SOIL SURVEY OF

Pipestone County, Minnesota

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

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

Major fieldwork for this soil survey was completed in the period 1963–69. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made cooperatively by the Soil Conservation Service and the University of Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Pipestone Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and windbreaks; 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 Pipestone County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

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

Finding and Using Information

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

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

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

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

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

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

Resource planners and others concerned with recreational development can read about soil properties that affect the choice of sites for parks, picnic areas, and for recreational uses in the section "Recreation."

Engineers, community planners, builders, and others can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties, ratings that summarize limitations of the soils for dwellings, roads, and other related uses, 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 Pipestone County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "General Nature of the County."

Cover: **Contour stripcropping on rolling Barnes soils in the Barnes-Buse association.**

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SOIL SURVEY OF PIPESTONE COUNTY, MINNESOTA

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

PIPESTONE COUNTY is in the southwestern part of Minnesota. It has a total area of 464 square miles, or 296,960 acres (fig. 1). Pipestone is the county seat.

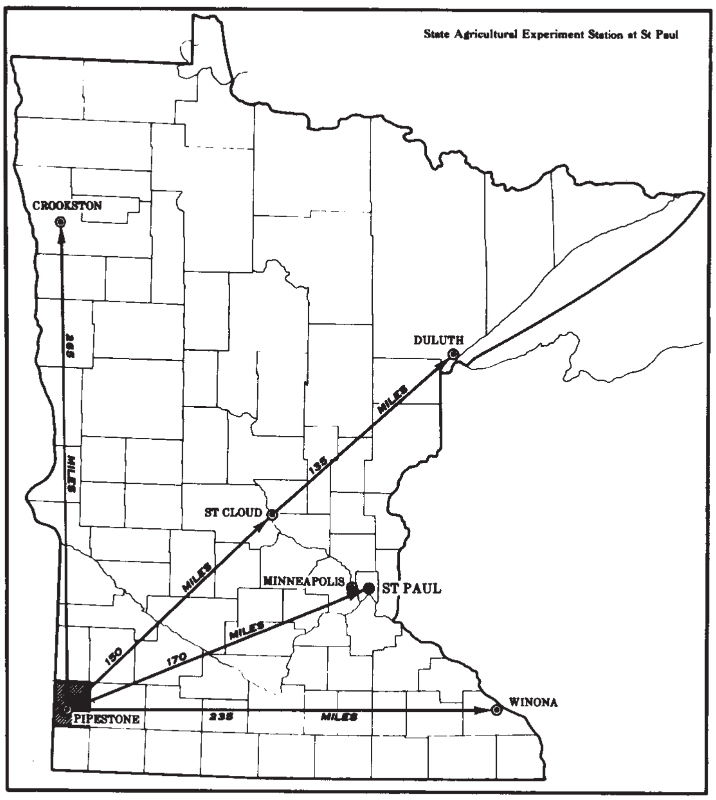

Figure 1.—**Location of Pipestone County in Minnesota.**

Farming is the most important enterprise in the county. Corn, oats, flax, soybeans, and hay are the main crops. The main livestock are beef cattle and hogs. Dairying and sheep raising are also important.

Pipestone County has mostly dark-colored, gently sloping soils that formed in medium-textured or moderately fine textured wind- or glacier-deposited material. The original vegetation was tall and medium prairie grasses.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Pipestone 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 the action of plant roots.

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. 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. Kranzburg and Trosky, 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, Estelline silty clay loam, 0 to 2 percent slopes, is one of several phases within the Estelline series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Pipestone 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. Buse-Sioux complex, 18 to 40 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. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Flom and Roliss clay loams 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 it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Marsh is a land type in Pipestone 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 its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Pipestone 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. This is because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil associations and delineations on the general soil map in this soil survey do not fully agree with those of the general soil maps in adjacent counties published at a different date. Differences in the maps are the result of improvements in the classification of soils, particularly in the modifications or refinements in soil series concepts. Still another difference is caused by the range in slope that is permitted with associations in different surveys.

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

1. Estelline-Lamoure association

Well drained and poorly drained, mainly nearly level soils that formed in wind- and water-deposited silty materials on stream terraces and bottom lands

This association consists of terraces and bottom lands along streams and creeks in the county. The largest areas of this association are along Rock River and Pipestone Creek, the major streams in the county. Slopes are mostly nearly level, except where escarpments separate the uplands from the stream terraces and the terraces from the bottom lands.

This association covers about 27 percent of the county. It is about 30 percent Estelline soils, 20 percent Lamoure soils, and 50 percent minor soils (fig. 2).

Estelline soils are on stream terraces. These soils are mostly nearly level, but they are gently sloping in pla-

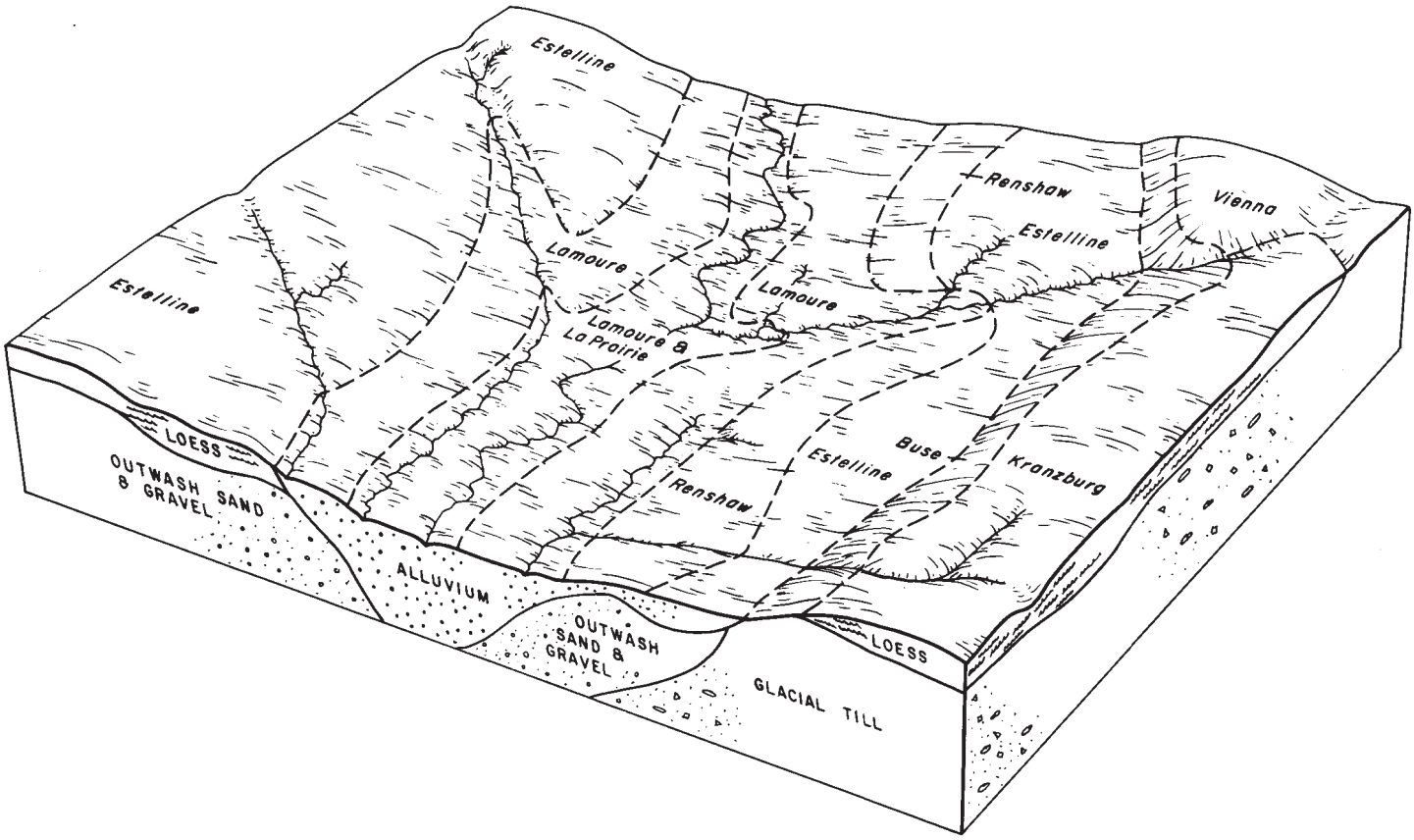

***Figure 2.*—Relationship of soils, underlying materials, and landform in association 1. Buse, Kransburg, and Vienna soils on adjacent uplands are in association 3.**

ces. They are well drained. The surface layer, about 10 inches thick, is black silty clay loam that grades to very dark brown in the lower part. The subsoil, about 20 inches thick, is friable silty clay loam that is very dark grayish brown in the upper part and dark yellowish brown in the lower part. The underlying material is dark grayish-brown and brown sand and gravel.

Lamoure soils are on bottom lands. These soils are nearly level and poorly drained. The surface layer, about 30 inches thick, is black and very dark gray silty clay loam. The underlying material is very dark gray to grayish-brown silty clay loam that contains thin layers of sandy clay loam and loamy sand.

The minor soils of this association are in the Renshaw, Sioux, Athelwold, Trosky, La Prairie, and Rauville series. Renshaw, Sioux, Athelwold, and Trosky soils are on stream terraces. La Prairie and Rauville soils are on bottom lands. The position of Renshaw soils is similar to that of Estelline soils, but Renshaw soils are less deep over sand and gravel than Estelline soils. Sioux soils are on escarpments. Athelwold soils, which are moderately well drained, and Trosky soils, which are poorly drained, are in slight swales and in lower positions on the stream terraces. Intermingled with Lamoure soils are the better drained La Prairie soils in higher positions and the wetter Rauville soils in lower positions.

Droughtiness is the main limitation to use of Estelline soils, because available water capacity is moderate. Estelline soils are very well suited to irrigation, but an adequate water supply is difficult to find. The part of this association that extends from Holland to Pipestone is mostly Trosky and Athelwold soils, which are less apt to become droughty. Wetness and susceptibility to occasional flooding are the main limitations to use of Lamoure soils. Suitable outlets for tile drains are difficult to establish, because of the low position of these soils. In some places Lamoure soils need special fertilizer because the surface layer is extremely high in lime.

Estelline soils are fairly well suited to crops commonly grown in the county, especially when rainfall is timely and adequate. Lamoure soils can be row cropped intensively. The frequently flooded areas on bottom lands are used for pasture and range. Most of the farms are used to raise livestock. Estelline soils are a good source of sand and gravel.

2. *Brookings-Hidewood association*

Moderately well drained and somewhat poorly drained, mainly nearly level soils that formed in loess on uplands

This association consists of a nearly level moraine that is covered by a mantle of loess. The underlying

glacial till has been filled in and leveled by moderately fine textured, wind-deposited, silty material. Slopes are mostly nearly level, but they range to gently sloping.

This association covers about 13 percent of the county. It is about 48 percent Brookings soils, 37 percent Hidewood soils, and 15 percent minor soils.

Brookings soils are on slight rises and on the lower part of side slopes. They are moderately well drained. The surface layer is black silty clay loam about 16 inches thick. It is very dark grayish brown in the lower part. The subsoil is friable, olive-brown and light olive-brown silty clay loam. Light olive-brown and light brownish-gray loam glacial till is at a depth of 29 inches.

Hidewood soils are in drainageways and on wet flats. They are somewhat poorly drained. These soils have a black silty clay loam surface layer about 23 inches thick. The surface layer is very dark gray in the lower part. The subsoil, about 14 inches thick, is friable, dark-gray and grayish-brown silty clay loam. The underlying material is mottled, gray clay loam glacial till.

The minor soils of this association are in the Kranzburg, Tonka, and Estelline series. Kranzburg soils are on some of the higher landscape positions in the association. Tonka soils are in depressions. Estelline soils formed in places that are underlain by sand and gravel.

Wetness is the major limitation to the use of Hidewood soils. Brookings soils have no serious limitations. Hidewood soils benefit from supplemental tile drainage.

In a few areas of the association the underlying glacial till is dense, heavy clay loam or clay. Septic tank drain fields work poorly in these areas, and special precautions are needed to prevent basement walls and foundations from cracking or heaving. Good supplies of well water are difficult to find in some areas of the association.

This association is well suited to intensive farming. Good farming methods and drainage are needed. Most farms are cash grain enterprises.

3. *Kranzburg-Vienna association*

Well-drained, mainly gently sloping soils that formed in loess and loamy glacial till on uplands

This association consists of broad ridgetops and side slopes that end in drainageways. It has the landscape that is most nearly typical of that of Pipestone County. Most areas of this association are covered by a thin mantle of loess that overlies glacial till. Slopes are long, smooth, and gentle because most irregularities in the glacial till have been filled in and leveled by wind-deposited silty material.

This association covers about 41 percent of the county. It is about 56 percent Kranzburg soils, 16 percent Vienna soils, and 38 percent minor soils (fig. 3).

Kranzburg soils formed in loess. These soils are generally gently sloping, but they are nearly level in places.

