drop, a 2,500 foot run, a rope lift, and a chalet.

Hunting is very popular in the fall of the year. Pheasants, waterfowl, and deer are the major game.

The wooded areas of the Sieche soils provide natural areas for hikes and nature studies. These areas provide habitat for woodland birds and animals that are not prevalent in open parts of the county.

Many roadside and lakeside parks and camp areas have been developed. These parks provide camp areas for tourists who stay overnight or vacationists who stay for a week. Some have been developed to provide electricity and sewage facilities while others are quite primitive.

A golf course located at Sisseton provides recreation for many of the residents of the county.

Table 8 rates the degree and kind of limitation each soil in Roberts County has for selected types of recreation. The degrees of limitation are *slight*, *moderate*, and *severe*. If the limitation is *slight*, the soil is well suited for the specified use; if *moderate*, the soil is suited to the use but needs

Figure 21.—**Snowmobiling on Lake Traverse. LaDelle and Lamoure soils are in the background.**

certain elements of management; and if *severe*, the soil is poorly suited to recreational use or needs careful management.

Camp areas are used intensively for tents, small camp trailers, and the accompanying activities of outdoor living. Little or no site preparation is required. The sites should be suitable for unsurfaced parking as well as traffic by people, horses, and vehicles. The most suitable sites are well-drained, nearly level to gently sloping soils that are not subject to flooding.

Picnic areas are for intensive use as park-type picnic areas. It is assumed that vehicular traffic will be confined to access roads.

Playgrounds are designed for intensively used play areas and for organized games that subject the soil to heavy foot traffic. The most suitable sites are on well-drained, nearly level to gently sloping soils that have a firm consistence and are not subject to flooding.

Paths and trails rate soils for use as bridle paths, hiking trails, and local footpaths. It is assumed that little or no soil will be moved. Soil features that affect trafficability, design, and maintenance are given special emphasis. Soils that have severe limitations but are desirable because the landscape is scenic require special preparation and maintenance.

Further information on the use of soils for recreational development can be obtained from local personnel of the Soil Conservation Service.

TABLE 8.—*Interpretations of the soils for use in recreation*

Soil	Degree of limitation and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Aastad loam, 0 to 2 percent slopes	Severe: flooding	Severe: flooding	Severe: flooding	Moderate: flooding.
Antler-Colvin silt loams	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Antler-Tonka silt loams:				
Antler part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Tonka part	Severe: wetness; flooding; permeability.	Severe: wetness; flooding.	Severe: wetness; flooding; permeability.	Severe: wetness; flooding.
Antler and Hamerly soils, 0 to 2 percent slopes:				
Antler part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hamerly part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Barnes-Buse stony complex, 9 to 40 percent slopes.	Severe: slope; stoniness.	Severe: slope; stoniness.	Severe: slope; stoniness.	Severe: slope; stoniness.
Bearden silty clay loam	Severe: wetness; permeability.	Moderate: wetness; texture.	Severe: wetness; permeability.	Moderate: wetness.
Borup silt loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Buse-Forman loams, 20 to 40 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate or severe: slope.
Colvin silt loam, saline	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Dickey fine sandy loam, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Dickey fine sandy loam, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Divide-Marysland loams:				
Divide part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Marysland part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Doran loam	Moderate: permeability.	Moderate: wetness	Moderate: permeability.	Moderate: wetness.
Dovray clay	Severe: wetness; permeability; texture.	Severe: wetness; texture.	Severe: wetness; permeability; texture.	Severe: wetness; texture.
Eckman loam, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Eckman loam, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Eckman-Zell complex, 6 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
Embden-Hamar fine sandy loams:				
Embden part	Slight	Slight	Slight	Slight.
Hamar part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Fordville loam, 0 to 3 percent slopes.	Slight	Slight	Slight	Slight.
Fordville-Renshaw loams, 3 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Forman-Aastad loams, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Forman-Aastad loams, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Forman-Aastad loams, 6 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
Forman-Aastad loams, 9 to 15 percent slopes.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Forman-Aastad stony complex, 0 to 9 percent slopes.	Severe: stoniness	Severe: stoniness	Severe: stoniness	Severe: stoniness.
Forman-Buse loams, 6 to 9 percent slopes, eroded.	Slight	Slight	Severe: slope	Slight.
Forman-Buse loams, 9 to 15 percent slopes, eroded.	Moderate: slope	Moderate: slope	Severe: slope	Slight.

TABLE 8.—*Interpretations of the soils for use in recreation*—Continued

Soil	Degree of limitation and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Forman-Buse loams, 15 to 25 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Forman-Buse stony complex, 9 to 40 percent slopes.	Severe: slope; stoniness.	Severe: slope; stoniness.	Severe: slope; stoniness.	Severe: slope; stoniness.
Gardena silt loam	Slight	Slight	Slight	Slight.
Glyndon silt loam, 0 to 3 percent slopes.	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Hamar fine sandy loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hamerly-Tonka complex, 0 to 3 percent slopes:				
Hamerly part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Tonka part	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Hamerly-Vallers loams, 0 to 2 percent slopes:				
Hamerly part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Vallers part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hamerly-Vallers loams, 2 to 4 percent slopes:				
Hamerly part	Moderate: wetness	Moderate: wetness	Moderate: wetness; slope.	Moderate: wetness.
Vallers part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hattie clay loam, 9 to 15 percent slopes.	Moderate: permeability; slope; texture.	Moderate: slope; texture.	Severe: slope	Moderate: texture.
Hattie clay loam, 15 to 40 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate or severe: slope.
Hattie and Kloten soils, 9 to 25 percent slopes:				
Hattie part	Moderate or severe: permeability; slope; texture.	Moderate or severe: slope; texture.	Severe: slope	Slight or moderate: slope; texture.
Kloten part	Moderate or severe: permeability; slope; texture.	Moderate or severe: slope; texture.	Severe: slope; depth to bedrock.	Slight or moderate: slope; texture.
Hecla-Hamar loamy fine sands, 0 to 3 percent slopes:				
Hecla part	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Hamar part	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness; texture.	Severe: wetness; texture.
Heimdal-Sisseton loams, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Heimdal-Sisseton loams, 6 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
Heimdal-Svea loams, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Heimdal-Svea loams, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
LaDelle silt loam	Severe: flooding	Moderate: flooding	Moderate: flooding	Slight.
Lamoure silty clay loam	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Loamy Fluvaquents	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Ludden clay	Severe: wetness; permeability; texture.	Severe: wetness; texture.	Severe: wetness; permeability; texture.	Severe: wetness; texture.
Maddock loamy fine sand, 0 to 6 percent slopes.	Moderate: texture	Moderate: texture	Moderate: slope; texture.	Moderate: texture.
Maddock loamy fine sand, 6 to 25 percent slopes.	Moderate or severe: slope; texture.	Moderate or severe: slope; texture.	Severe: slope	Moderate: slope; texture.
Marsh	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Marysland silt loam, wet	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Parnell silty clay loam	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Peever clay loam, 0 to 2 percent slopes.	Moderate: texture; permeability.	Moderate: texture	Moderate: texture; permeability.	Moderate: texture.
Peever clay loam, 2 to 6 percent slopes.	Moderate: texture; permeability.	Moderate: texture	Moderate: slope; texture.	Moderate: texture.
Peever clay loam, 6 to 9 percent slopes.	Moderate: texture; permeability.	Moderate: texture	Severe: slope	Moderate: texture.
Peever-Cavour complex, 0 to 3 percent slopes:				
Peever part	Moderate: texture; permeability.	Moderate: texture	Moderate: texture; permeability.	Moderate: texture.
Cavour part	Severe: permeability	Slight	Severe: permeability	Slight.