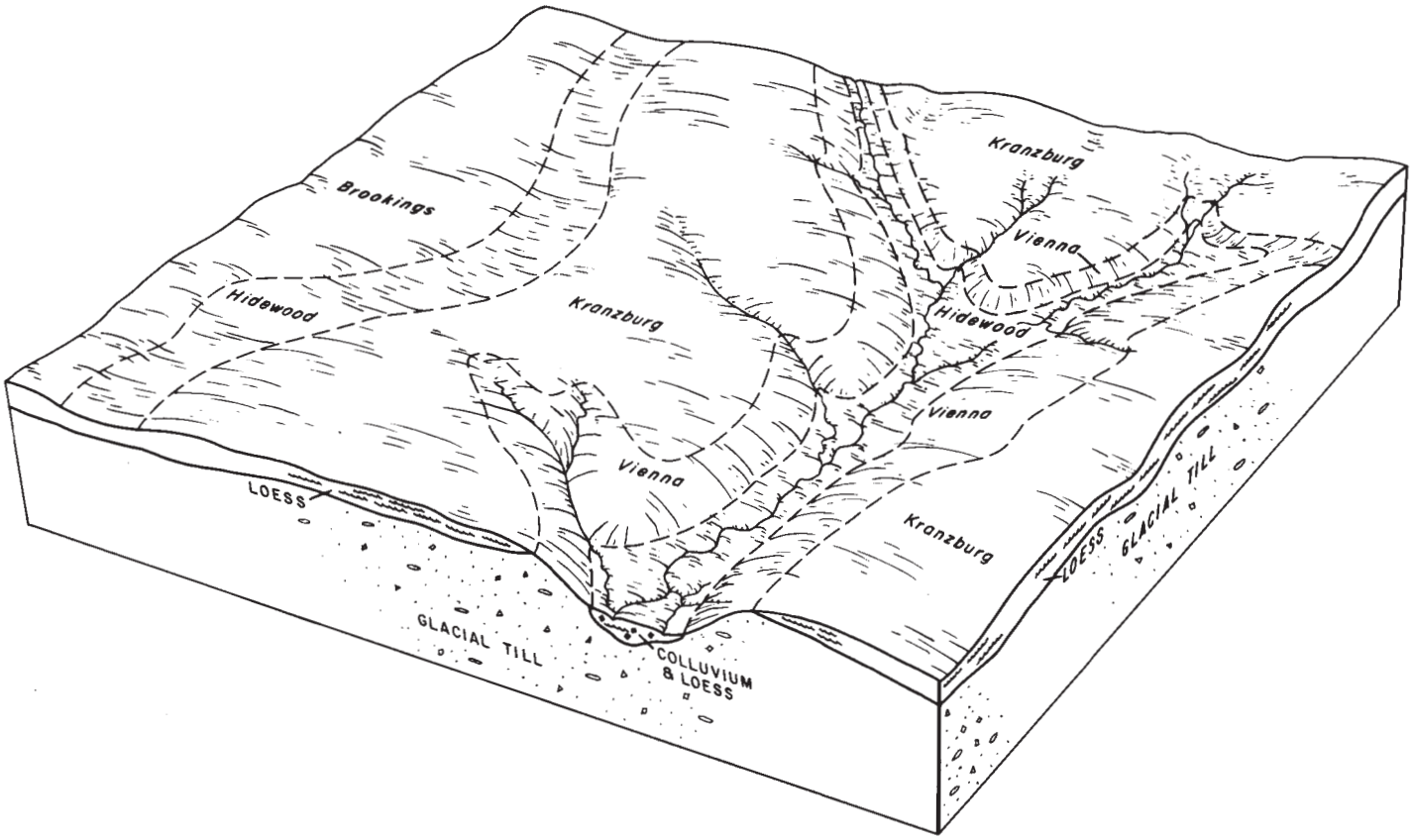

Figure 3.—**Relationship of soils, underlying materials, and landform in association 3.**

The surface layer, about 10 inches thick, is black silty clay loam that grades to dark brown. The subsoil, about 22 inches thick, is friable, very dark grayish-brown to dark-brown, brown, and light olive-brown silty clay loam. The underlying material is grayish-brown and light olive-brown clay loam glacial till.

Vienna soils formed in areas where the glacial till was exposed or where the mantle of loess was very thin. These soils are generally gently sloping, but they are sloping to moderately steep along the sides and heads of drainageways. The surface layer and the subsoil contain stones and pebbles. The surface layer, about 16 inches thick, is black to very dark gray and grayish-brown silty clay loam. The subsoil, about 11 inches thick, is friable, dark grayish-brown clay loam and dark yellowish-brown and yellowish-brown loam. The underlying material is yellowish-brown and grayish-brown loam and clay loam.

The minor soils of this association are in the Brookings, Hidewood, Lismore, Buse, and Darnen series. The moderately well drained Brookings soils occupy positions below Kranzburg and Vienna soils, and the somewhat poorly drained Hidewood soils are in drainageways. The moderately well drained Lismore soils occupy some of the lower elevations in areas of Vienna soils. In many places the steep Buse soils are closely intermingled with sloping and moderately steep Vienna soils. Darnen soils are on foot slopes and at the head of drainageways.

Erosion is the major limitation to the use of the soils in this association. In many places the surface layer is brownish because erosion and tillage have mixed material from the subsoil with that in the surface layers. The long, smooth slopes make these soils well suited to contour farming. Drainage is needed, and waterways should be constructed in some of the drainageways.

Corn, small grain, and alfalfa grow well on these soils if erosion is controlled, fertility is adequate, and rainfall is ample. Most of the farms are used to raise livestock.

4. *Barnes-Buse Association*

Well-drained, gently undulating to steep soils that formed in loamy glacial till on uplands

This association consists of a rolling to hilly moraine known locally as "Buffalo Ridge." Slopes are gently undulating to steep. The texture of the glacial till is loam or clay loam.

This association covers about 5 percent of the county. It is about 44 percent Barnes soils, 20 percent Buse soils, and 36 percent minor soils (fig. 4).

Barnes soils are gently undulating to moderately steep. The surface layer is black loam about 9 inches thick. The subsoil, about 12 inches thick, is friable, dark

Figure 4.—**Stripcropping on rolling soils in association 4. Buse soils are closely intermingled with Barnes soils.**

yellowish-brown loam. The underlying material is yellowish-brown, light olive-brown, and grayish-brown loam glacial till.

Buse soils are generally steep, but they are not so steep in areas where they are closely intermingled with Barnes soils. The surface layer is black and very dark grayish-brown loam about 7 inches thick. A layer, 7 inches thick, that is mostly dark-brown, very dark grayish-brown, and very dark gray loam worm casts is transitional to light olive-brown loam glacial till.

The minor soils of the association are in the Flom, Quam, Darnen, Sverdrup, and Renshaw series. The poorly drained Flom soils are in drainageways. Quam soils are in closed depressions. Darnen soils are at the foot of slopes and at the head of drainageways. Small areas of Sverdrup and Renshaw soils, which are underlain by sand and gravel, are scattered throughout the association.

If the soils in this association are cultivated, the hazard of erosion is severe. Runoff is excessive, and the steep soils are somewhat droughty. Farming on the contour helps to reduce erosion and runoff.

Much of the acreage of the association is in pasture or is used for range. If the range is well managed, native grasses are the dominant vegetation. If the grasses are heavily grazed, the native grasses are almost depleted and less desirable Kentucky bluegrass becomes dominant.

Most of the farms are used to raise livestock. Corn, small grain, and hay crops are also grown.

5. *Barnes-Flom association*

Well drained and poorly drained, mainly gently undulating and nearly level soils that formed in loamy glacial till on uplands

This association has an undulating relief that is marked by swells and swales. Slopes are mainly gently undulating and nearly level, but they range to rolling. Closed depressions are common.

This association covers about 4 percent of the county. It is about 48 percent Barnes soils, 25 percent Flom soils, and 27 percent minor soils.

Barnes soils are mainly gently undulating and are on swells. They are well drained. The surface layer is black loam about 9 inches thick. The subsoil is friable, dark yellowish-brown loam about 12 inches thick. The underlying material is yellowish-brown, light olive-brown, and grayish-brown loam glacial till.

Flom soils are nearly level and are in swales. They are poorly drained. The surface layer is mostly black clay loam about 20 inches thick. The subsoil, about 15 inches thick, is friable, mottled, dark-gray and grayish-brown clay loam. The underlying material is mottled, olive-gray clay loam glacial till.

The minor soils of this association are in the Svea, Roliss, Quam, and Lamoure series. The moderately well drained Svea soils are on the low swells and in some nearly level areas. The poorly drained Roliss soils are in swales and on the edges of closed depressions that are occupied by Quam soils. Lamoure soils are on the bottom lands along the Redwood River and its tributaries.

Susceptibility of the Barnes soils to erosion and wetness in the Flom soils are the major limitations to the use of the soils in this association. Many areas of Barnes soils have slopes that are too irregular or complex for contour farming. Using minimum tillage and growing grasses and legumes help to control erosion. Constructing tile and surface ditches are practices that help to drain Flom soils and other soils that are limited by wetness.

Cash grain farms are common in this association. A few farms are used to raise livestock.

6. *Ihlen-Rock outcrop association*

Well-drained, nearly level and gently sloping soils that formed in loess and rock outcrop on uplands

This association has a nearly level to gently sloping landscape. Slopes are very long. Areas of rock outcrop are numerous, and quartzite bedrock is at a depth of less than 3 feet in most places. A large acreage of this association is near Ihlen, and a small acreage is near the Pipestone National Monument. A few areas too small to be shown on the soil map are between these two areas.

This association covers about 1 percent of the county. It is about 57 percent Ihlen-Rock outcrop complex, 26 percent Ihlen soils, and 17 percent minor soils.

The Ihlen-Rock outcrop complex is mostly nearly level and gently sloping. About half of the Ihlen-Rock outcrop complex consists of Ihlen soils, which are 20 to 40 inches thick over bedrock. The rest consists mostly of Rock outcrop and some areas of soils that are less than 20 inches thick over bedrock.

The well-drained Ihlen soils are nearly level and gently sloping. The surface layer is generally very dark-brown silty clay loam about 8 inches thick. The subsoil, about 23 inches thick, is mainly friable, dark yellowish-brown and brown silty clay loam. The lower part of the subsoil is dark grayish-brown silt loam that overlies bedrock.

The minor soils of this association are in the Moody, Trent, and Whitewood series. The well-drained Moody soils are on higher parts of side slopes; the moderately well drained Trent soils are on the lower parts of side slopes; and the somewhat poorly drained Whitewood soils are in drainageways that dissect these side slopes. Most areas of these soils contain a few rock outcrops or spots where the soils are shallow to bedrock.

Most of the acreage of Ihlen soils is cultivated, and susceptibility to erosion is the major limitation to use. Farming on the contour and terracing are easily adapted to these soils and help to reduce further soil losses. Farm machinery is difficult to use on areas of Rock outcrops and areas of soils that are shallow to bedrock. Sioux quartzite, the underlying bedrock, is a hard reddish rock. Pipestone or catlinite, which is reddish, hardened clay, occurs in thin layers in the quartzite at the National Monument. Where the Ihlen-Rock outcrop complex is used for pasture and range, erosion is not a hazard. Control of grazing is the main management need.

Most of the farms in this association are used to raise livestock.

7. *Moody-Trent-Whitewood association*

Well drained, moderately well drained, and somewhat poorly drained, nearly level and gently sloping soils that formed in loess on uplands

This association is in the southwestern part of Pipestone County. It consists of broad ridgetops and side slopes that end in drainageways. Most areas of this association are covered by a thick mantle of loess. Slopes are long, smooth, and gentle, because irregularities in the underlying glacial till were filled in and leveled by wind-deposited silty materials.

This association covers about 9 percent of the county. It is about 31 percent Moody soils, 30 percent Trent soils, 26 percent Whitewood soils, and 13 percent minor soils (fig. 5).

The well-drained Moody soils are nearly level and gently sloping. The surface layer, about 10 inches thick, is very dark brown silty clay loam. The subsoil, about 25 inches thick, is friable, dark yellowish-brown to dark grayish-brown silty clay loam. The underlying material is brown silt loam that contains thin layers of fine sandy loam.

The moderately well drained Trent soils are nearly level. The surface layer, about 21 inches thick, is black silty clay loam that is very dark gray in the lower part. The subsoil, about 10 inches thick, is friable, dark grayish-brown to light olive-brown silty clay loam. The underlying material is mottled, light olive-brown and grayish-brown silt loam.

The somewhat poorly drained Whitewood soils are nearly level. The surface layer, about 24 inches thick, is black silty clay loam that is very dark gray, black, and olive gray in the lower part. The subsoil, about 7 inches thick, is friable, mottled, olive-gray silty clay loam. The underlying material is mottled, olive and light olive-gray silt loam.

The minor soils of this association are in the Lamoure, Sverdrup, and Renshaw series. Lamoure soils are on bottom lands along the rivers and creeks. Sverdrup and Renshaw soils, which overlie sand and gravel, are in a few small areas.

Susceptibility to erosion is the major limitation to use of the Moody soils. The slopes are well suited to erosion-control practices. Trent soils have no serious limitations to use. Wetness is a limitation on Whitewood soils, and supplemental drainage and grassed waterways are needed.

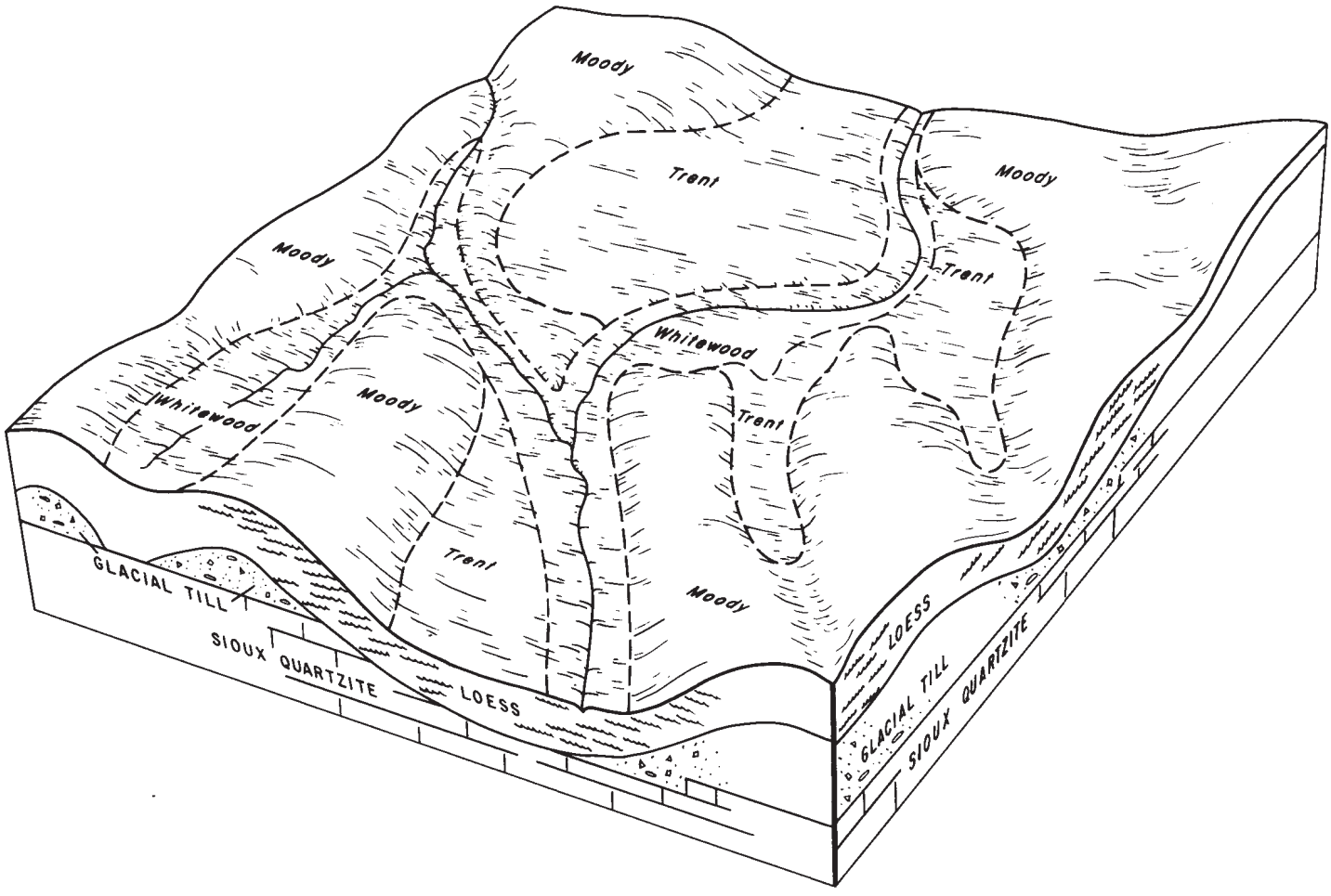

Figure 5.—**Relationship of soils, underlying material, and landform in association 7.**

Nearly all of the acreage of this association is cultivated. Corn, small grain, and alfalfa are the main crops. Most of the farms are used to raise livestock.

Descriptions of the Soils

This section describes the soil series and mapping units in Pipestone 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 moist soil unless otherwise stated.

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

The names, descriptions, and delineations of soils discussed in this survey do not necessarily agree or join fully with those shown on soil maps of adjoining counties that were published at an earlier date. Differences are brought about by better knowledge about soils or modifications and refinements in soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include small acreages of soils with soils that respond to use and management in much the same way rather than to separate these soils and give them names. The soil descriptions reflect these combinations. Other differences are brought about by the predominance of different soils in taxonomic units made up by two or three series. Still another difference may be caused by the range in slope allowed within the mapping unit for each survey.

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, range site, windbreak suitability group, or other interpretative group can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*8*).[1]

Athelwold Series

The Athelwold series consists of moderately well drained, nearly level soils. These soils formed under prairie vegetation in moderately fine textured loess or silty alluvium underlain by calcareous sand and gravel. They are on the lower part of stream terraces and on outwash plains.

In a representative profile the surface layer is silty clay loam about 17 inches thick. It is black in the upper 13 inches and very dark gray and dark grayish brown in the lower 4 inches. The subsoil is friable, dark grayish-brown and olive-brown silty clay loam about 10 inches thick. The underlying material is light olive-brown sandy clay loam to a depth of about 31 inches. Below this depth it is light yellowish-brown gravelly coarse sand.

Permeability is moderate above the sand and gravel and rapid in the sand and gravel. Available water capacity is moderate. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonable high water table is at a depth of 2 to 5 feet and usually coincides with the boundary of the underlying sand and gravel.

Most areas of Athelwold soils are used for crops, and they are well suited to all crops commonly grown in the county. The soils are free of stones, easy to work, and productive. The major limitation to use of these soils is the moderate available water capacity.

Representative profile of Athelwold silty clay loam, in a cultivated field, 1,830 feet north and 200 feet west of the southeast corner of sec. 1, T. 107 N., R. 45 W.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam; cloddy; slightly sticky; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) silty clay loam; weak vertical cleavage parting to moderate, very fine and fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

A3—13 to 17 inches, very dark gray (10YR 3/1) and dark grayish-brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) crushed; a few spots of olive brown (2.5Y 4/4); moderate, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B21—17 to 22 inches, dark grayish-brown (2.5Y 4/2) grading to olive-brown (2.5Y 4/4) silty clay loam; weak, medium and coarse, prismatic structure parting to weak, fine and medium, subangular blocky; friable; a few very dark gray (10YR 3/1) casts and root channels; moderately alkaline; clear, smooth boundary.

B22—22 to 27 inches, olive-brown (2.5Y 4/4) silty clay loam; weak and moderate, very fine and fine, subangular blocky structure; friable; moderately alkaline; clear, wavy boundary.

C1ca—27 to 31 inches, light olive-brown (2.5Y 5/4) sandy clay loam; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; very weak, medium, subangu-

[1] Italic numbers in parentheses refer to Literature Cited, p. 89.

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

Soil	Acres	Percent	Soil	Acres	Percent
Athelwold silty clay loam	6,700	2.3	La Prairie loam	2,100	0.7
Barnes loam, 1 to 4 percent slopes	3,000	1.0	Lismore silty clay loam, 0 to 3 percent slopes	1,500	.5
Barnes loam, 3 to 6 percent slopes, eroded	7,400	2.5	Marsh	150	(1)
Barnes loam, 6 to 12 percent slopes, eroded	1,400	.5	Moody silty clay loam, 0 to 2 percent slopes	1,700	.6
Brookings silty clay loam, 0 to 3 percent slopes	48,600	16.4	Moody silty clay loam, 2 to 4 percent slopes	4,700	1.6
Buse loam, 18 to 25 percent slopes	1,300	.4	Moody silty clay loam, 3 to 6 percent slopes, eroded	3,700	1.2
Buse loam, 25 to 40 percent slopes	1,400	.5	Quam silty clay loam	390	.1
Buse-Barnes loams, 6 to 12 percent slopes, eroded	1,500	.5	Rauville silty clay loam	1,600	.5
Buse-Barnes loams, 12 to 18 percent slopes	510	.2	Renshaw loam, 0 to 2 percent slopes	590	.2
Buse-Sioux complex, 12 to 18 percent slopes	940	.3	Renshaw loam, 2 to 6 percent slopes	2,600	.9
Buse-Sioux complex, 18 to 40 percent slopes	570	.2	Renshaw loam, 6 to 12 percent slopes	1,100	.4
Buse-Vienna loams, 6 to 12 percent slopes	420	.1	Renshaw loam, 12 to 18 percent slopes	290	.1
Buse-Vienna loams, 6 to 12 percent slopes, eroded	970	.3	Renshaw-Vienna-Buse loams, 2 to 6 percent slopes, eroded	375	.1
Buse-Vienna loams, 12 to 18 percent slopes	1,900	.6	Renshaw-Vienna-Buse loams, 6 to 12 percent slopes, eroded	800	.3
Buse-Vienna loams, 12 to 18 percent slopes, eroded	620	.2	Rock outcrop-Ihlen complex, 6 to 12 percent slopes	220	.1
Darnen loam, 2 to 6 percent slopes	1,500	.5	Sioux gravelly loamy coarse sand, 2 to 40 percent slopes	1,300	.4
Estelline silty clay loam, 0 to 2 percent slopes	16,000	5.4	Svea clay loam, 0 to 3 percent slopes	3,500	1.2
Estelline silty clay loam, 2 to 6 percent slopes	3,600	1.2	Sverdrup fine sandy loam, 0 to 2 percent slopes	230	.1
Estelline silty clay loam, 2 to 6 percent slopes, eroded	2,900	1.0	Sverdrup fine sandy loam, 2 to 6 percent slopes	750	.3
Estelline silty clay loam, deep, 0 to 2 percent slopes	8,200	2.8	Swenoda loam, 0 to 2 percent slopes	475	.2
Flandreau silt loam, 0 to 2 percent slopes	820	.3	Swenoda loam, 2 to 6 percent slopes	390	.1
Flandreau silt loam, 2 to 6 percent slopes	790	.3	Tonka silt loam	125	(1)
Flandreau silt loam, 2 to 6 percent slopes, eroded	610	.2	Trent silty clay loam, 0 to 3 percent slopes	9,800	3.3
Flom and Roliss clay loams	5,000	1.7	Trosky silty clay loam	8,600	2.9
Fordville loam, 0 to 2 percent slopes	385	.1	Vienna loam, 6 to 12 percent slopes	580	.2
Fordville loam, 2 to 6 percent slopes, eroded	880	.3	Vienna loam, 6 to 12 percent slopes, eroded	2,200	.7
Gravel pit	390	.1	Vienna silty clay loam, 0 to 2 percent slopes	500	.2
Hidewood silty clay loam	20,000	6.7	Vienna silty clay loam, 2 to 4 percent slopes	3,500	1.2
Ihlen silty clay loam, 0 to 2 percent slopes	510	.2	Vienna silty clay loam, 3 to 6 percent slopes, eroded	12,100	4.1
Ihlen silty clay loam, 2 to 6 percent slopes	580	.2	Whitewood silty clay loam	12,200	4.1
Ihlen-Rock outcrop complex, 0 to 6 percent slopes	1,100	.4	Water	100	(1)
Kranzburg silty clay loam, 0 to 2 percent slopes	7,600	2.6			
Kranzburg silty clay loam, 2 to 4 percent slopes	24,900	8.4			
Kranzburg silty clay loam, 3 to 6 percent slopes, eroded	26,200	8.8			
Lamoure silty clay loam	5,500	1.8			
Lamoure silty clay loam, frequently flooded	9,200	3.1			
Lamoure and La Prairie soils, frequently flooded	4,900	1.6	Total	296,960	100.0

[1] Less than 0.05 percent.

lar blocky structure; friable; slightly effervescent; moderately alkaline; abrupt, wavy boundary.

IIC2—31 to 60 inches, light yellowish-brown (2.5Y 6/4) gravelly coarse sand; common, coarse, distinct, yellowish-brown (10YR 5/4) mottles; single grained; loose; slightly and strongly effervescent; moderately alkaline.

The A1 horizon is silty clay loam or silt loam 10 to 20 inches thick. The A3 horizon generally is 3 to 5 inches thick. The B2 horizon ranges from 10 to 20 inches in thickness. The sandy clay loam C1 or B3 horizon is 3 to 6 inches thick. Free lime occurs above, at, or slightly below the boundary of the IIC horizon. Depth to sand and gravel generally is between 30 and 40 inches, but it ranges from 30 to 48 inches. The IIC horizon typically is gravelly coarse sand, but it ranges from sand to gravel.

In most of the Athelwold soils mapped in Pipestone County, the IIC horizon is at a shallower depth than is defined as within the range for the series. Because these soils are moderately well drained, however, this difference does not appreciably alter their usefulness and behavior.

Athelwold soils are near Estelline and Trosky soils. They have a thicker A1 horizon and a yellower B horizon than the well-drained Estelline soils. They are better drained and have a less mottled, brighter colored B horizon than Trosky soils.

Athelwold silty clay loam (0 to 2 percent slopes) (At).—This soil is mainly on the lower part of stream terraces and on outwash plains. A few areas are also on uplands.

Included with this soil in mapping are a few areas of soils in which sand and gravel are at a depth of less than 30 inches. These included soils have lower available water capacity than this soil, and they are the first to be affected by a lack of moisture during periods of drought. Also included are a few areas of soils that have a calcareous surface layer and subsoil.

This soil is slightly droughty, because available water capacity is moderate. It is not subject to serious limitations because of erosion or wetness.

Most areas of this soil are used for corn and soybeans, but some areas are used for range and pasture. This soil is well suited to these uses. Capability unit IIs–1; windbreak suitability group 1; Overflow range site.

Barnes Series

The Barnes series consists of well-drained, gently undulating to moderately steep soils on glacial uplands. These soils formed under prairie vegetation in medium-textured glacial till. They are on the higher parts of the uplands.

In a representative profile the surface layer is black loam about 9 inches thick. The subsoil is friable, dark yellowish-brown loam about 12 inches thick. The under-

lying material, to a depth of 40 inches, is yellowish-brown and light olive-brown loam that contains small pockets of lime. Below this it is grayish-brown loam. Stones and pebbles are common throughout the profile.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of Barnes soils are used for crops, but a few areas are used for range and pasture. These soils are well suited to all crops commonly grown in the county. The major limitation to the use of these soils is susceptibilty to erosion.

Representative profile of Barnes loam, 1 to 4 percent slopes, in a cultivated field, 1,000 feet south and 60 feet west of the northeast corner sec. 27, T. 108 N., R. 44 W.:

Ap—0 to 5 inches, black (10YR 2/1) loam; cloddy; friable; neutral; abrupt, smooth boundary.

A12—5 to 9 inches, black (10YR 2/1) loam; very weak, very fine and fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B21—9 to 16 inches, dark yellowish-brown (10YR 3/4) loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; a few very dark gray (10YR 3/1) casts; neutral; clear, wavy boundary.

B22—16 to 21 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; about 6 percent coarse fragments; moderately alkaline; abrupt, wavy boundary.

C1ca—21 to 27 inches, yellowish-brown (10YR 5/4) loam; very weak, medium and coarse, prismatic structure parting to weak, medium, subangular blocky; friable; about 9 percent coarse fragments; violently effervescent; moderately alkaline; clear, wavy boundary.

C2ca—27 to 40 inches, light olive-brown (2.5Y 5/4) loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; massive; friable; few limy masses; about 8 percent coarse fragments; strongly and violently effervescent; moderately alkaline; clear, wavy boundary.

C3—40 to 60 inches, grayish-brown (2.5Y 5/2) loam; many, course, distinct, yellowish-brown (10YR 5/6) mottles; massive; friable; about 6 percent coarse fragments; strongly effervescent; moderately alkaline.

Texture throughout the profile is dominantly loam, but it ranges to clay loam. The A horizon ranges from 6 to 13 inches in thickness and from black to very dark gray or very dark brown in color. The B2 horizon typically ranges from 6 to 12 inches in thickness. Earthworms have caused some mixing in the upper part of the B horizon. The B horizon ranges from dark grayish brown and dark brown to dark yellowish brown and yellowish brown. Depth to free lime is variable but typically is about 20 inches.

Barnes soils formed in parent material similar to that of the nearby Buse and Svea soils, and they have a profile that is similar to that of Vienna soils. They are more gently sloping and have greater profile development than Buse soils. They are better drained and generally are steeper than Svea soils. They have complex slopes and formed in loam or clay loam glacial till, whereas Vienna soils have simple slopes, and the upper part of their solum is loess or glacial till that is mixed with loess.

Barnes loam, 1 to 4 percent slopes (BaB).—This soil has slopes that are short and irregular. It has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Flom, Roliss, and Svea soils and some sandy, gravelly, stony, and eroded spots. Many of these spots are shown on the soil map by a special symbol. Also included in places are soils in which thin layers of sandy, gravelly, or cobbly material are in the subsoil or in the underlying material.

The hazard of erosion is slight. Most slopes are too short and irregular to permit the use of such erosion-control practices as contour farming. Row crops, small grain, and alfalfa grow well on this soil. Many areas are within farmsteads, and some areas are used for range and pasture. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Barnes loam, 3 to 6 percent sloped, eroded (BaB2).—This soil has a profile similar to that described as representative of the series, but the surface layer is about 3 inches thinner. Also, the surface layer has a grayish-brown cast because tillage has mixed material from the subsoil with that in the surface layer. In addition, organic matter has been lost through erosion.

Included with this soil in mapping are small areas of Buse soils that generally have slopes of 6 to 12 percent and some sandy, gravelly, and stony spots. Also included are areas of soils in which thin layers of sandy, gravelly, or cobbly materials are in the subsoil or in the underlying material. Areas of steeper soils, about 1 acre in size, are included, and they are indicated on the map by a special symbol.

This soil is subject to water erosion. Soil blowing is a hazard on bare knobs. Where slopes are not too short and irregular, such practices as farming on the contour are effective in controlling futher erosion and holding water on this soil. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Barnes loam, 6 to 12 percent slopes, eroded (BaC2).—This soil is along the sides and around the head of drainageways and in short sloping areas around shallow depressions.

This soil has a profile similar to that described as representative of the series, but the surface layer and the subsoil are thinner. The present surface layer, about 6 inches thick, is grayish brown because erosion and tillage have mixed material originally in the surface layer with that in the subsoil.