TABLE 8.—*Interpretations of the soils for use in recreation*—Continued

Soil	Degree of limitation and soil features affecting use for—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Peever-Tonka complex:				
Peever part	Moderate: texture; permeability.	Moderate: texture	Moderate: texture; permeability.	Moderate: texture.
Tonka part	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Playmoor silty clay loam	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Poinsett silt loam, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Poinsett silt loam, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Rauville mucky silt loam	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Renshaw loam, 0 to 3 percent slopes.	Slight	Slight	Slight	Slight.
Renshaw loam, 3 to 9 percent slopes.	Slight	Slight	Moderate or severe: slope.	Slight.
Renshaw-Sioux loams, 3 to 9 percent slopes.	Slight	Slight	Moderate or severe: slope.	Slight.
Renshaw-Sioux loams, 9 to 20 percent slopes.	Moderate or severe: slope.	Moderate or severe: slope.	Severe: slope	Slight or moderate: slope.
Renshaw-Sioux stony loams, 9 to 40 percent slopes.	Severe: stoniness; slope.	Severe: stoniness; slope.	Severe: stoniness; slope.	Severe: stoniness; slope.
Rentill loam, 0 to 2 percent slopes	Slight	Slight	Slight	Slight.
Rentill loam, 2 to 6 percent slopes	Slight	Slight	Moderate: slope	Slight.
Sandy lake beaches	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Sieche loam, 15 to 40 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate or severe: slope.
Sinai silty clay, 0 to 2 percent slopes.	Severe: permeability; texture.	Severe: texture	Severe: permeability; texture.	Severe: texture.
Sinai silty clay, 2 to 6 percent slopes.	Severe: permeability; texture.	Severe: texture	Severe: permeability; texture.	Severe: texture.
Sisseton loam, 25 to 40 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Sisseton-Heimdal loams, 9 to 25 percent slopes.	Moderate or severe: slope.	Moderate or severe: slope.	Severe: slope	Slight or moderate: slope.
Svea loam, 5 to 9 percent slopes	Slight	Slight	Severe: slope	Slight.
Sverdrup sandy loam, 0 to 3 percent slopes.	Slight	Slight	Slight	Slight.
Sverdrup sandy loam, 3 to 9 percent slopes.	Slight	Slight	Moderate or severe: slope.	Slight.
Tonka silt loam	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.	Severe: wetness; flooding.
Towner fine sandy loam	Slight	Slight	Slight	Slight.
Ulen sandy loam	Slight	Slight	Slight	Slight.
Vallers-Hamerly loams, 0 to 2 percent slopes:				
Vallers part	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Hamerly part	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
Vienna silt loam, 0 to 2 percent slopes.	Slight	Slight	Slight	Slight.
Vienna silt loam, 2 to 6 percent slopes.	Slight	Slight	Moderate: slope	Slight.
Vienna silt loam, 6 to 9 percent slopes.	Slight	Slight	Severe: slope	Slight.
Waubay silty clay loam	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Zell-Eckman complex, 9 to 25 percent slopes.	Moderate or severe: slope.	Moderate or severe: slope.	Severe: slope	Slight or moderate: slope.

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 development of soils in Roberts County. The second explains the system of soil classification currently used and places each soil series in the classes of that system.

Factors of Soil Formation

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

Climate and plant and animal life, 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 the profile to develop. It may be a lot of time or a little, but some time is required for differentiation of soil horizons. Usually a long time is required for the development of distinct horizons.

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

Parent material [9]

Parent material is the weathered, disintegrated or unconsolidated rock masses from which soils are formed. It determines the mineralogical and chemical composition of the soil and, to a large extent, the rate that the soil-forming processes take place.

The most prominent type of parent material in Roberts County is the glacial drift deposited during the Late Wisconsin Epoch when ice moved, reworked, melted, and deposited vast quantities of materials. Glacial till, glacial outwash, and alluvial sediment are the main types of glacial drift deposition. Glacial lake lacustrine sediment is another type of parent material. Older glacial drift and cretaceous-age rocks are covered by the Wisconsin drift and have little influence on soil formation.

Loam and clay loam glacial till consisting of silt, clay, sand, and gravel mixtures is the most prevalent parent material (fig. 22). The landscape of the till plains varies from nearly level to rolling and steep hills. The hills have swales and internally drained depressions that form potholes and sloughs. Soils that formed on the nearly level to undulating and sloping till areas are Aastad, Forman, and Peever. Buse soils formed on the ridges and hilltops of the till moraine.

Vienna soils formed in a thin mantle of silt underlain by glacial till on nearly level to sloping uplands in the southwestern part of the county. Heimdal and Sisseton soils formed in glacial material that is high in content of silt and fine sand. This material probably resulted mainly from sorting of glacial till by shallow, slow-moving water.

Glacial outwash, which consists of gravel and sand that contain very little silt and clay, are in the southwest corner of the county and in scattered areas throughout the county. Fordville and Renshaw are soils formed in glacial outwash. These soils are generally well drained to excessively drained because permeability is high in the outwash material.

Alluvium, or stream-deposited sediment, is a major type of parent material. This material is mainly fine grained, and

[9] By JAMES R. MONAGHAN, geologist, Soil Conservation Service.

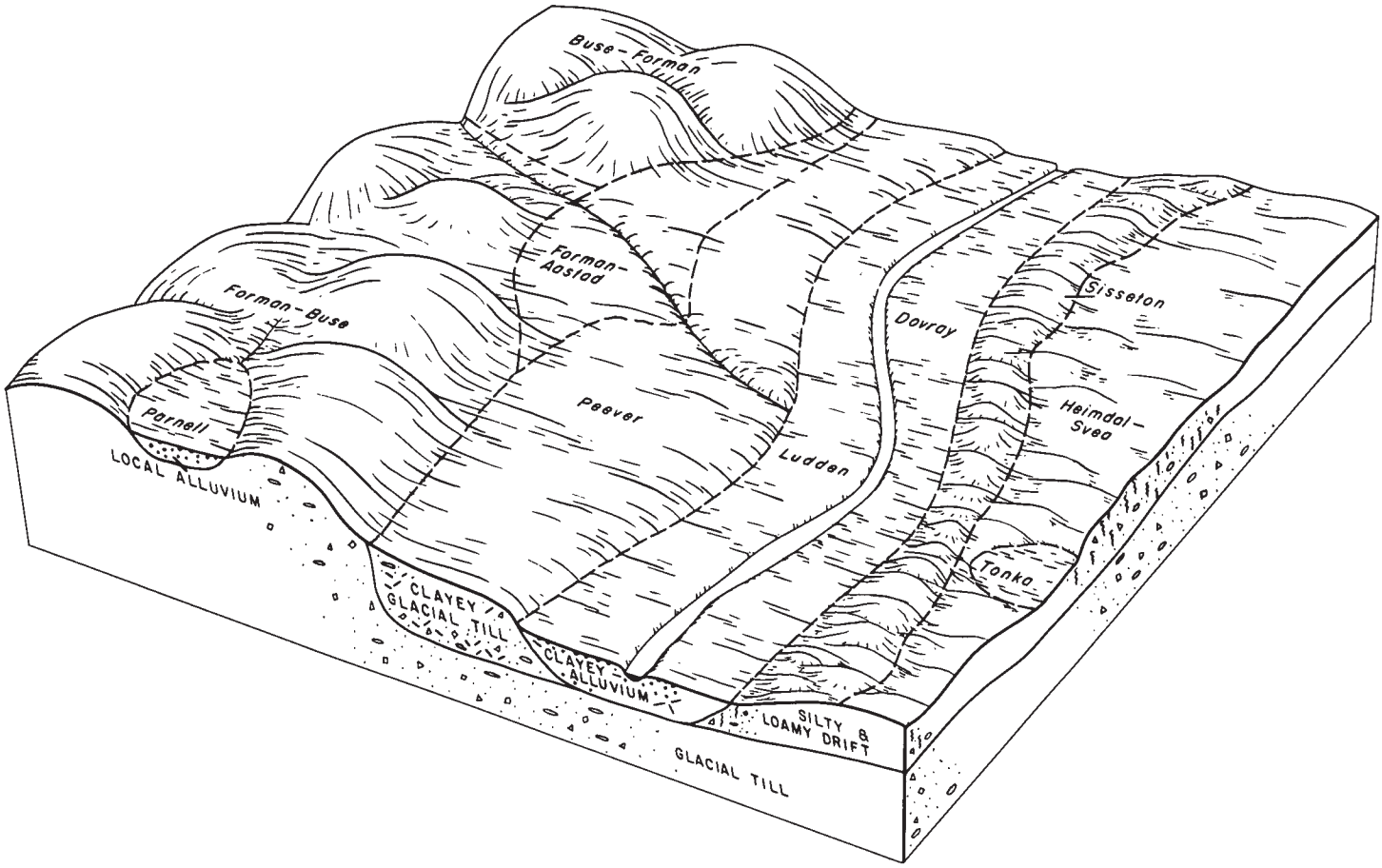

Figure 22.—**Sequence of soils as related to parent material in the west-central part of Roberts County.**

it is slowly permeable. It is affected by a high water table because of its low positions. Alluvium is in the valleys of most stream systems. LaDelle, Lamoure, and Playmoor soils are the main soils that formed in alluvium.

The northeast part of the county is dominated by parent material of lacustrine origin. The lacustrine sediment is generally silt and very fine sand that contain a small amount of clay. Eckman, Gardena, and Glyndon soils formed in silty lacustrine sediment. Hamar, Hecla, and Towner soils formed in lacustrine and eolian sand. In the northwest part of the county are Dovray and Ludden soils that formed in lacustrine sediment high in clay content.

Climate

Climate is a factor of soil formation in which temperature and precipitation have a direct influence on the rates of chemical and physical processes of weathering. The climate of Roberts County is characteristic of a continental climate that is marked by extreme, seasonal temperature changes. The average annual air temperature is about 43° F. The average for January is 11°, and the average for July is 72°. Cool temperatures promote the accumulation of organic matter and dark colors in the surface layers of the soils. The soils are frozen for about 120 days in most years.

The annual precipitation is about 21 inches. Prolonged periods of drought followed by periods of high precipitation are common. The lack of sufficient moisture causes lime to accumulate at a moderate depth in most soils. In these ways climate has had an effect on soil formation in this county.

Plant and animal life

All forms of life play an important part in soil formation, including vegetation, animals, bacteria, and fungi. Vegetation affects soil formation by leaving residue in the soil and by transferring elements from lower layers to the surface layer. Earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

In Roberts County, mid and tall mixed prairie grasses have had more influence on soil formation than other living organisms. As a result the soils have a high content of organic matter in the surface layer. Also, reactions generally are favorable to plant growth, and soil amendments such as lime are not required.

Relief

The relief, topography, or the position of the soil in the landscape, affects the soil by influencing its drainage, erosion, plant cover, and soil temperature. In Roberts County the slopes range from less than 1 percent to more than 40 percent. In soils on east-facing and north-facing slopes, temperatures are slightly lower than in those on west-facing and south-facing slopes.

Steep soils such as those of the Buse series have a limy, thin surface layer, while more gently sloping soils such as those of the Forman series have a thicker, dark-colored surface layer. These soils, however, formed in similar material. Excessive runoff because slopes are steep and the higher rate of erosion have retarded formation of the Buse soils. Soils in positions that receive additional moisture are thicker and darker, and generally lime is leached to a greater depth. Forman soils in well-drained positions and Aastad soils in moderately well drained positions are examples.

Soils in positions that are affected by a fluctuating water table generally have a dark-colored surface layer and are mottled. Some are calcareous or contain soluble salts that are brought upward in the soil and precipitated in the upper layers when the soil dries out. Hamerly and Vallers soils are examples of this.

Time

The formation of soils requires time for changes to take place in the parent material. This is generally a long time when measured in the space of years. Generally length of time determines whether the soil has reached an equilibrium with its environment. Soils are "aged" as to the degree of soil formation in a soil profile. Those that have little or no soil formation are immature, while those that have well-expressed soil horizons are mature soils, even though the parent material from which they formed are of the same age.

Soils in Roberts County range from mature to immature. Soils that formed on alluvial bottoms subject to varying degrees of overflow receive new sediment each time they are flooded. These soils have a thick, dark-colored surface layer, but their structure is weak. The continual addition of sediment and other unfavorable conditions has retarded soil formation. LaDelle soils are examples. The Buse soils are considered immature soils because they lack well-developed soil horizons, even though they formed from a comparable age as Forman and Peever soils that have well-developed soil horizons. Forman and Peever are mature soils.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 and revised later. The system currently used by the National Cooperative Soil Survey was developed in the early sixties and adopted in 1965. It is under continual study (4, 8).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 9 shows the classification of each soil series of Roberts County by family, subgroup, and order, according to the current system. Most of the classes of the current system are briefly defined in the following paragraphs.