Included with this soil in mapping are small areas of Buse soils that have steeper, more convex slopes than this soil, small areas of sandy or gravelly material, and some areas of soils where numerous stones are on the surface. Also included are areas of soils where thin layers of sandy, gravelly, or cobbly material are in the subsoil or in the underlying material.

The hazard of further erosion is severe on this soil. Most of the acreage of this soil is cropped, but a few areas are pastured. This soil is suited to cultivated crops if further erosion is controlled and fertility is maintained. Capability unit IIIe–1; windbreak suitability group 1; Silty range site.

Brookings Series

The Brookings series consists of moderately well drained, nearly level to gently sloping soils on loess-covered uplands and on the sides of shallow upland

drainageways. These soils formed under prairie vegetation in moderately fine textured loess over calcareous glacial till.

In a representative profile the surface layer is silty clay loam about 16 inches thick. It is black in the upper 13 inches and very dark grayish brown in the lower 3 inches. The subsoil is about 13 inches thick. It is friable, olive-brown silty clay loam that grades to mottled, light olive-brown, friable silty clay loam in the lower part. The underlying material is light olive-brown and light brownish-gray loam.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

Almost all the acreage of Brookings soil is used for crops. These soils have no major limitations to use.

Representative profile of Brookings silty clay loam, 0 to 3 percent slopes, in a cultivated field, 80 feet west and 40 feet north of the southeast corner SW¼ sec. 34, T. 107 N., R. 45 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam; cloddy parting to weak, very fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A12—6 to 13 inches, black (10YR 2/1) silty clay loam; weak and moderate, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—13 to 16 inches, very dark grayish-brown (2.5Y 3/2) silty clay loam; moderate, very fine, subangular blocky structure; friable; numerous black (10YR 2/1) worm casts; neutral; clear, smooth boundary.

B21—16 to 22 inches, olive-brown (2.5Y 4/4) silty clay loam, very dark grayish brown (2.5Y 3/2) crushed; weak and moderate, fine, subangular blocky structure; friable; a few, very dark gray (10YR 3/1) worm casts; moderately alkaline; gradual, smooth boundary.

B22—22 to 29 inches, olive-brown (2.5Y 4/4) grading to light olive-brown (2.5Y 5/4) silty clay loam; few, fine, faint, olive-yellow (2.5Y 6/8) mottles; weak and moderate, medium, prismatic structure parting to weak, medium, subangular blocky; friable; a few spots are slightly effervescent in lower part; moderately alkaline; clear, smooth boundary.

IIC1ca—29 to 32 inches, light olive-brown (2.5Y 5/4) loam; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; about 7 percent coarse fragments; strongly effervescent; moderately alkaline; clear, smooth boundary.

IIC2ca—32 to 60 inches, light brownish-gray (2.5Y 6/2) and light olive-brown (2.5Y 5/4) loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; fractures readily; friable and firm; common, white, soft, limy masses 5 to 25 millimeters in size; few, black, manganese oxide concretions 2 millimeters in size; about 12 percent coarse fragments; strongly and violently effervescent; moderately alkaline.

The A1 horizon ranges from black to very dark gray in color and from 10 to 15 inches in thickness. The mantle of loess ranges from 20 to 40 inches in thickness, but it is commonly 29 to 38 inches thick. The B2 horizon ranges from 8 to 16 inches in thickness. The thickness of the B2 horizon is commonly proportional to the thickness of the loess mantle. The color of the B2 horizon is generally brown, olive brown, light olive brown, or grayish brown. A B3 horizon is present in many places. Free lime generally has been leached into the B3 horizon. The depth to free lime generally ranges from 29 to 36 inches. The IIC horizon is commonly light olive brown, grayish brown, and light brownish gray. The IIC horizon ranges from loam to clay loam.

Brookings soils are near Kranzburg soils and are similar to Lismore soils. They commonly are downslope from the well-drained Kranzburg soils. They have a thicker A horizon and a more olive B horizon than Kranzburg soils. They contain less sand and fewer pebbles than Lismore soils.

Brookings silty clay loam, 0 to 3 percent slopes (BrA).—This soil is on side slopes adjacent to drainageways. Included in mapping are a few areas of soils in which the surface layer is silt loam and a few areas of soils in which a thin layer of sandy, gravelly, or cobbly material is above the till. Also included are some areas of Darnen soils and some small areas of Kranzburg soils and Hidewood soils.

This soil generally has no serious limitations to use for intensive row cropping. It is well suited to corn, small grain, and alfalfa. Capability unit I–1; windbreak suitability group 1; Overflow range site.

Buse Series

The Buse series consists of well-drained, gently sloping to very steep soils on uplands. These soils formed under prairie vegetation in medium-textured to moderately fine textured glacial till. Most areas of these soils are along streams and drainageways.

In a representative profile (fig. 6) the surface layer is mixed black, very dark gray, and dark grayish-brown loam about 7 inches thick. The next layer, about 7 inches thick, is transitional to the underlying material. It is a mixture of dark-brown, very dark grayish-brown, and very dark gray loam worm casts. The underlying material is light olive-brown loam that has many masses of lime in the upper part.

Permeability is moderate, and available water capacity is high. The content of organic matter is medium, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of moderately steep and steep Buse soils are used for pasture and range. Many areas of rolling Buse soils are used for crops. Buse soils are droughty because their steepness of slope results in excessive runoff. If these soils are cultivated, the hazard of erosion is very severe.

Representative profile of Buse loam, 18 to 25 percent slopes, in permanent pasture, 300 feet east and 40 feet north of the southwest corner SE¼ sec. 31, T. 108 N., R. 44 W.:

A1—0 to 7 inches, mixed very dark gray (10YR 3/1), black (10YR 2/1), and dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) crushed; moderate, very fine, subangular blocky structure; friable; many worm casts; about 4 percent coarse fragments; strongly effervescent; mildly alkaline; clear, irregular boundary.

AC—7 to 14 inches, mixed dark-brown (10YR 4/3), very dark grayish-brown (10YR 3/2), and very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) crushed; moderate, very fine, subangular blocky structure; friable; horizon is a mixture of worm casts; about 5 percent coarse fragments; strongly and violently effervescent; moderately alkaline; gradual, irregular boundary.

C1ca—14 to 22 inches, light olive-brown (2.5Y 5/4) loam, light yellowish brown (2.5Y 6/4) dry; moderate, fine and very fine, subangular blocky structure;

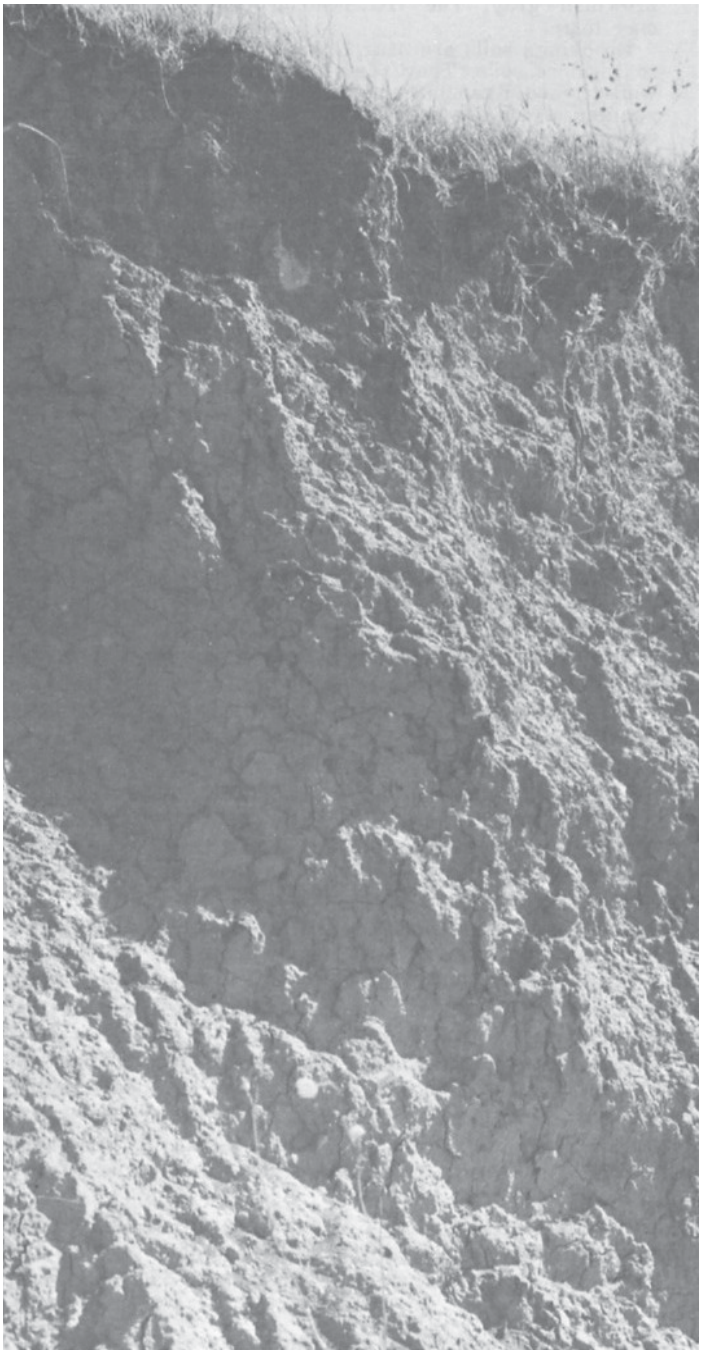

Figure 6.—**Profile of a Buse soil that has been exposed by streambank erosion.**

friable; many, soft, white, limy masses less than 15 millimeters in diameter; about 8 percent coarse fragments; violently effervescent; moderately alkaline; gradual, smooth boundary.

C2—22 to 60 inches, light olive-brown (2.5Y 5/4) loam; few, fine, distinct, strong-brown (7.5YR 5/8) iron mottles; weak, fine, subangular blocky structure; friable; about 9 percent coarse fragments; strongly effervescent; moderately alkaline.

The A1 horizon ranges from 5 to 10 inches in thickness. An AC horizon, 3 to 10 inches thick, which was formed by earthworm activity, is prominent in most undisturbed areas. In cropped areas this horizon is less evident or is absent because it has been disturbed by tillage and erosion. The C horizon is loam or clay loam. It is typically light olive brown, grayish brown, or yellowish brown.

The Buse soils are near the well-drained Barnes and Vienna soils. They are calcareous in the A horizon, unlike those soils, and they lack a B horizon.

Buse loam, 18 to 25 percent slopes (BuE).—This soil is along streams and drainageways and around the edges of ponds and lakes. A few stones and boulders are on the surface and in the soil in most places. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Renshaw, Fordville, and Sverdrup soils. Also included in some places are Darnen, Flom, Rauville, Lamoure, or Hidewood soils in deep, dissected, narrow drainageways. In places there are small sandy and gravelly spots.

The hazard of erosion is very severe in areas that are cropped. Because of the rapid runoff, this soil is droughty.

This soil is better suited to range or pasture than to most other uses. If it is cultivated, alfalfa and grasses are more suitable than most other crops. Capability unit VIe–1; windbreak suitability group 6; Thin Upland range site.

Buse loam, 25 to 40 percent slopes (BuF).—This soil is along rivers, creeks, and deep drainageways. Stones and boulders are on the surface and in the soil in most places. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping, along Chanarambie Creek, are areas of stony Buse soils that have slopes of 15 to 40 percent. These areas have very complex slopes and are in permanent pasture. Also included in some places are sandy and gravelly spots.

If this soil is disturbed, the hazard of erosion is very severe. Because of excessive runoff, this soil is droughty. Deep gullies form if excessive runoff flows into the drainageways.

Most areas of this soil are used for range and pasture. The soil is too steep to be cultivated. Capability unit VIIe–1; windbreak suitability group 6; Thin Upland range site.

Buse-Barnes loams, 6 to 12 percent slopes, eroded (BwC2).—This complex consists of rolling soils along the sides and around the head of drainageways and around depressions. Buse soils make up more than 50 percent of the complex and Barnes soils about 25 to 50 percent. Buse soils have steeper, more convex slopes than Barnes soils. The surface layer of the soils in this complex is grayish because tillage and erosion have mixed material originally in the surface layer with that in the subsoil or the underlying material. The Barnes soils have a profile similar to that described as representaitve of the Barnes series, but in most places the surface layer and the subsoil are thinner.

Included with these soils in mapping are many spots of Buse soils in which erosion and plowing have exposed the yellowish underlying material. On the fringe of these spots are areas of Barnes soils in which the brownish subsoil is exposed. Also included are small

spots of Sverdrup and Sioux soils and some areas of soils where many stones are on the surface.

The hazard of further erosion is severe.

Most of the acreage of these soils is cultivated. If erosion is controlled and fertility is maintained, these soils are well suited to crops. Some of the acreage is used for range and pasture. Management of grazing and maintenance of fertility are needed. Both soils in capability unit IIIe–1; Buse soils in windbreak suitability group 5 and Barnes soils in windbreak suitability group 1; both soils in Silty range site.

Buse-Barnes loams, 12 to 18 percent slopes (BwD).—This complex is along the sides and around the head of drainageways. About 60 to 80 percent of the complex is Buse soils. The rest is mostly Barnes soils, which are on the upper and lower parts of the slopes. In places the surface layer is stony. The Barnes soils have a profile similar to that described as representative of the series, but in most places the surface layer and subsoil are thinner.

Included with these soils in mapping are small spots of sandy and gravelly soils. Included on many hillsides are large areas of eroded Buse soils in which the yellowish underlying material is exposed. Included on the fringes of these areas are Barnes soils in which the brownish subsoil has been exposed.

If the soils of this complex are cultivated, the hazard of erosion is very severe. Because runoff is rapid, the soils are droughty.

Most of the acreage of these soils is used for range and pasture, but some of the acreage is cultivated. Alfalfa and small grain are suitable crops. The major management needs are controlling grazing and maintaining fertility. Capability unit IVe–1; windbreak suitability group 6; Thin Upland range site.

Buse-Sioux complex, 12 to 18 percent slopes (BxD).—This complex is 40 to 60 percent Buse loam and about 40 to 50 percent Sioux gravelly loamy coarse sand. Buse soils formed in loam or clay loam glacial till. Sioux soils formed on ridges of gravelly glacial outwash or in pockets or on knobs of glacial outwash present in the till. In some places the crest of slopes is capped by Sioux soils, and Buse soils are on the side slopes.

Included with these soils in mapping are areas of Barnes and Vienna soils that make up as much as 15 percent of the mapped areas. Also included are areas of Sverdrup, Darnen, Renshaw, and Fordville soils.

Runoff is rapid. Available water capacity is very low in the Sioux soils. If the soils in this complex are cropped, the hazard of erosion is very severe.