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

TABLE 9.—*Soils classified according to the current system*

Series	Family	Subgroup	Order
Aastad	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Antler	Fine-loamy, frigid	Typic Calciaquolls	Mollisols.
Barnes	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Bearden	Fine-silty, frigid	Aeric Calciaquolls	Mollisols.
Borup	Coarse-silty, frigid	Typic Calciaquolls	Mollisols.
Buse	Fine-loamy, mixed	Udorthentic Haploborolls	Mollisols.
Cavour	Fine, mixed	Udic Natriborolls	Mollisols.
Colvin	Fine-silty, frigid	Typic Calciaquolls	Mollisols.
Dickey	Sandy over loamy, mixed	Udic Haploborolls	Mollisols.
Divide	Fine-loamy over sandy or sandy-skeletal, frigid.	Aeric Calciaquolls	Mollisols.
Doran	Fine, mixed	Aquic Argiborolls	Mollisols.
Dovray	Fine, montmorillonitic, frigid	Cumulic Haplaquolls	Mollisols.
Eckman	Coarse-silty, mixed	Udic Haploborolls	Mollisols.
Embdem	Coarse-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed.	Pachic Udic Haploborolls	Mollisols.
Forman	Fine-loamy, mixed	Udic Argiborolls	Mollisols.
Gardena	Coarse-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Glyndon	Coarse-silty, frigid	Aeric Calciaquolls	Mollisols.
Hamar	Sandy, mixed, frigid	Typic Haplaquolls	Mollisols.
Hamerly	Fine-loamy, frigid	Aeric Calciaquolls	Mollisols.
Hattie	Fine, montmorillonitic	Udertic Haploborolls	Mollisols.
Hecla	Sandy, mixed	Udic Haploborolls	Mollisols.
Heimdal	Coarse-loamy, mixed	Udic Haploborolls	Mollisols.
Kloten	Loamy, mixed	Lithic Haploborolls	Mollisols.
LaDelle	Fine-silty, mixed	Cumulic Udic Haploborolls	Mollisols.
Lamoure	Fine-silty, mixed (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Ludden	Fine, montmorillonitic (calcareous), frigid	Vertic Haplaquolls	Mollisols.
Maddock	Sandy, mixed	Udorthentic Haploborolls	Mollisols.
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid.	Typic Calciaquolls	Mollisols.
Parnell	Fine, montmorillonitic, frigid	Typic Argiaquolls	Mollisols.
Peever	Fine, montmorillonitic	Udic Argiborolls	Mollisols.
Playmoor	Fine-silty, mixed (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Poinsett	Fine-silty, mixed	Udic Haploborolls	Mollisols.
Rauville	Fine-silty, mixed (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed.	Udic Haploborolls	Mollisols.
Rentill	Coarse-loamy over clayey, mixed	Udic Haploborolls	Mollisols.
Sieche	Fine, mixed	Pachic Udic Arigborolls	Mollisols.
Sinai	Fine, montmorillonitic	Pachic Udic Haploborolls	Mollisols.
Sioux	Sandy-skeletal, mixed	Udorthentic Haploborolls	Mollisols.
Sisseton	Coarse-loamy, mixed (calcareous), frigid	Typic Udorthents	Entisols.
Svea	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Sverdrup	Sandy, mixed	Udic Haploborolls	Mollisols.
Tonka	Fine, montmorillonitic, frigid	Argiaquic Argialbolls	Mollisols.
Towner	Sandy over loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Ulen [1]	Sandy, mixed	Aeric Calciaquolls	Mollisols.
Vallers	Fine-loamy, frigid	Typic Calciaquolls	Mollisols.
Vienna	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Waubay	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Zell	Coarse-silty, mixed	Udorthentic Haploborolls	Mollisols.

[1] This series is a taxadjunct to the Ulen series, because in Roberts County the soils contain more medium and coarse sand than is typical for the series.

Mollisols formed under grass and have a thick, dark-colored surface layer that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

Entisols are light-colored soils that do not have natural genetic layers or they have only weakly expressed beginnings of such layers. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

SUBORDER.—Each order has been subdivided into suborders, mainly on the basis of the characteristics that seemed to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUPS.—Suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clay, temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 9, because it is the last work in the name of the subgroup.

SUBGROUP.—Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in

those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

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

SERIES.—A series is a group of soils having major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Additional Facts About the County

Roberts County was created by an act of the Dakota Territorial Legislature on March 8, 1883. It is made up of parts of the former Grant and Richland Counties and the former Sisseton-Wahpeton Indian Reservation. Wilmot was the first county seat; however, with the expansion of Sisseton, the county seat was transferred to Sisseton in 1898, where it is presently located.

Much of Roberts County is made up of the former Sisseton-Wahpeton Indian Reservation. This reservation was created by treaty in 1867 and confirmed by an act of Congress in 1874 as the home of the Sisseton and Wahpeton tribes of the Sioux Indians. Then, as settlers attempted to obtain homesteads, the U.S. Government entered in an agreement with the Indians that provided each tribe member selected an allotment of 160 acres. The remaining land was purchased in cash by the U.S. Government and was opened for settlement in 1892.

According to the U.S. Census of population, Roberts County had 1,997 people in 1890. An influx of settlers increased the county's population to 16,514 by 1920. Since then the population declined to 11,678 (1970). Sisseton, the largest town in the county, has a population of 3,094.

Two railroads that serve the county are the Chicago, Milwaukee, St. Paul and Pacific, and the Soo Line. U.S. Highways 12 and 89 and State Highways 15 and 10 are the main thoroughfares in the county. A municipal airport is located at Sisseton. Most of the county roads are graded and either hard surfaced or graveled.

The main source of domestic water in Roberts County is from wells. Shallow water is mainly in gravelly glacial deposits and in local deposits of sand and gravel alluvium along streams. In an area on the east side of the Coteau Des Prairies, free flowing deep wells can be drilled. Water from these wells is hard and contains enough chlorides, magnesium, and sulfates to affect the taste and use. Many wells provide enough water for household uses; however, there may not be enough for livestock. Dams and dugouts are used to provide additional water for livestock on many farms.

Three major drainage systems affect the drainage of Roberts County. The Little Minnesota River and the North Fork of the Whetstone River and their tributaries drain the western and southern part of the county. Small tributaries that flow in a southwesterly direction and drain the extreme southwest corner of the county then drain into the Big Sioux River which flows southerly into the Missouri River. The Bois de Sioux River, which forms a part of the east boundary of the county, flows north from Lake Traverse. The northeast part of the county has a poorly defined drainage pattern and is characterized by numerous sloughs and potholes.

Agriculture is the main industry in Roberts County. A combination of grain farming, livestock raising, dairying, and poultry production make up this enterprise.

Roberts County is one of the larger counties east of the Missouri River in the State, ranking 25th among the 67 counties in total land area.

Climate [10]

The climate of Roberts County is a continental type and is largely determined by the movement and interaction of large-scale weather systems. Winters are generally cold and summers are warm to hot. Precipitation is marginal to adequate for adapted crops.

Bodies of water and topography have some effect on the climate in the county. Numerous small lakes are in an area about 40 miles long and 15 miles wide just to the west of the western boundary of the county. Lake Traverse, about 15 miles long and 1 to 2 miles wide, extends along a southwest-northeast line forming the northern part of the eastern boundary of the county. Big Stone Lake, about 25 miles long and 1 mile wide, extends along a northwest-southeast line forming the southern part of the eastern boundary of the county. In places these lakes have a local moderating effect on the temperature. An escarpment extending south-southeastward from the northwestern part of the county rises to about 800 to 1,000 feet above the eastern part of the county.

The climatic summary for this county is based on 37 years (1921–1968) of weather records taken at or near Sisseton, which is located in the central part of the county at an elevation of about 1,200 feet. The climatic conditions at Sisseton are representative of those at the lower elevations of the county. The mean annual temperature at lower elevations of the county is expected to be within one degree of that at Sisseton. At times the temperature in the western part of the county averages as much as 3 degrees cooler than the temperature in the east because of the difference in elevation. Locally heavier precipitation occurs at times along or near the escarpment caused by the upslope effect with easterly winds. The average annual precipitation is expected to be within one inch of that at Sisseton at the lower elevations of the county.