Corn and other clean-tilled crops are not suited to these soils. Most areas are used for hay, pasture, and range. Grazing management is needed. In places small gravel pits in some areas of Sioux soils are a source of gravel. Both soils in capability unit VIe–2; Buse soils in windbreak suitability group 6 and Thin Upland range site; Sioux soils in windbreak suitability group 8 and Very Shallow range site.

Buse-Sioux complex, 18 to 40 percent slopes (BxE).—This complex consists of soils along streams or on side slopes along deep drainageways. Buse loam and Sioux gravelly loamy coarse sand each make up 40 to 60 percent of areas of this complex. Stones and boulders are on the surface and in the soils in most areas. In some places Sioux soils cap the crest of slopes and Buse soils are on the side slopes.

Runoff is very rapid. The hazard of erosion is very severe, and droughtiness is a very severe limitation.

Most of the acreage of these soils is used for range and pasture. Some small areas are cropped if they are within tracts of other soils that are suitable for crops, but crop growth is poor. Some gravel pits are in areas of Sioux soils. Both soils are in capability unit VIIe–1; Buse soils in windbreak suitability group 6 and Thin Upland range site; Sioux soils in windbreak suitability group 8 and Very Shallow range site.

Buse-Vienna loams, 6 to 12 percent slopes (ByC).—This complex consists of Buse and Vienna soils around the head and sides of drainageways. It is about 50 percent Buse soils and 50 percent Vienna soils. The Buse soils have the steeper, more convex slopes. The Vienna soils have the more gentle, less convex slopes. The Vienna soils have a profile similar to that described as representative of the Vienna series, but they have a loam surface layer and a thinner surface layer and subsoil.

Included with these soils in mapping are small areas of sloping Kranzburg soils. Also included are small spots of sandy and gravelly soils and small stony areas.

Runoff is rapid. If these soils are cultivated, the hazard of erosion is severe.

Most of the acreage of these soils is uncultivated and is used for range and pasture. Management of grazing and maintenance of fertility are needed. Both soils are in capability unit IIIe–1; Buse soils in windbreak suitability group 5 and Vienna soils in windbreak suitability group 1; both soils in Silty range site.

Buse-Vienna loams, 6 to 12 percent slopes, eroded (ByC2).—This complex is along the sides and around the head of drainageways. It is about 50 percent Buse soils and 50 percent Vienna soils. The Buse and Vienna soils in this complex have profiles similar to those described as representative of their respective series, but the surface layer is thinner because of erosion. The Vienna soils also have a loam surface layer and a subsoil that is thinner than that described as representative of the series.

Included with these soils in mapping are spots where erosion and plowing have exposed the yellowish underlying material of the Buse soils. On the fringes of these spots, the brownish subsoil of the Vienna soils is exposed. Also included are spots of sandy and gravelly soils and small areas of sloping Kranzburg soils.

The hazard of erosion is severe.

Nearly all of the acreage of these soils is used for crops. If measures for the control of erosion and conservation of water are used and fertility is maintained, these soils are suited to all crops commonly grown in the county. Both soils in capability unit IIIe–1; Buse soils in windbreak suitability group 5 and Vienna soils in windbreak suitability group 1; both soils in Silty range site.

Buse-Vienna loams, 12 to 18 percent slopes (ByD).—This complex consists of soils along the sides and

around the head of drainageways. About 60 to 80 percent of the complex is Buse soils, and 20 to 40 percent is Vienna soils. Vienna soils generally are more gently sloping and are on the upper and lower parts of hillsides. In some places the surface layer is stony. The Vienna soils in this complex have a profile similar to that described as representative of the Vienna series, but they have a loam surface layer and a thinner surface layer and subsoil.

Included with these soils in mapping are small spots of sandy and gravelly soils. Also included are a few areas of moderately steep, firm, heavy clay loams that have been leached of free lime to a depth of 12 to 18 inches.

If these soils are cultivated, the hazard of erosion is very severe. Because of the rapid runoff, the soils are droughty.

Most of the acreage of these soils is in range and pasture. Grazing management is needed. Capability unit IVe–1; windbreak suitability group 6; Thin Upland range site.

Buse-Vienna loams, 12 to 18 percent slopes, eroded (ByD2).—This complex is along the sides and around the head of drainageways. Areas of this complex are 60 to 80 percent Buse soils and 20 to 40 percent Vienna soils. The Buse and Vienna soils in this complex have profiles similar to those described as representative of their respective series, but Buse soils have a slightly thinner surface layer and Vienna soils have a loam surface layer and a thinner surface layer and subsoil.

Included with these soils in mapping are large spots on some of the side slopes where the yellowish underlying material of the Buse soils is exposed. On the fringes of these spots, the brownish subsoil of the Vienna soils is exposed. Also included are small spots of sandy and gravelly soils and a few areas of moderately steep, firm, heavy clay loams that have been leached of free lime at a depth of 12 to 18 inches.

The hazard of further erosion is very severe. Because of rapid runoff, this complex is also droughty.

Most areas of this complex are cropped. Small grain and alfalfa are suitable crops. Because of the hazard of further erosion, and because of droughtiness caused by rapid runoff, row crops generally are not grown. Capability unit IVe–1; windbreak suitability group 6; Thin Upland range site.

Darnen Series

The Darnen series consists of moderately well drained, gently sloping soils. These soils formed under prairie vegetation in medium-textured sediment that was moved from higher areas by soil creep and local wash. They are in narrow strips at the base of sloping to very steep areas and in some gently sloping drainageways.

In a representative profile the surface layer is black loam about 27 inches thick. The subsoil is friable, very dark brown and very dark grayish-brown loam about 11 inches thick. The underlying material, to a depth of about 46 inches, is grayish-brown and light olive-brown loam. Below this depth it is light brownish-gray silty clay loam.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

The very thick, permeable, dark-colored surface layer makes these soils nearly ideal for row crops. Because they commonly are adjacent to steeper soils, many areas of these soils are in pasture.

Representative profile of Darnen loam, 2 to 6 percent slopes, in native prairie, 500 feet east and 15 feet south of the northwest corner sec. 33, T. 108 N., R. 44 W.:

A11—0 to 18 inches, black (10YR 2/1) loam; moderate, fine, subangular blocky structure; friable; upper 3 inches is mostly thick matted roots; neutral; gradual, smooth boundary.

A12—18 to 27 inches, black (10YR 2/1) grading to very dark brown (10YR 2/2) loam; weak and moderate, fine and medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2—27 to 38 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) loam; weak, medium, subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear, smooth boundary.

C1ca—38 to 46 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; friable; about 6 percent coarse fragments; strongly effervescent; moderately alkaline; clear, smooth boundary.

C2—46 to 66 inches, light brownish-gray (2.5Y 6/2) silty clay loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; friable; common pebble bands; about 1 percent coarse fragments; strongly and violently effervescent; moderately alkaline.

The A horizon ranges from 2 to 4 feet in thickness. It is black, very dark gray, and very dark brown and ranges from loam to silt loam. The B horizon typically ranges from 6 to 16 inches in thickness and has a weakly developed structure. It ranges from very dark brown and very dark grayish brown to dark grayish brown. The B and C horizons generally are loam, clay loam, or silty clay loam. Depth to carbonates ranges from 3 to 4 feet.

Darnen soils are near the moderately well drained Svea, Brookings, and Lismore soils. They have a thicker A1 horizon and a less well developed B horizon than those soils.

Darnen loam, 2 to 6 percent slopes (DaB).—This soil is in narrow strips along the foot of steeper slopes and in the upper end of drainageways. In some places the surface layer is stone-free silt loam. In places stones are scattered on the surface and in the soil.

Included with this soil in mapping in places are soils that have thin gravelly, sandy, or cobbly layers in the underlying material. A small acreage of nearly level Darnen soils and a small acreage of more sloping Darnen soils are included. Also included are a few areas of moderately well drained or well drained alluvial soils above the overflow level on bottom lands.

The hazard of erosion is slight. Where erosion occurs on adjacent higher lying soils, the eroded soil material is likely to injure or smother plants growing on this soil. Gullies form if this soil is not protected from action of flowing water. If runoff from the higher lying soils is controlled, this soil is well suited to corn, small grain, and alfalfa. Capability unit IIe–1; windbreak suitability group 1; Overflow range site.

Estelline Series

The Estelline series consists of well-drained, nearly level to gently sloping soils on stream terraces, outwash plains, and uplands. These soils formed under prairie vegetation in moderately fine textured windblown or water-laid material over calcareous sand and gravel.

In a representative profile (fig. 7) the surface layer is silty clay loam about 10 inches thick. It is black in the upper 6 inches and very dark brown in the lower 4 inches. The subsoil, about 20 inches thick, is friable silty clay loam that is very dark grayish brown in the upper part, dark grayish brown and brown in the middle part, and dark yellowish brown in the lower part. The underlying material is dark grayish-brown and brown sand and gravel.

Figure 7.—**Profile of an Estelline silty clay loam, shows prismatic structure in the subsoil and underlying sand and gravel.**

Permeability is moderate above the sand and gravel, and it is rapid in the sand and gravel. Available water capacity is generally moderate, but where depth to the underlying sand and gravel is greater it is high. The content of organic matter is high, the content of phosphorus is low, and the content of potassium is high. The seasonal high water table is at a depth of 5 to 10 feet or more.

These soils are suited to all crops commonly grown in the county. Crops grow well except in years of below-average rainfall. These soils are slightly droughty, and this is the major limitation to use. In most places the gravelly underlying material is suitable for road gravel.

Representative profile of Estelline silty clay loam, 0 to 2 percent slopes, in a cultivated field, 40 feet east and 25 feet south of the northwest corner SW¼ sec. 4, T. 105 N., R. 44 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam; cloddy; friable; neutral; abrupt, smooth boundary.

A3—6 to 10 inches, very dark brown (10YR 2/2) silty clay loam; weak, medium and coarse, prismatic structure parting to weak and moderate, fine and medium, subangular blocky; slightly hard, friable; slightly acid; clear, smooth boundary.

B1—10 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak, medium and coarse, prismatic structure parting to moderate, very fine and fine, subangular blocky; slightly hard, friable; slightly acid; clear, smooth boundary.

B21—16 to 21 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) silty clay loam; moderate, medium and coarse, subangular blocky structure; very hard, friable; very thin patchy clay films on vertical faces of peds; common pinholes less than 1 millimeter in diameter; slightly acid; gradual, smooth boundary.

B22—21 to 30 inches, dark yellowish-brown (10YR 3/4) silty clay loam, dark yellowish brown (10YR 4/4) crushed; moderate and strong, medium and coarse, subangular blocky structure; very hard, friable; moderately thick, patchy clay films on vertical faces of peds; common pinholes less than 1 millimeter in diameter; cobbly layer at bottom; slightly acid; abrupt, smooth boundary.

IIC—30 to 60 inches, dark grayish-brown (10YR 4/2) and brown (10YR 5/3) sand and gravel; single grained; loose; slightly effervescent; moderately alkaline.

The A1 horizon, in uncultivated areas, ranges from 6 to 14 inches in thickness, from black to very dark gray and very dark brown in color, and from silty clay loam to silt loam in texture. The A3 horizon is similar to the A1 horizon in texture. It ranges from 3 to 6 inches in thickness. The B horizon ranges from 15 to 30 inches in thickness and from silt loam to silty clay loam. Free lime has been leached from the A and B horizons and has accumulated in the upper part of the gravelly layer or in the layer just above it. The loess or silty alluvium ranges from 24 to 40 inches in thickness. The B3 horizon or the C1 horizon, where present, is loam, sandy clay loam, or silt loam 3 to 6 inches thick. The IIC horizon ranges from gravelly coarse sand to sand and gravel.

In Pipestone County, Estelline silty clay loam, 2 to 6 percent slopes, has a thinner A horizon than is defined as within the range for the series. This difference, however, does not greatly affect its use and behavior. In this county, the combined thickness of the A and B horizons of Estelline silty clay loam, deep, 0 to 2 percent slopes, is greater than is defined as within the range for the series. This difference, however, does not greatly affect its use and behavior. Also, available water capacity is high in this soil and growth

of plants is better than on the other soils of the Estelline series.

Estelline soils are near Athelwold and Fordville soils. They are better drained than Athelwold soils and are at higher elevations. They have more silt and less sand in their solum than Fordville soils because they formed in silty, medium-textured alluvium or loess, whereas Fordville soils formed in gritty, medium-textured alluvium or glacial drift.

Estelline silty clay loam, 0 to 2 percent slopes (EsA).—This soil is on broad stream terraces, on outwash plains, and on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Fordville soils and some areas of soils where the underlying gravelly material is only a few feet thick over glacial till or silty alluvium. Also included in narrow drainageways are areas of moderately well drained Athelwold soils and poorly drained Trosky soils. There is also a small acreage of eroded soils.

Droughtiness is a slight to moderate limitation. This soil is subject to soil blowing (fig. 8), especially if it is plowed in fall. This soil can be farmed intensively if measures are used to help control soil blowing and to minimize the effects of droughtiness. Capability unit IIs–1; windbreak suitability group 7; Silty range site.

Estelline silty clay loam, 2 to 6 percent slopes (EsB).—This soil is along the sides of drainageways, in areas next to terrace escarpments that break into the bottom lands, on stream terraces, on outwash plains, and on uplands. Slopes are short. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner.

Included with this soil in mapping are areas of moderately well drained Athelwold soils and poorly drained Trosky soils in drainageways. In places areas are included in which the underlying gravelly material is only a few feet thick over glacial till or silty alluvium. Also included are small areas of Fordville soils.

Droughtiness is a slight to moderate limitation to use of this soil. The hazard of water erosion is slight to moderate. This soil is subject to soil blowing, especially if it is plowed in fall. A large acreage of this soil is used for pasture and range. If this soil is cultivated, small grain and alfalfa are suitable crops. Capability unit IIe–2; windbreak suitability group 7; Silty range site.

Estelline silty clay loam, 2 to 6 percent slopes, eroded (EsB2).—This soil is on stream terraces, on outwash plains, and on uplands. It is also along the sides of drainageways and in areas next to terrace escarpments

Figure 8.—**Effects of soil blowing on an Estelline silty clay loam. Soil has been blown from clean-tilled field on right and deposited in corn stubble on left.**

that break into bottom lands. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner. The surface layer contains material from the subsoil as a result of erosion and tillage. Depth to sand and gravel ranges from 24 to 30 inches.

Included with this soil in mapping are some areas of soils in which the gravelly underlying material is only a few feet thick over glacial till or silty alluvium. Also included are small areas of Fordville soils.

The hazard of water erosion is slight to moderate, and droughtiness is a slight to moderate limitation. This soil is subject to soil blowing if the areas are not protected, especially after fall plowing. Most of the acreage of this soil is used for crops. Small grain and alfalfa are better suited than corn. Capability unit IIe–2; windbreak suitability group 7; Silty range site.

Estelline silty clay loam, deep, 0 to 2 percent slopes (EtA).—This soil is on broad river terraces and on outwash plains. It has a profile similar to that described as representative of the series, but sand and gravel are at a depth of 40 to 60 inches, and available water capacity is high. Free lime generally is immediately over the underlying gravelly material.

Included with this soil in mapping are some areas of soils that are similar to this soil but are gently sloping. Also included are areas of moderately well drained Athelwold soils in drainageways; these soils are mottled in the lower part of the subsoil. There are also areas of soils that are similar to this Estelline soil but in which the gravelly underlying material is only a few feet thick over glacial till or silty alluvium.

Erosion generally is not a hazard on this soil. Droughtiness is a limitation in years of below-average rainfall. This soil is well suited to corn, small grain, and alfalfa. Capability unit I–1; windbreak suitability group 1; Silty range site.

Flandreau Series

The Flandreau series consists of well-drained, nearly level to gently sloping soils on uplands. These soils formed under prairie vegetation in medium-textured loess over fine sands.

In a representative profile the surface layer is silt loam about 14 inches thick. It is black in the upper 9 inches and very dark grayish brown in the lower 5 inches. The subsoil is about 19 inches thick. It is friable, dark grayish-brown silt loam in the upper 12 inches; friable, olive-brown loam in the next 4 inches; and very friable, light olive-brown sandy loam in the lower 3 inches. The underlying material, to a depth of 50 inches, is light yellowish-brown fine sand. Below this, it is pale-yellow fine sand that contains thin bands of silt loam.

Permeability is moderate in the loess and rapid in the underlying sand. Available water capacity is moderate. The content of organic matter is high, the content of phosphorus is low or very low, and the content of potassium is medium or high. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of these soils are used for crops. These soils are suited to all crops commonly grown in the county. In years of below-average rainfall, these soils tend to be droughty. These silty soils are free of stones, and they are easy to work. The hazard of erosion is slight to moderate.

Representative profile of Flandreau silt loam, 0 to 2 percent slopes, in a cultivated field, 320 feet west and 75 feet north of the southeast corner sec. 14, T. 108 N., R. 46 W.:

Ap—0 to 6 inches, black (10YR 2/1) grading to very dark gray (10YR 3/1) silt loam, very dark brown (10YR 2/2) crushed; cloddy; friable; neutral; abrupt, smooth boundary.

A12—6 to 9 inches, black (10YR 2/1) silt loam, very dark brown (10YR 2/2) crushed; weak, very fine and fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—9 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, medium and coarse, prismatic structure parting to moderate, very fine, subangular blocky; friable; about 50 percent very dark gray (10YR 3/1) worm casts; slightly acid; clear, smooth boundary.

B21—14 to 26 inches, dark grayish-brown (10YR 4/2) silt loam, brown (10YR 4/3) crushed; moderate, medium and coarse, prismatic structure parting to weak, fine and medium, subangular blocky; friable; common pinholes and roots; neutral; clear, smooth boundary.

B22—26 to 30 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; neutral; abrupt, smooth boundary.

B3ca—30 to 33 inches, light olive-brown (2.5Y 5/4) sandy loam; very weak, medium, subangular blocky structure; very friable; strongly effervescent; mildly alkaline; abrupt, smooth boundary.

IIC1ca—33 to 50 inches, light yellowish-brown (2.5Y 6/4) fine sand; single grained; loose; strongly effervescent; mildly alkaline; clear, wavy boundary.

IIC2—50 to 60 inches, pale-yellow (2.5Y 7/4) banded fine sand and silt loam; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; single grained; loose; strongly effervescent; mildly alkaline.

The A1 horizon ranges from 6 to 12 inches in thickness. The A3 horizon or the B1 horizon ranges from 4 to 6 inches in thickness. The B horizon ranges from 14 to 30 inches in thickness. The B2 horizon ranges from loam and silt loam to silty clay loam. Depth to the IIC horizon ranges from 24 to 40 inches. The IIC horizon ranges from sand to loamy sand. Free lime has been leached into the B3 horizon or into the C horizon.

Flandreau soils are similar to Swenoda and Estelline soils. They have more sand and less silt and clay in the IIC horizon than Swenoda soils. They have a sandy IIC horizon instead of a gravelly IIC horizon that is typical of Estelline soils.

Flandreau silt loam, 0 to 2 percent slopes (FaA).—This soil has the profile described as representative of the series. Typically, it overlies sandy material at a depth of 30 to 40 inches. This soil generally is silt loam that has a high content of sand.

Included with this soil in mapping are a small acreage of soils in which the surface layer and the subsoil are loam and a few areas of soils in which sand is only a few feet thick over silty material or glacial till. Also included are areas of moderately well drained Athelwold soils in narrow drainageways.

Droughtiness is a slight limitation to use of this soil. This soil is subject to soil blowing, especially after fall plowing. The main management needs are increasing fertility and organic-matter content to in-

crease available water capacity. Small grain and alfalfa are suited to this soil. Capability unit IIs–1; windbreak suitability group 7; Silty range site.

Flandreau silt loam, 2 to 6 percent slopes (FaB).—This soil has smooth, simple slopes. It has a profile similar to that described as representative of the series, but the surface layer is a few inches thinner, and depth to the underlying sandy material is a few inches less.

Included with this soil in mapping are some areas of this soil in which the surface layer and the subsoil are loam. Also included are some areas of this soil that are underlain by silty material or glacial till at a depth of 3 to 4 feet.

The hazard of erosion is slight on this soil. This soil is more affected by a lack of moisture during periods of drought than the adjacent Kranzburg or Moody soils because its available water capacity is lower. This soil is subject to soil blowing in spring or after fall plowing. The main management needs are maintaining fertility, maintaining tilth by returning crop residue to the soil, and controlling erosion. Small grain and alfalfa are suitable crops. Capability unit IIe–2; windbreak suitability group 7; Silty range site.

Flandreau silt loam, 2 to 6 percent slopes, eroded (FaB2).—This soil has smooth, uniform slopes that are dominantly 4 to 6 percent in gradient. This soil has a profile similar to that described as representative of the series, but the surface layer is 4 to 8 inches thinner and depth to the sandy underlying material is 6 to 12 inches less.

Included with this soil in mapping are a few areas of this soil where the brownish subsoil has been exposed by erosion. Also included are small acreages where the surface layer and the subsoil are loam and a few areas where the sand is only a few feet thick over silty material or glacial till.

The hazard of erosion is moderate on this soil. Droughtiness is a moderate limitation because of the moderate available water capacity. The main management needs are controlling further erosion by returning crop residue to the soil, maintaining soil fertility, and maintaining a favorable infiltration rate in the surface layer through rotation of crops. Small grain and alfalfa are suitable crops. Capability unit IIe–2; windbreak suitability group 7; Silty range site.

Flom Series

The Flom series consists of poorly drained, nearly level soils in drainageways, at the base of steep slopes, around the edges of depressions, and in low-lying, somewhat wet, flat areas. These soils formed under wet prairie vegetation in medium-textured or moderately fine textured glacial material.

In a representative profile the surface layer is about 20 inches thick. It is black clay loam in the upper part; black silty clay loam in the middle part, and very dark gray and dark-gray clay loam in the lower part. The subsoil is slightly calcareous, friable clay loam about 15 inches thick. It is dark gray and has distinct light olive-brown mottles in the upper part and is grayish brown and has distinct olive-brown mottles in the lower part. The underlying material is calcareous, mottled, olive-gray glacial till of clay loam texture.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is low, and the content of potassium is medium or high. The seasonal high water table is within a depth of 2 feet or less.

Most areas of these soils are used for crops, but a few areas are in pasture. If adequately drained, fertilized, and managed, these soils are well suited to all crops commonly grown in the county. Most of the areas are too small and irregular to be farmed separately; consequently they are farmed along with adjoining soils. Wetness is the major limitation to use.

Flom soils in this county are mapped only in an undifferentiated group with Roliss soils.

Representative profile of Flom clay loam, in an area of Flom and Roliss clay loams, in a cropped field, 500 feet south and 15 feet west of the northeast corner of SE¼ sec. 18, T. 108 N., R. 44 W.:

Ap—0 to 7 inches, black (N 2/0) clay loam; cloddy; friable, sticky; mildly alkaline; abrupt, smooth boundary.

A12—7 to 15 inches, black (N 2/0) silty clay loam; weak and moderate, very fine, subangular blocky structure; friable, sticky; mildly alkaline; clear, smooth boundary.

A3g—15 to 20 inches, very dark gray (N 3/0) and dark-gray (5Y 4/1) clay loam, very dark gray (5Y 3/1) crushed; moderate, very fine, subangular and angular blocky structure; friable; about 2 percent coarse fragments; dark gray part is slightly effervescent; mildly alkaline; clear, irregular boundary.

B2g—20 to 26 inches, dark-gray (5Y 4/1) clay loam; many, medium, distinct, light olive-brown (2.5Y 5/4) mottles; weak and moderate, very fine and fine, subangular blocky structure; friable; few black (5Y 2/1) worm casts; about 6 percent coarse fragments; slightly effervescent; mildly alkaline; clear, irregular boundary.

B3g—26 to 35 inches, grayish-brown (2.5Y 5/2) clay loam; many, medium, distinct, olive-brown (2.5Y 4/4) mottles; weak, very fine, subangular blocky structure; friable; about 11 percent coarse fragments; strongly effervescent; moderately alkaline; gradual, smooth boundary.

Cg—35 to 60 inches, olive-gray (5Y 5/2) clay loam; common, coarse, prominent olive-brown (2.5Y 4/4) mottles; very weak, fine and medium, subangular blocky structure; firm; about 5 percent coarse fragments; strongly effervescent; moderately alkaline.

The A horizon typically ranges from 12 to 20 inches in thickness. It generally is clay loam but ranges to silty clay loam. The B horizon ranges from 6 to 18 inches in thickness and is typically clay loam but ranges to silty clay loam and loam. The B horizon is commonly dark gray, olive gray, grayish brown, very dark grayish brown, dark olive gray, and olive brown. The C horizon is glacial till of clay loam, loam, or silty clay loam texture and is light olive gray, grayish brown, olive gray, and light olive brown. In many places the upper part of the profile is free of stones and pebbles because the till has been reworked by water. The glacial till is generally nearly free of stones in many areas. Depth to free lime is variable.

Flom soils are near Barnes, Svea, and Roliss soils, and they have a profile that is somewhat similar to that of Hidewood soils. They are more poorly drained and are at lower elevations than Barnes and Svea soils. They do not have the highly calcareous horizon that is typical of Roliss soils. They are sandier and less silty than Hidewood soils, which formed in loess, and depth to carbonates is less.

Flom and Roliss clay loams (0 to 2 percent slopes) (Fm).—These soils are in irregularly shaped areas around depressions and in drainageways and other low places.

Some areas are Flom clay loam, some are Roliss clay loam, and a few areas consist of both soils.

The Roliss soil has the profile described as representative of the Roliss series. It is very dark gray or dark gray when dry, whereas the Flom soil is black. In some drainageways a surface layer more than 24 inches thick has accumulated. Fragments of snail shells are in the Roliss soil in some places. In many places the glacial till in the upper part of the profile has been sorted and redeposited by water. The reworked material is less stony and more silty than the underlying glacial till.

Included with these soils in mapping are some areas of soils that are finer textured than is typical of Flom soils. Also included are areas of Quam soils in small depressions and in very wet drainageways.

The major limitation to use of these soils is wetness. A hazard of gullying exists if the drainageways are not grassed. Soil blowing is a hazard in some large open areas. A high content of lime in the Roliss soil causes an imbalance of nutrients.

The soils in this unit are suited to intensive use if they are adequately drained and if the nutrient balance is corrected. Both soils in capability unit IIw–1 and Subirrigated range site; Flom soil in windbreak suitability group 2; Roliss soil in windbreak suitability group 3.

Fordville Series

The Fordville series consists of well-drained, nearly level to gently sloping soils. These soils formed under prairie vegetation in medium-textured alluvium or outwash over sand and gravel. These soils are on river terraces, outwash plains, and gravelly uplands.

In a representative profile the surface layer is loam about 14 inches thick. It is black in the upper 10 inches and very dark grayish brown in the lower 4 inches. The subsoil is about 17 inches thick. It is friable, dark-brown loam in the upper part; friable, dark yellowish-brown clay loam in the middle part; and friable, dark yellowish-brown sandy loam in the lower part. The underlying material is calcareous, dark grayish-brown and brown gravelly coarse sand.

Permeability above the underlying sand and gravel is moderately rapid. Permeability in the underlying sand and gravel is rapid. Available water capacity ranges from moderate to low. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium or low. The seasonal high water table is at a depth of 5 to 10 feet or more.

These soils are used for crops and pasture. Crops grow well in years when the rainfall is timely. Corn and small grain "fire" and do not grow well, however, if the summer is hot and dry. Gravel pits are located on these soils. The major limitations to the use of these soils are susceptibility to erosion and droughtiness.

Representative profile of Fordville loam, 0 to 2 percent slopes, in a cultivated field, 1,160 feet west and 30 feet south of the northeast corner sec. 23, T. 108 N., R. 45 W.:

A1—0 to 10 inches, black (10YR 2/1) loam; cloddy, parting to weak, fine and medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—10 to 14 inches, very dark grayish-brown (10YR 3/2) loam; weak, fine and medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; few, very dark gray (10YR 3/1) casts; neutral; clear, smooth boundary.

B21—14 to 20 inches, dark-brown (10YR 3/3) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; slightly acid; clear, smooth boundary.

B22—20 to 27 inches, dark yellowish-brown (10YR 4/4) light clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, patchy clay films on vertical faces of prisms; slightly acid; abrupt, smooth boundary.

B3—27 to 31 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, medium, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

IICca—31 to 62 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) gravelly coarse sand; single grained; loose; strongly effervescent; moderately alkaline.

Depending on the degree of mixing with the B horizon, the A1 horizon ranges from black to very dark brown in color and from 6 to 12 inches in thickness. An A3 horizon or a B1 horizon, 3 to 6 inches thick, is present in most places. It is typically very dark gray and very dark grayish brown. The B horizon ranges from 10 to 30 inches in thickness and is most commonly dark yellowish brown, brown, dark brown, and dark grayish brown. Free lime is in the gravel, and in some places free lime is in the lower part of the loamy sediment. The IIC horizon is gravelly coarse sand or stratified sand and gravel. Depth to the IIC horizon ranges from 20 to 40 inches.

Fordville soils are near Renshaw and Estelline soils. They are deeper over sand and gravel than Renshaw soils. They have more sand and less silt in the solum than Estelline soils.

Fordville loam, 0 to 2 percent slopes (FoA).—This soil is on river terraces along some of the streams and in a few areas on uplands. This soil has the profile described as representative of the series. The sandy and gravelly underlying material is at a depth of 24 to 40 inches. There are some areas in which the sandy and gravelly underlying material is only a few feet thick over silty material or glacial till.