Temperatures have a large variation annually, and occasionally this variation is large from day to day. The temperature generally rises to 100° F. or more during the summer and drops to −20° or colder during the winter. Based on data taken at Sisseton, a reading of 100° or more can be expected on the average of about 3 days per year. A −20° or lower temperature can be expected on the average of 3 to 4 days per year. A temperature of −30° or lower can be expected on the average of about 1 day in 4 years. The temperature drops to 0° or lower on the average of about 40 days per year, and it fails to climb above 0° on an average of about 5 days per year. Temperatures drop from 20 to 40 degrees from one day to the next with the passage of a strong cold front.

The chance of certain low temperatures after specified dates in spring or before indicated dates in fall is given in table 10. For example, the upper half of the table shows a 50

[10] By WALTER SPUHLER, climatologist for South Dakota, National Weather Service, U.S. Department of Commerce.

TABLE 10.—*Probabilities of specified temperatures after specified dates in spring and before specified dates in fall*

[Date from Sisseton, South Dakota, for the period 1932–1968. Table prepared by William F. Lytle, South Dakota State University]

Probability	Dates for given probability and temperature					
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower	36° F or lower
After specified dates in spring:						
90 percent	March 13	March 22	April 2	April 15	April 23	May 7
70 percent	March 20	March 30	April 9	April 21	April 29	May 14
50 percent	April 2	April 12	April 20	May 1	May 11	May 24
30 percent	April 14	April 24	May 1	May 11	May 22	June 3
10 percent	April 21	May 2	May 8	May 16	May 29	June 9
Before specified dates in fall:						
10 percent	October 15	October 7	September 24	September 19	September 10	September 2
30 percent	October 23	October 16	October 3	September 27	September 17	September 8
50 percent	November 6	October 30	October 16	October 10	September 28	September 18
70 percent	November 20	November 13	October 30	October 23	October 9	September 28
90 percent	November 28	November 21	November 8	October 30	October 16	October 4

percent chance that a 32° temperature will occur on or after May 11th. This is the same as saying in about 5 years out of 10 a temperature of 32° or lower can be expected at Sisseton on May 11 or later. The 50 percent chance data is also the average data of the indicated temperature.

Similarly, the lower half of table 10 shows there is a 70 percent chance that a temperature of 32° or lower will occur by October 9th. Therefore, on the average, 7 years out of 10 it will be 32° or lower at Sisseton on or before this date. These figures refer to air temperatures measured in a standard instrument shelter. Soil and plant temperatures vary somewhat from the temperature of the free air. Other temperature data as well as precipitation data are given in table 11.

The average annual precipitation at Sisseton is 21.76 inches with 16.98 inches or 78 percent falling during the growing season. Thundershowers are the main source of the growing season precipitation and produce a wide range of intensities and amounts. A rainfall of 1 inch or more in 1 hour can be expected about once a year and a rainfall of 2 inches or more in 1 hour can be expected about once in 10 years. A 24-hour rainfall of 3 inches or more can be expected about once in 5 years.

Hail occasionally accompanies the thundershowers and can be expected about 3 times per year in any one location in the Sisseton area and at lower elevations of the county. At times precipitation in the form of hail occurs more frequently along or near the escarpment. The months of most frequent hail precipitation are June, July, and August, but hail does fall as early as March and as late as October.

The seasonal snowfall in the Sisseton area averages 33 inches but has varied from 10 inches during the 1941–42 season to 71 inches during the 1936–37 season. Strong winds often accompany snowfall and cause large drifts in and near sheltered areas while open fields remain nearly bare. Snow cover of 1 inch or more is present on an average of about 65

TABLE 11.—*Temperature*

[Data from Sisseton, South Dakota, for the period 1932–1968.

Month	Temperature				Precipitation
			Two years in 10 will have—		
	Average daily maximum	Average daily minimum	Average maximum temperature equal to or higher than—	Average minimum temperature equal to or lower than—	Average total
	°F	°F	°F	°F	*Inches*
January	21.5	1.8	31.1	−7.4	0.53
February	25.5	5.6	34.3	−2.7	.60
March	38.7	18.8	47.6	11.7	1.05
April	56.0	32.4	63.0	28.0	2.48
May	69.7	44.5	76.5	39.8	3.05
June	78.3	54.6	83.9	72.6	4.06
July	85.0	59.9	89.9	80.1	2.89
August	83.5	57.8	87.9	79.0	2.81
September	73.3	47.6	78.8	67.8	1.69
October	62.4	37.2	68.0	56.9	1.26
November	41.3	21.7	48.3	34.4	.75
December	27.9	9.1	34.8	20.9	.59
Year	55.3	32.6	57.4	30.5	21.76

[1] In 1962.

days per year, and a cover of 4 inches or more is present about 33 days per year.

Wind speed averages 11 mph, and the prevailing direction is from the south during summer and from the northwest during winter in most of the county. At times the escarpment has a local effect on the wind direction. Strong winds of 50 mph or more can occur during any month of the year, but they are most likely to occur during summer thunderstorms. During other months strong winds sometimes accompany the passage of a cold front or an intense low-pressure area.

It is possible for a tornado to touch down in this county, but it is difficult to give a meaningful probability of this rare event.

Relative humidity has an appreciable variation from early in the morning to afternoon. It averages from about 85 percent early in the morning to 50 percent in the afternoon during summer and from about 80 percent early in the morning to 65 percent in afternoon during winter.

Sunshine is an important factor in crop production. This county receives about 65 percent of the possible sunshine. The highest amount of possible sunshine is in July and August when it reaches about 75 percent.

Water loss experienced by soils and crops is indicated by evaporation from a large pan. The average annual National Weather Service class A pan evaporation is about 44 inches of which about 40 inches, or 84 percent, evaporates from May through October. The pan evaporation represents a maximum or potential evaporation. Average annual lake evaporation is about 32 inches. The actual loss from soil and crops is generally less since soil moisture is often limiting.

Farming

Prior to 1900 many settlers were speculators and tradesmen who were not dependent on farming for a livelihood. A few farmers found livestock raising profitable; however, because livestock prices declined after the turn of the century, they began to raise small grains. Today, a combination of grain farming, livestock raising, dairying, and poultry production makes up the county's farming enterprise.

According to the U.S. Census of Agriculture, there were 1,554 farms in the county in 1964. Of these, 74 were 1,000 acres or more in size, and 290 were less than 180 acres in size. The size of Roberts County farms is increasing, and the average size in 1964 was 427 acres. Of the 1,554 farms reported 483 were classified as livestock farms, 465 as cash-grain farms, 236 as dairy farms, 193 as general farms, 13 as poultry farms, and 161 as miscellaneous and unclassified. Full owners operate 485, part owners 715, tenants 350, and managers 4.

Raising livestock is the most important enterprise in Roberts County. Approximately 56 percent of the total cash farm income comes from the sale of livestock and livestock products. Livestock reported in the 1964 census include 76,000 head of cattle and calves, 18,700 hogs and pigs, 21,100 sheep and lambs, and 165,000 chickens.