Included with this soil in mapping is a small acreage of soils where soil blowing has exposed the brownish subsoil in some areas.

Droughtiness is the major limitation to use of this soil. This soil is subject to soil blowing, especially after fall plowing. The main management needs are increasing fertility and organic-matter content so as to increase the available water capacity. Corn, small grain, and alfalfa are fairly well suited except in years when there is a long drought. Capability unit IIs–1; windbreak suitability group 7; Silty range site.

Fordville loam, 2 to 6 percent slopes, eroded (FoB2).—This soil is mainly on stream terraces next to bottom lands, but some areas are on uplands. A few stones are on the surface in some areas.

This soil has a profile similar to that described as representative of the series, but the surface layer and the subsoil are each a few inches thinner and the depth to the gravelly underlying material is a few inches less. The plow layer, about 6 to 8 inches thick, contains material from the subsoil that has been mixed into it by tillage after erosion. The depth to the

gravelly underlying material ranges from 20 to 40 inches, but in most places it is only 20 to 28 inches.

Included with this soil in mapping are areas of noneroded Fordville soils and a small acreage of Fordville soils that are more sloping than this soil. Also included are some areas in which the sandy and gravelly underlying material is only a few feet thick over silty alluvium or glacial till.

The major limitations to the use of this soil are moderate available water capacity and a moderate hazard of erosion. The main management needs are controlling further erosion, returning crop residue to the surface layer and maintaining the content of organic matter through crop rotation. Small grain and alfalfa are suitable crops. Some areas of this soil are used for range and pasture, for which it is well suited. Capability unit IIe–2; windbreak suitability group 7; Silty range site.

Gravel Pit

Gravel pit (Gp) consists of open excavations from which gravel has been removed. A few areas of Gravel pit have been leveled and are used for crops or pasture. Some abandoned pits provide shelter for wildlife. Not placed in a capability unit or in a range site; windbreak suitability group 8.

Hidewood Series

The Hidewood series consists of somewhat poorly drained, nearly level soils on wet flats and in drainageways on uplands. These soils formed under wet prairie vegetation in loess or in local alluvium derived from loess in nearby areas. They overlie calcareous glacial till.

In a representative profile the surface layer is silty clay loam about 23 inches thick. It is black in the upper 17 inches and very dark gray in the lower 6 inches. The subsoil, about 14 inches thick, is friable, mottled, very dark gray and dark grayish-brown silty clay loam in the upper part and friable, mottled, grayish-brown silty clay loam in the lower part. The underlying material is calcareous, mottled, gray glacial till of loam texture.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is within a depth of 2 feet or less.

Most areas of these soils are used for crops, but some small areas along drainageways are used for hay and pasture. If wetness is corrected and the soils are otherwise well managed and properly fertilized, crops commonly grown in the county grow well.

Representative profile of Hidewood silty clay loam, in a meadow, 700 feet north and 220 feet east of the southwest corner sec. 18, T. 106 N., R. 45 W.:

A11—0 to 7 inches, black (10YR 2/1) silty clay loam; moderate, very fine, subangular blocky structure; friable, slightly sticky; mildly alkaline; abrupt, smooth boundary.

A12—7 to 17 inches, black (N 2/0) silty clay loam; weak and moderate, very fine, subangular blocky structure; friable, slightly sticky; mildly alkaline; clear, smooth boundary.

A3g—17 to 23 inches, very dark gray (10YR 3/1 grading to N 3/0) silty clay loam that contains a few streaks of grayish brown (2.5Y 5/2); weak, very fine, subangular blocky structure; friable, sticky; mildly alkaline; clear, irregular boundary.

B2g—23 to 29 inches, very dark gray (N 3/0) and dark grayish-brown (2.5Y 4/2) silty clay loam, dark gray (5Y 4/1) crushed; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, very fine and fine, subangular blocky structure; friable; sticky; few gypsum crystals 1 to 2 millimeters in diameter; slightly effervescent; mildly alkaline; clear, irregular boundary.

B3g—29 to 37 inches, grayish-brown (2.5Y 5/2) crushed, silty clay loam; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium and fine, subangular blocky structure; friable, sticky; common, fine, gypsum crystals 1 to 2 millimeters in diameter; few, soft, white limy masses 5 to 10 millimeters in diameter; about 2 percent coarse fragments; violently effervescent; mildly alkaline; clear, smooth boundary.

IIC1g—37 to 60 inches, gray (5Y 5/1) clay loam; many, coarse, prominent, dark yellowish-brown (10YR 4/4) mottles; massive and weak, coarse, subangular blocky structure; firm, sticky; few, soft, white, irregular limy masses 10 to 25 millimeters in diameter; strongly effervescent; mildly alkaline.

The mantle of loess ranges from 20 to 40 inches in thickness, but it generally is about 34 inches. The A1 horizon ranges from 14 to 18 inches in thickness. The A3 horizon ranges from 3 to 6 inches in thickness. The B horizon ranges from 12 to 18 inches in thickness and from dark grayish brown and grayish brown to olive and olive gray in color. Structure in the B horizon is weakly developed to moderately developed. Free lime has been leached to a depth of 28 to 32 inches in most places. The IIC horizon is glacial till of clay loam or loam texture. It is gray, olive gray, olive, or grayish brown.

Hidewood soils have a profile similar to that of Whitewood soils. They are near well drained Kranzburg soils and moderately well drained Brookings soils. They formed in a thinner mantle of loess than Whitewood soils. They formed in material similar to that in which Kranzburg and Brookings soils formed, but they are at lower elevations.

Hidewood silty clay loam (0 to 2 percent slopes) (Hd).—This soil is on somewhat wet flats and in drainageways. The surface layer is typically less than 24 inches thick. In some of the drainageways, however, it is more than 24 inches thick because soil material has washed in from adjacent sloping areas. Where areas of this soil are near areas of the higher lying Vienna soils, the upper part of the washed-in surface layer is loamy in many places. In many places a thin sandy, gravelly, or cobbly layer is at the boundary between the loess and the underlying glacial till.

Included with this soil in mapping are some areas of soils in which the loess layer is less than 20 inches thick; these soils formed mainly in glacial till of clay loam texture. Also included are a few small areas of poorly drained soils and some areas of soils that have a calcareous surface layer.

Wetness is the major limitation to the use of this soil. During or after heavy rains the sediment-laden runoff can damage crops. This risk is especially great if practices are not used to protect the surrounding sloping soils against erosion. In places gullies form in the drainageways. If adequate drainage and protection are provided, this soil is nearly ideal for row crops.

Capability unit IIw–1; windbreak suitability group 2; Subirrigated range site.

Ihlen Series

The Ihlen series consists of well-drained, nearly level to gently sloping soils on the loess plain, mostly in the vicinity of Ihlen. These soils formed under prairie vegetation in moderately fine textured loess 20 to 40 inches thick over Sioux quartzite.

In a representative profile the surface layer is black to very dark brown silty clay loam about 8 inches thick. The subsoil is about 21 inches thick. It is friable, dark yellowish-brown silty clay loam in the upper part; friable, brown silty clay loam in the middle part; and friable, dark grayish-brown silt loam in the lower part. The underlying material is calcareous, dark grayish-brown silt loam about 2 inches thick. Hard, reddish Sioux quartzite bedrock is at a depth of 31 inches.

Permeability is moderately rapid, and available water capacity is moderate or low. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium.

These soils are used for crops, pasture, and range. They are suited to all crops commonly grown in the county. The major limitation to the use of these soils is susceptibility to erosion and droughtiness. Practices are needed that help to control erosion and to conserve water because these soils are shallow to bedrock.

Representative profile of Ihlen silty clay loam, 0 to 2 percent slopes, in a pasture, 133 feet south and 50 feet west of the northeast corner sec. 27, T. 105 N., R. 46 W.:

A1—0 to 8 inches, black (10YR 2/1) grading to very dark brown (10YR 2/2) silty clay loam, very dark brown (10YR 2/2) dry; weak and moderate, fine and medium, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

B21—8 to 15 inches, dark yellowish-brown (10YR 3/4) silty clay loam that contains a few very dark gray (10YR 3/1) worm casts; moderate, medium and coarse, prismatic structure parting to weak and moderate, fine and medium, subangular blocky; friable; slightly acid; gradual, smooth boundary.

B22—15 to 23 inches, brown (10YR 4/3) silty clay loam; weak, medium and coarse, prismatic structure parting to weak, fine and medium, subangular blocky; friable; neutral; clear, smooth boundary.

B3—23 to 29 inches, dark grayish-brown (10YR 4/2) silt loam, light olive brown (2.5Y 5/4) dry; weak, medium and coarse, prismatic structure parting to very weak, medium, subangular blocky; friable; neutral; abrupt, smooth boundary.

Cca—29 to 31 inches, dark grayish-brown (10YR 4/2) silt loam, light olive brown (2.5Y 5/4) dry; very weak, medium and coarse, subangular blocky structure; friable; few, hard and soft, white limy concretions; strongly and violently effervescent; moderately alkaline; abrupt, smooth boundary.

IIR—31 inches, Sioux quartzite bedrock.

Depth to bedrock ranges from 20 to 40 inches. Thickness of the solum and depth to bedrock commonly are the same. In places where the mantle of loess is more than 28 inches thick, some profiles have a C horizon as much as 10 inches thick. Reaction in the solum is neutral or slightly acid. The profile is typically silty clay loam but ranges to silt loam.

The A1 horizon is very dark brown or black and is 8 to 14 inches thick. An A3 horizon, which is present in places, is as much as 6 inches thick, and it is very dark grayish brown, dark grayish brown, or a dark brown. The B horizon is brown, dark yellowish brown, yellowish brown, or dark grayish brown. The C horizon, where present, is dark grayish brown, brown, or light olive brown. Free lime is present in the C horizon as both concretions and soft masses.

Ihlen soils are near the well-drained Moody soils and the moderately well drained Trent soils. They formed in 20 to 40 inches of loess over bedrock, whereas Moody and Trent soils formed in a mantle of loess more than 40 inches thick. They are better drained than Trent soils.

Ihlen silty clay loam, 0 to 2 percent slopes (IhA).—This soil is on loess-mantled uplands. A few rocks generally crop out in each area. Shallow, well-drained drainageways dissect areas of this soil. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of soils that have bedrock at a depth of less than 20 inches. Also included are a few areas of Moody soils that have a mantle of loess more than 40 inches thick.

This soil is somewhat droughty because of its moderate available water capacity. Most areas are used for crops, but a few areas near the Pipestone National Monument are in native prairie grasses. If rainfall is average or above average, this soil is fairly well suited to corn, small grain, and alfalfa. Capability unit IIs–1; windbreak suitability group 7; Silty range site.

Ihlen silty clay loam, 2 to 6 percent slopes (IhB).—This soil is in large smooth areas of the loess mantled upland plain. A few rocks crop out in each area of this soil. Well-drained, shallow drainageways dissect this soil. This soil has a profile similar to that described as representative of the series, but in a few cultivated areas, tillage and erosion have mixed material from the subsoil with that in the surface layer, and the surface layer is brown.

Included with this soil in mapping are some areas of soils that have bedrock at a depth of less than 20 inches. Also included are a few small areas of Moody soils in which depth to bedrock is more than 40 inches.

Available water capacity is moderate. This soil is somewhat susceptible to droughtiness. The hazard of erosion is moderate. Most areas of this soil are cultivated, but some areas are used for pasture and range. Controlling erosion and controlling grazing are the main management needs. Small grain and alfalfa are suitable crops. Capability unit IIs–1; windbreak suitability group 7; Silty range site.

Ihlen-Rock outcrop complex, 0 to 6 percent slopes (IrB).—This complex consists of nearly level and gently sloping Ihlen soils that are intermingled with areas of Rock outcrop and loess soils that are less than 20 inches deep over bedrock. It is about 50 percent Ihlen soils. Shallow rocky drainageways dissect these areas.

Ihlen soils in this complex have a profile similar to that described as representative of the Ihlen series, but they formed in a thinner mantle of loess.

Included with this complex in mapping are a few small areas of Moody soils that have a mantle of loess more than 40 inches thick.

Available water capacity ranges from moderate to very low. Droughtiness is a limitation to use of these soils. Most areas of this complex are in pasture and range. The soils generally are too rocky for crops.

Controlling grazing is the major management need. Both soils in capability unit VIs–1; Ihlen soils in windbreak suitability group 8; Rock outcrop in windbreak suitability group 8; Ihlen soils in Silty range site; Rock outcrop in Very Shallow range site.

Kranzburg Series

The Kranzburg series consists of well-drained, nearly level to gently sloping soils on uplands. These soils formed under prairie vegetation in moderately fine textured loess over glacial till. They are the most extensive soils in the loess-mantled parts of the county. Irregularities in the landscape of glacial till have been filled in by windblown sediment and slopes are long, smooth, and convex.

In a representative profile (fig. 9) the surface layer is black to very dark brown silty clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper 5 inches is friable, very dark grayish-brown silty clay loam that contains a few very dark gray worm casts; the middle 12 inches is friable, dark-brown and brown silty clay loam, and the lower 3 inches is calcareous, friable, light olive-brown silty clay loam. The underlying material is calcareous, grayish-brown and light olive-brown glacial till of clay loam texture.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of these soils are cultivated. The soils are well suited to all crops commonly grown in the county. The major limitation to the use of these soils is susceptibility to erosion.

Representative profile of Kranzburg silty clay loam, 2 to 4 percent slopes, in a cultivated field, 1,610 feet north and 50 feet west of the southeast corner sec. 32, T. 106 N., R. 46 W.:

Ap—0 to 6 inches, black (10YR 2/1) grading to very dark brown (10YR 2/2) silty clay loam; cloddy; friable; slightly acid; abrupt, smooth boundary.

A12—6 to 10 inches, black (10YR 2/1) grading to very dark brown (10YR 2/2) silty clay loam; weak and moderate, very fine and fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B1—10 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak, medium and coarse, prismatic structure parting to moderate, fine, subangular blocky; friable; few, very dark gray (10YR 3/1) casts; neutral; clear, smooth boundary.

B21—15 to 21 inches, dark-brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) and brown (10YR 4/3) crushed; moderate, medium and coarse, prismatic structure parting to weak, fine and medium, subangular blocky; friable; common root holes, mostly less than 1 millimeter in diameter; neutral; clear, smooth boundary.

B22—21 to 27 inches, brown (10YR 4/3) silty clay loam; moderate, medium, prismatic structure parting to weak, medium, subangular blocky; friable; mildly alkaline; clear, smooth boundary.

B3ca—27 to 32 inches, light olive-brown (2.5Y 5/4) silty clay loam; weak, coarse, prismatic structure parting to very weak, medium, subangular blocky; friable; few, soft, white limy masses 5 to 10 millimeters in diameter; strongly and violently effervescent; moderately alkaline; clear, wavy boundary.