Generally inventory reports of all cattle in Roberts County have shown an upward trend in numbers over the years. The number of hogs, however, has shown considerable variation, because production can be quickly increased or decreased depending on changes in market conditions and feed suplies.

The major crops in Roberts County are wheat, corn, oats, flax, soybeans, barley, rye, alfalfa, and wild hay. According to the 1969 census wheat was harvested from 41,100 acres, corn from 51,500 acres, oats from 77,400 acres, flax from 65,300 acres, soybeans from 16,500 acres, barley from 6,600 acres, rye from 14,100 acres, alfalfa or an alfalfa mixture for hay was cut from 40,500 acres. There were 52,000 acres of native grass cut for hay.

Information about the past history of cropping and livestock raising in Roberts County can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service (*5*).

Literature Cited

(1) American Association of State Highway Officials. 1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2v., 401 and 617 pp., illus.

and precipitation data

Table prepared by William F. Lytle, South Dakota State University]

Precipitation—Continued						
Maximum total	Minimum total	One year in 10 will have—		Average total snowfall	Average number of days with—	
		Less than—	More than—		Snowfall 1 inch or more	Depth of snow cover 1 inch or more
Inches	*Inches*	*Inches*	*Inches*	*Inches*		
2.01	0	0.05	1.18	5.6	3	19
1.63	0	.09	1.28	6.8	2	16
3.19	.03	.24	2.11	7.3	3	8
5.79	.34	.67	4.79	3.5	1	2
9.76	.36	.93	5.72	.6	0	0
9.08	.98	2.04	6.41	0	0	0
8.13	.33	1.09	5.10	0	0	0
6.91	.32	.90	5.21	0	0	0
4.59	.30	.48	3.24	.1	0	0
3.78	.02	.16	2.80	.5	0	0
2.97	.05	.14	1.56	3.9	1	5
2.03	0	.01	1.34	4.7	2	13
[1] 30.83	[2] 13.03	17.25	27.15	33.0	11	63

[1] In 1952.

(2) Dyksterhuis, E. J. 1958. Range conservation as based on sites and condition classes. Journal of Soil and Water Conservation. v. 13, pp. 151-155, illus.
(3) Flint, Richard Foster. 1955. Pleistocene geology of eastern South Dakota. Geol. Survey Prof. Paper 262, 173 pp., illus.
(4) Simonson, Roy W. 1962. Soil classification in the United States. Science, v. 137, No. 3535: 1027–1034.
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(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dept. Agr. Handbook No. 18, 503 pp., illus.
(7) _____1967. Land-capability classification. U.S. Dept. Agr. Handbook No. 210, 21 pp.
(8) _____1960. Soil classification, a comprehensive system. 7th approximation. 265 pp., illus. [Supplement issued in March 1967]
(9) United States Department of Defense. 1962. Unified soil classification system for roads, airfields, embankments, and foundations. MIL-STD-619A, 13 pp., illus.

Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but that in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

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

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

Bearing capacity (engineering). The capacity of a soil to support loads.

Bottom land. A lowland that has been formed by alluvial deposition along a stream or in a lake basin. A flood plain.

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

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

California bearing ratio. The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California, and abbreviated CBR. A soil with a CBR of 16 will support 16 percent of the load that would be supported by the standard crushed limestone, per unit area and with the same degree of distortion.

Chiseling. Tillage of soil with an implement having one of more soil penetrating points that loosen the subsoil and brings *clods* to the surface. A form of emerging tillage to control soil blowing.

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

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly or very slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly within 10 inches of the surface and contains appreciable amounts of exchangeable sodium.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

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.

Continental climate. The climate in areas distant from the ocean; characterized by considerable variation in temperature and in other weather conditions.

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.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

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.

Eluviation. The movement of material from one place to another within the soil, in either true solution or colloidal suspension. Soil horizons that have lost material through eluviation are said to be eluvial; those that have received material are illuvial.

Emergency tillage. Cultivation by listing, ridging, duckfooting, chiseling, pitting, basin listing, or other means to roughen the soil surface for temporary control of soil blowing.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Eutrophication. Refers to the decrease in lakes of oxygen in the bottom waters and the increase in plant nutrients.

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.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also included the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial Lake Agassiz. A large, nearly level, historic lake bed formed by deposition of sediment when glacial melt waters were blocked by the glacier and a large body of ponded water accumulated.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Green manure (agronomy). A crop grown for the purpose of being turned

under in an early stage of maturity or soon after maturity for soil improvement.

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.

Illuviation. The accumulation of material in a soil horizon through the deposition of suspended material and organic matter removed from horizons above. Since part of the fine clay in the B horizon (or subsoil) of many soils has moved into the B horizon from the A horizon above, the B horizon is called an illuvial horizon.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. It may be limited either by the infiltration capacity of the soil or by the rate at which water is applied to the surface soil.

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Leached soil. A soil from which most of the soluble material has been removed from the entire profile or has been removed from one part of the profile and has accumulated in another part.

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

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

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 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil, and carbon, hydrogen, and oxygen obtained largely from the air and water, and plant nutrients.

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

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

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.* Numerical ranges in inches per hour for each class of permeability are as follows:

Very slow	Less than 0.06
Slow	0.06–0.2
Moderately slow	0.2–0.6
Moderate	0.6–2.0
Moderately rapid	2.0–6.0
Rapid	6.0–20.0
Very rapid	More than 20.0

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

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

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

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

	pH
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.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

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

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

Shear strength (engineering). The maximum ability of a soil to resist shearing or sliding along internal surfaces within a mass.

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

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

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

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.

Stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy*

(laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

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

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

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

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

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 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.

Wind stripcropping. Growing crops in strips that run crosswise to the general direction of prevailing wind and without strict adherence to the contour of the land.

GUIDE TO MAPPING UNITS

Absence of a capability unit, pasture group, range site, or windbreak group designation indicates that the mapping unit is not placed in that specified grouping, or the individual soils of a mapping unit are designated separately. 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. Other information is given in tables as follows:

Acreage and extent, table 1, page 12.
Predicted yields, table 2, page 64.
Woodland and windbreaks, table 3, page 70.
Engineering uses of the soils, tables 4, 5, 6, and 7, pages 76 through 103.
Recreation, table 8, page 105.

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group	Range site	Windbreak suitability group	
			Symbol	Page	Letter	Name	Number	Page
AaA	Aastad loam, 0 to 2 percent slopes-	13	I-3	56	K	Overflow	1	68
Ac	Antler-Colvin silt loams----------	13	IIe-4	56	-------	----------	--	--
	Antler soil----------	--	--------	--	K	Silty	1	68
	Colvin soil----------	--	--------	--	B	Wetland	10	71
At	Antler-Tonka silt loams----------	14	IIe-4	56	-------	----------	--	--
	Antler soil----------	--	--------	--	K	Silty	1	68
	Tonka soil----------	--	--------	--	A[2/],B[3/]	Wetland	10	71
AvA	Antler and Hamerly soils, 0 to 2 percent slopes----------	14	IIe-4	56	K	Silty	1	68
BbE	Barnes-Buse stony complex, 9 to 40 percent slopes----------	14	VIIs-1	61	-------	----------	10	71
	Barnes soil----------	--	--------	--	-------	Silty	--	--
	Buse soil----------	--	--------	--	-------	Thin Upland	--	--
Be	Bearden silty clay loam----------	15	IIe-4	56	K	Silty	1	68
Bo	Borup silt loam [1/]----------	16	IIw-2[2/], IVw-2[3/]	57 60	A[2/],B[3/]	Subirrigated	2	69
BpF	Buse-Forman loams, 20 to 40 percent slopes----------	16	VIIe-1	61	-------	----------	10	71
	Buse soil----------	--	--------	--	-------	Thin Upland	--	--
	Forman soil----------	--	--------	--	-------	Silty	--	--
Co	Colvin silt loam, saline----------	17	Vw-2	61	B	Wetland	10	71
DcA	Dickey fine sandy loam, 0 to 2 percent slopes----------	18	IIIs-1	59	H	Sandy	5	70
DcB	Dickey fine sandy loam, 2 to 6 percent slopes----------	18	IIIe-7	58	H	Sandy	5	70
Dm	Divide-Marysland loams----------	19	IIIs-4	59	-------	----------	2	69
	Divide soil----------	--	--------	--	A	Silty	--	--
	Marysland soil----------	--	--------	--	B	Subirrigated	--	--
Do	Doran loam----------	19	IIs-2	57	A	Clayey	4	69
Dv	Dovray clay----------	20	IIw-1	57	A	Clayey	2	69
EcA	Eckman loam, 0 to 2 percent slopes-	21	I-2	56	F	Silty	3	69
EcB	Eckman loam, 2 to 6 percent slopes-	21	IIe-3	56	F	Silty	3	69
EeC	Eckman-Zell complex, 6 to 9 percent slopes----------	21	IIIe-2	58	-------	----------	--	--
	Eckman soil----------	--	--------	--	F	Silty	3	69
	Zell soil----------	--	--------	--	G	Thin Upland	8	70
Eh	Embden-Hamar fine sandy loams------	22	IIIs-1	59	-------	----------	--	--
	Embden soil----------	--	--------	--	H	Sandy	1	68
	Hamar soil----------	--	--------	--	A	Subirrigated	2	69
FdA	Fordville loam, 0 to 3 percent slopes----------	22	IIs-3	57	D	Silty	6	70
FeB	Fordville-Renshaw loams, 3 to 6 percent slopes----------	23	IIIs-2	59	-------	----------	--	--
	Fordville soil----------	--	--------	--	D	Silty	6	70
	Renshaw soil----------	--	--------	--	D	Shallow to Gravel	10	71

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group		Range site	Windbreak suitability group	
			Symbol	Page	Letter		Name	Number	Page
FoA	Forman-Aastad loams, 0 to 2 percent slopes	24	I-2	56	-------		----------	--	--
	Forman soil	--	--------	--	F		Silty	3	69
	Aastad soil	--	--------	--	K		Overflow	1	68
FoB	Forman-Aastad loams, 2 to 6 percent slopes	24	IIe-2	56	-------		Silty	--	--
	Forman soil	--	--------	--	F		----------	3	69
	Aastad soil	--	--------	--	K		----------	1	68
FoC	Forman-Aastad loams, 6 to 9 percent slopes	24	IIIe-1	57	-------		Silty	--	--
	Forman soil	--	--------	--	F		----------	3	69
	Aastad soil	--	--------	--	K		----------	1	68
FoD	Forman-Aastad loams, 9 to 15 percent slopes	24	IVe-1	60	-------		Silty	--	--
	Forman soil	--	--------	--	F		----------	3	69
	Aastad soil	--	--------	--	K		----------	1	68
FsB	Forman-Aastad stony complex, 0 to 9 percent slopes	25	VIIs-1	61	-------		----------	10	71
	Forman soil	--	--------	--	-------		Silty	--	--
	Aastad soil	--	--------	--	-------		Overflow	--	--
FuC	Forman-Buse loams, 6 to 9 percent slopes, eroded	25	IVe-1	60	-------		----------	--	--
	Forman soil	--	--------	--	F		Silty	3	69
	Buse soil	--	--------	--	G		Thin Upland	10	71
FuD	Forman-Buse loams, 9 to 15 percent slopes, eroded	25	VIe-1	61	-------		----------	10	71
	Forman soil	--	--------	--	F		Silty	--	--
	Buse soil	--	--------	--	G		Thin Upland	--	--
FuE	Forman-Buse loams, 15 to 25 percent slopes	25	VIe-1	61	-------		----------	10	71
	Forman soil	--	--------	--	F		Silty	--	--
	Buse soil	--	--------	--	-------		Thin Upland	--	--
FvE	Forman-Buse stony complex, 9 to 40 percent slopes	26	VIIs-1	61	-------		----------	10	71
	Forman soil	--	--------	--	-------		Silty	--	--
	Buse soil	--	--------	--	-------		Thin Upland	--	--
Ga	Gardena silt loam	27	I-3	56	K		Silty	1	68
GyA	Glyndon silt loam, 0 to 3 percent slopes	27	IIe-4	56	K		Silty	1	68
Ha	Hamar fine sandy loam	29	IIIw-4	59	A		Subirrigated	2	69
HbA	Hamerly-Tonka complex, 0 to 3 percent slopes	29	IIe-4	56	-------		----------	--	--
	Hamerly soil	--	--------	--	K		Silty	1	68
	Tonka soil 1/	--	--------	--	A 2/, B 3/		Wetland	10	71
HcA	Hammerly-Vallers loams, 0 to 2 percent slopes	30	IIe-4	56	-------		----------	--	--
	Hamerly soil	--	--------	--	K		Silty	1	68
	Vallers soil 1/	--	--------	--	A 2/, B 3/		Subirrigated	2	69
HcB	Hamerly-Vallers loams, 2 to 4 percent slopes	30	IIIe-8	58	-------		----------	--	--
	Hammerly soil	--	--------	--	K		Silty	1	68
	Vallers soil 1/	--	--------	--	A 2/, B 3/		Subirrigated	2	69
HdD	Hattie clay loam, 9 to 15 percent slopes	30	IVe-5	60	E		Clayey	4	69
HdE	Hattie clay loam, 15 to 40 percent slopes	31	VIe-3	61	-------		Clayey	10	71
HkD	Hattie and Kloten soils, 9 to 25 percent slopes	31	VIe-3	61	-------		----------	10	71
	Hattie soil	--	--------	--	E		Clayey	--	--
	Kloten soil	--	--------	--	G		Thin Upland	--	--

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group	Range site	Windbreak suitability group	
			Symbol	Page	Letter	Name	Number	Page
HmA	Hecla-Hamar loamy fine sands, 0 to 3 percent slopes	31	IVs-1	60	-------	----------	--	--
	Hecla soil	--	--------	--	H	Sands	1	68
	Hamar soil	--	--------	--	A	Subirrigated	2	69
HsB	Heimdal-Sisseton loams, 2 to 6 percent slopes	32	IIe-2	56	-------	----------	--	--
	Heimdal soil	--	--------	--	F	Silty	3	69
	Sisseton soil	--	--------	--	G	Thin Upland	8	70
HsC	Heimdal-Sisseton loams, 6 to 9 percent slopes	32	IIIe-1	57	-------	----------	--	--
	Heimdal soil	--	--------	--	F	Silty	3	69
	Sisseton soil	--	--------	--	G	Thin Upland	8	70
HvA	Heimdal-Svea loams, 0 to 2 percent slopes	33	I-2	56	-------	----------	--	--
	Heimdal soil	--	--------	--	F	Silty	3	69
	Svea soil	--	--------	--	K	Overflow	1	68
HvB	Heimdal-Svea loams, 2 to 6 percent slopes	33	IIe-2	56	-------	Silty	--	--
	Heimdal soil	--	--------	--	F	----------	3	69
	Svea soil	--	--------	--	K	----------	1	68
La	LaDelle silt loam	34	I-1	56	K	Overflow	1	68
Lm	Lamoure silty clay loam 1/	36	IIw-3 2/	57	A 2/, B 3/	Subirrigated	2	69
			IVw-2 3/	60				
Lt	Loamy Fluvaquents	36	VIw-2	61	-------	Overflow	10	71
Lu	Ludden clay 1/	36	IIw-3 2/	57	A 2/, B 3/	Overflow	10	71
			IVw-2 3/	60				
MaB	Maddock loamy fine sand, 0 to 6 percent slopes	37	IVs-1	60	H	Sands	7	70
MaD	Maddock loamy fine sand, 6 to 25 percent slopes	37	VIs-1	61	H	Sands	10	71
Mr	Marsh	37	VIIIw-1	62	-------	----------	--	--
Mw	Marysland silt loam, wet	38	Vw-1	60	B	Wetland	10	71
Pa	Parnell silty clay loam 1/	38	IIIw-1 2/	58	A 2/, B 3/	Wetland	10	71
			Vw-2 3/	61				
PeA	Peever clay loam, 0 to 2 percent slopes	39	IIs-2	57	E	Clayey	4	69
PeB	Peever clay loam, 2 to 6 percent slopes	39	IIIe-3	57	E	Clayey	4	69
PeC	Peever clay loam, 6 to 9 percent slopes	39	IIIe-4	58	E	Clayey	4	69
PhA	Peever-Cavour complex, 0 to 3 percent slopes	39	IIs-2	57	-------	----------	--	--
	Peever soil	--	--------	--	E	Clayey	4	69
	Cavour soil	--	--------	--	C	Claypan	9	70
Pk	Peever-Tonka complex	40	IIs-2	57	-------	----------	--	--
	Peever soil	--	--------	--	E	Clayey	4	69
	Tonka soil 1/	--	--------	--	A 2/, B 3/	Wetland	10	71
Pm	Playmoor silty clay loam	40	IVw-2	60	J	Subirrigated	10	71
PoA	Poinsett silt loam, 0 to 2 percent slopes	41	I-2	56	F	Silty	3	69
PoB	Poinsett silt loam, 2 to 6 percent slopes	41	IIe-3	56	F	Silty	3	69
Ra	Rauville mucky silt loam	42	Vw-1	60	-------	Wetland	10	71
ReA	Renshaw loam, 0 to 3 percent slopes	43	IIIs-3	59	D	Shallow to Gravel	10	71
ReB	Renshaw loam, 3 to 9 percent slopes	43	IVs-2	60	D	Shallow to Gravel	10	71

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit		Pasture group		Range site	Windbreak suitability group	
			Symbol	Page	Letter		Name	Number	Page
RhB	Renshaw-Sioux loams, 3 to 9 percent slopes	44	IVs-2	60	-------		----------	10	71
	Renshaw soil	--	--------	--	D		Shallow to Gravel	--	--
	Sioux soil	--	--------	--	-------		Very Shallow	--	--
RhD	Renshaw-Sioux loams, 9 to 20 percent slopes	44	VIe-6	61	-------		----------	10	71
	Renshaw soil	--	--------	--	-------		Shallow to Gravel	--	--
	Sioux soil	--	--------	--	-------		Very Shallow	--	--
RsE	Renshaw-Sioux stony loams, 9 to 40 percent slopes	44	VIIs-1	61	-------		----------	10	71
	Renshaw soil	--	--------	--	-------		Shallow to Gravel	--	--
	Sioux soil	--	--------	--	-------		Very Shallow	--	--
RtA	Rentill loam, 0 to 2 percent slopes	45	IIs-3	57	F		Silty	3	69
RtB	Rentill loam, 2 to 6 percent slopes	45	IIIs-2	59	F		Silty	3	69
Sb	Sandy lake beaches	45	VIw-2	61	-------		Subirrigated	10	71
ScF	Sieche loam, 15 to 40 percent slopes	46	VIIe-1	61	-------		----------	10	71
SnA	Sinai silty clay, 0 to 2 percent slopes	47	IIs-2	57	I		Clayey	4	69
SnB	Sinai silty clay, 2 to 6 percent slopes	47	IIIe-3	58	I		Clayey	4	69
SsF	Sisseton loam, 25 to 40 percent slopes	48	VIIe-1	61	-------		Thin Upland	10	71
StD	Sisseton-Heimdal loams, 9 to 25 percent slopes	48	VIe-3	61	-------		----------	10	71
	Sisseton soil	--	--------	--	G		Thin Upland	--	--
	Heimdal soil	--	--------	--	F		Silty	--	--
SvC	Svea loam, 5 to 9 percent slopes	49	IIIe-2	58	K		Silty	1	68
SwA	Sverdrup sandy loam, 0 to 3 percent slopes	49	IIIs-1	59	H		Sandy	5	70
SwB	Sverdrup sandy loam, 3 to 9 percent slopes	50	IIIe-7	58	H		Sandy	5	70
Tk	Tonka silt loam [1]	50	IIw-1 [2] / IVw-2 [3]	57 / 60	A [2], B [3]		Wetland	10	71
To	Towner fine sandy loam	51	IIIs-1	59	H		Sandy	1	68
Un	Ulen sandy loam	51	IIIs-5	59	H		Sandy	2	69
VhA	Vallers-Hamerly loams, 0 to 2 percent slopes [1]	52	IIw-2 [2] / IVw-2 [3]	57 / 60	-------		----------	--	--
	Vallers soil	--	--------	--	A [2], B [3]		Subirrigated	2	69
	Hamerly soil	--	--------	--	K		Silty	1	68
VnA	Vienna silt loam, 0 to 2 percent slopes	53	I-2	56	F		Silty	3	69
VnB	Vienna silt loam, 2 to 6 percent slopes	53	IIe-2	56	F		Silty	3	69
VnC	Vienna silt loam, 6 to 9 percent slopes	53	IIIe-1	57	F		Silty	3	69
Wa	Waubay silty clay loam	54	I-3	56	K		Silty	1	68
ZeD	Zell-Eckman complex, 9 to 25 percent slopes	54	VIe-3	61	-------		----------	--	--
	Zell soil	--	--------	--	G		Thin Upland	10	71
	Eckman soil	--	--------	--	F		Silty	3	69

[1] Status of artificial drainage and feasibility of drainage determined by onsite inspection.

[2] Drained.

[3] Undrained.

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