Figure 9.—**Profile of a Kranzburg silty clay loam.**

IIC—32 to 60 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) clay loam; common, medium, distinct, strong-brown (7.5YR 5/6) mottles; firm; few, soft, white limy masses 5 to 25 millimeters in diameter in upper part; about 3 percent coarse fragments; strongly effervescent.

The A1 horizon ranges from 6 to 12 inches in thickness, depending on the steepness of slope and the degree of erosion. It ranges from black to very dark gray and to very dark brown. The mantle of loess ranges from 20 to 40 inches in thickness, but the range is commonly between 28 and 36 inches. It is silty clay loam or silt loam. The B2 horizon ranges from dark yellowish brown and dark brown to brown and dark grayish brown. In most places the B horizon formed in loess, but in some places where the mantle of loess is thinner, this horizon formed partly in glacial till. Depending on the thickness of the loess, free lime is present in the lower part of the loess or in the upper part of the underlying glacial till. A thin sandy, gravelly, or cobbly layer is between the loess and the glacial till in many places. The till is loam or clay loam and is commonly brown, light olive brown, and grayish brown.

Kranzburg soils are near Vienna, Brookings, Moody, and Hidewood soils. They have a profile that is somewhat similar to that of Moody soils. Their solum formed in loess, and that of Vienna soils formed in glacial till. They are the well-drained members of a drainage sequence that includes the moderately well drained Brookings soils and the somewhat poorly drained Hidewood soils. They formed in a thinner mantle of loess than Moody soils. They have A and B horizons that formed in loess, whereas the Moody soils have A, B, and C horizons that formed in loess.

Kranzburg silty clay loam, 0 to 2 percent slopes (KrA).—This soil is on the crest of hills and in other places that have good internal drainage.

This soil has a profile similar to that described as representative of the series, but in most places the surface layer is a few inches thinner. The mantle of silt typically is about 36 inches thick.

Included with this soil in mapping are small areas of Vienna soils, and a few areas of soils in which the surface layer is thin and brown because soil blowing has removed a part of the material in the surface layer. Also included are a few areas of Sverdrup and Renshaw soils.

Erosion on this soil is not a serious hazard. Plowing in fall increases susceptibility to soil blowing. Most areas of this soil are used for crops. This soil is well suited to all crops commonly grown in the county, and it has no serious limitations for intensive farming. Capability unit I-1; windbreak suitability group 1; Silty range site.

Kranzburg silty clay loam, 2 to 4 percent slopes (KrB).—This soil has long, smooth slopes and is mostly on the upper or lower parts of hillsides. This soil has the profile described as representative of the series. The mantle of silt in which most of this soil formed is about 32 inches thick in most places.

Included with this soil in mapping are a few small areas of Vienna soils. Also included are a few small areas of Sverdrup and Renshaw soils.

Susceptibility to water erosion is the major limitation to use of this soil. This soil is subject to soil blowing, especially after fall plowing. Most areas of this soil is used for corn and small grain. A small acreage is used for range and pasture. This soil is well suited to these uses. Many of the farms in the county are on this soil. Capability unit IIe-1; windbreak suitability group 1; Silty range site.

Kranzburg silty clay loam, 3 to 6 percent slopes, eroded (KrB2).—This soil has long, smooth slopes. It has a profile similar to that described as representative of the series, but the surface layer is 2 to 4 inches thinner. The mantle of loess in which most of this soil formed generally is about 30 inches thick, but in some places it is thinner, and glacial till is exposed in a few places. A few stones or pebbles are on the surface in areas where the loess is thin.

Included with this soil in mapping are areas of Vienna soils in which the silt mantle is less than 20 inches thick. Also included are a few small areas of Sverdrup and Renshaw soils.

Susceptibility to erosion is the major limitation to use of this soil. The main management needs are erosion control, water conservation, and maintenance of fertility. If measures are used to control erosion, to conserve water, and to maintain fertility, this soil is well suited to crops. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Lamoure Series

The Lamoure series consists of poorly drained, nearly level soils. These soils formed under wet prairie vegetation in moderately fine textured sediment deposited by flood waters. They are on flood plains that are a few feet higher than the streams.

In a representative profile the surface layer is silty clay loam about 30 inches thick. It is black in the upper 24 inches and very dark gray in the lower 6 inches. The underlying material, to a depth of about 38 inches, is very dark grayish-brown and very dark gray silty clay loam. Below this depth it is grayish-brown silty clay loam that contains thin layers of sandy clay loam and loamy sand.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is low, and the content of potassium is medium. The seasonal high water table is at or near the surface in spring and during periods of wetness.

These soils are used for crops and pasture. Corn, small grain, and legume-grass hay are the main crops. These soils are flooded nearly every year by snow melt water. About once in 10 years during the growing season, they are flooded by water from heavy rains, and crops are damaged. Wetness and susceptibility to occasional overflow are the major limitations to use of these soils.

Representative profile of Lamoure silty clay loam on a flood plain, 1,300 feet east and 60 feet north of the southwest corner sec. 5, T. 107 N., R. 44 W.:

Ap—0 to 10 inches, black (10YR 2/1 grading to N 2/0) silty clay loam; weak, fine, subangular blocky structure; sticky; strongly effervescent; moderately alkaline; clear, wavy boundary.

A12g—10 to 24 inches, black (N 2/0) grading to very dark gray (N 3/0) silty clay loam; weak, very fine, subangular blocky structure; sticky; strongly effervescent; moderately alkaline; clear, wavy boundary.

A13g—24 to 30 inches, very dark gray (N 3/0) silty clay loam; weak, very fine, subangular blocky structure; sticky; few spots of very dark grayish brown (2.5Y 3/2); strongly effervescent; moderately alkaline; clear, wavy boundary.

C1g—30 to 38 inches, very dark grayish-brown (2.5Y 3/2) and very dark gray (N 3/0) silty clay loam; few, fine, faint, yellowish-brown (10YR 5/6) mottles; very weak, very fine subangular blocky structure; sticky; strongly effervescent; moderately alkaline; clear, wavy boundary.

C2g—38 to 68 inches, grayish-brown (2.5Y 5/2) silty clay loam, thin layers of sandy clay loam and loamy sand; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; slightly sticky; slightly effervescent; moderately alkaline.

The A1 horizon ranges from 18 to 36 inches in thickness and from black to very dark gray in color. It is silt loam or silty clay loam. It is mildly alkaline or moderately alkaline. The A3 and the C1g horizons range from very dark gray and very dark grayish brown to dark gray. A thin, weakly developed B horizon is present in places. The C horizon is commonly dark grayish brown, grayish brown, or olive gray. Thin sandy layers are throughout the profile.

Lamoure soils are near Rauville and La Prairie soils. They are at higher elevations on the flood plain than the very poorly drained Rauville soils, and they are at slightly lower elevations than La Prairie soils.

Lamoure silty clay loam (0 to 2 percent slopes) (La).—This is a poorly drained, calcareous soil on bottom lands. It has the profile described as representative of the series.

Included with this soil in mapping are areas of soils that are similar to this soil, but they have a loam surface layer. Included in places are areas of soils that have layers or pockets of gypsum. Also included are areas where the calcareous alluvium is covered by 1 to 3 feet of noncalcareous, dark-colored sediment that washed from uplands. There are also a few small areas of somewhat poorly drained soils.

Wetness and susceptibility to occasional overflow are limitations to use of this soil. If this soil is adequately fertilized and kept in good tilth, it is well suited to crops. Capability unit IIw–3; windbreak suitability group 3; Subirrigated range site.

Lamoure silty clay loam, frequently flooded (0 to 2 percent slopes) (Lb).—This soil is on low bottom lands that are frequently subject to flooding. It is mapped on the first bottom and includes the main stream channel. Old stream channels also dissect this unit.

Included with this soil in mapping are small areas of Darnen soils and small areas of Rauville, and La Prairie soils, which are frequently flooded. Also included are areas of sandy, gravelly, and stony materials that have been deposited along the streams.

Susceptibility to frequent overflow and wetness are the main limitations to use of this soil. Most areas are used for pasture and range. Wild hay is cut in some places. Unpastured areas are valuable as wildlife habitat. If flooding is controlled, some areas are suited to crops. Capability unit VIw–1; windbreak suitability group 8; Subirrigated range site.

Lamoure and La Prairie soils, frequently flooded (0 to 2 percent slopes) (Lc).—This unit is along streams and creeks. The areas consist mostly of Lamoure silty clay loams and of La Prairie loams.

Included with these soils in mapping are areas of Rauville soils in old stream meanders and other low places. Also included are areas of sandy, gravelly, and stony materials that have been deposited along the streams. There are also a few small areas of somewhat poorly drained soils.

Most areas of these soils are subject to frequent flooding. Some areas are above the flood level, but they are so dissected by oxbows and stream channels that cultivation is not practical. Wild hay is cut in some areas, but most areas are used for pasture. If flooding is controlled, some areas of these soils are suited to crops. Both soils in capability unit VIw–1 and windbreak suitability group 8; Lamoure soils in Subirrigated range site; La Prairie soils in Overflow range site.

La Prairie Series

The La Prairie series consists of moderately well drained, nearly level soils on bottom lands that are subject to occasional flooding. These soils formed under prairie vegetation in medium-textured stream sediment.

In a representative profile the upper 24 inches is black loam. Below this the profile is very dark gray and very dark grayish-brown loam. Free lime is below a depth of 13 inches.

Permeability is moderate, and the available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

La Prairie soils are free of stones, are easy to work, and are well suited to all crops commonly grown in the county. Some areas are along streams where they are not accessible to use for crops. The major limitation to use of these soils is occasional flooding.

Representative profile of La Prairie loam, on a grassy roadside on the flood plain, 1,140 feet south of the northwest corner NE¼ sec. T. 105 N., R. 44 W.:

A11—0 to 13 inches, black (10YR 2/1) loam; weak and moderate, very fine and fine, subangular blocky structure; friable; moderately alkaline; abrupt, smooth boundary.

A12—13 to 24 inches, black (10YR 2/1) loam; weak, very fine and fine, subangular blocky structure; friable; strongly effervescent; moderately alkaline; clear, smooth boundary.

A13—24 to 60 inches, very dark gray (10YR 3/1) and very dark grayish-brown (2.5Y 3/2) loam; weak, fine and medium, subangular blocky structure; friable; cobbly layer at a depth of 48 inches; strongly effervescent; moderately alkaline.

The A1 horizon ranges from 36 to 70 inches in thickness and is loam, silt loam, or silty clay loam. Depth to free lime ranges from 10 to 24 inches. Thin layers of sandy, gravelly, or cobbly material commonly are in some parts of the profile. The C horizon, where present, ranges from loam to silty clay loam.

La Prairie soils are near Lamoure soils. They have a profile that is similar to that of Darnen soils on uplands. They have a thick, dark-colored A horizon that is similar to that of Lamoure soils, but they are in higher, better drained areas on flood plains. They formed in alluvium, whereas Darnen soils formed in local colluvium, and their solum is alkaline rather than neutral in reaction.

La Prairie loam (0 to 2 percent slopes) (Lp).—This soil is on flood plains, mainly adjacent to streams. It typically has been leached free of lime to a depth of 1 to 2 feet, but in a few areas the entire surface layer is limy.

Included with this soil in mapping is a small acreage of well-drained soils that are not subject to overflow. Also included are a few areas of soils where beds of sand and gravel are below a depth of 3 feet.

Susceptibility to occasional flooding is the only limitation to use. This soil can be farmed intensively. Most areas are used for crops, but some areas are in pasture or range. Capability unit IIw–4; windbreak suitability group 1; Overflow range site.

Lismore Series

The Lismore series consists of moderately well drained, nearly level to very gently sloping soils on uplands. These soils formed under prairie vegetation in medium textured or moderately fine textured glacial till or in loess overlying till. Drainage patterns are well defined, and there are no depressions or potholes.

In a representative profile the surface layer is silty clay loam about 17 inches thick. It is black in the upper 11 inches and very dark gray in the lower 6 inches. The subsoil is friable clay loam about 9 inches thick. It is dark grayish brown in the upper part and mottled, light olive brown in the lower part. The underlying material is calcareous, light olive-gray clay loam.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

Most areas are used for crops to which the soils are well suited. These soils have no major limitations to use.

Representative profile of Lismore silty clay loam, 0 to 3 percent slopes, in a cultivated field, 185 feet west and 85 feet north of the southeast corner sec. 36, T. 107 N., R. 44 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam; cloddy; friable; common quartz grains, mostly about 1 millimeter in diameter; neutral; abrupt, smooth boundary.

A1—6 to 11 inches, black (10YR 2/1) silty clay loam; weak and moderate, very fine, subangular blocky structure; friable; common quartz grains, mostly about 1 millimeter in diameter; mildly alkaline; clear, wavy boundary.

A3—11 to 17 inches, very dark gray (10YR 3/1) silty clay loam; friable; common quartz grains, mostly about 1 millimeter in diameter; few, light, olive-brown (2.5Y 5/4) worm casts; slightly effervescent worm casts; mildly alkaline; clear, wavy boundary.

IIB2—17 to 21 inches, dark grayish-brown (2.5Y 4/2) light clay loam; few, fine, faint, yellowish-brown (10YR 5/6) mottles; weak and moderate, fine, subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts and numerous light olive-brown (2.5Y 5/4) worm casts; light olive-brown casts are slightly effervescent; about 7 percent coarse fragments; moderately alkaline; clear, wavy boundary.

IIB3ca—21 to 26 inches, light olive-brown (2.5Y 5/4) light clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak and moderate, fine, subangular blocky structure; friable; few dark grayish-brown (2.5Y 4/2) worm casts; strongly effervescent; moderately alkaline; gradual, smooth boundary.

IIC—26 to 60 inches, light olive-gray (5Y 6/2) clay loam; many, coarse, prominent, yellowish-brown (10YR 5/6) mottles; massive; friable; few, soft, white, limy masses; few iron oxide concretions; about 4 percent coarse fragments; strongly effervescent; moderately alkaline.

The A horizon ranges from 12 to 20 inches in thickness and from silty clay loam to clay loam. The B horizon typically is clay loam, but it ranges to loam and silty clay loam. The B horizon ranges from dark grayish brown and very dark grayish brown to olive brown and light olive brown in color and from 8 to 16 inches in thickness. The C horizon is glacial till of clay loam or loam texture. It is commonly light olive brown, grayish brown, and light olive gray. Depth from the surface to free lime ranges from 18 to 24 inches.

Lismore soils are near Vienna and Hidewood soils. They have a profile similar to that of Svea soils. The nearly level areas are near the well-drained Vienna soils, and the very gently sloping areas along drainageways are near the somewhat poorly drained Hidewood soils. They have smoother, less complex slopes than Svea soils, and the upper part of their solum formed in loess or in a mixture of loess and glacial till, whereas Svea soils formed in glacial till.

Lismore silty clay loam, 0 to 3 percent slopes (LsA).—This soil has a few stones or pebbles on the surface and in the surface layer. The surface layer is more than 24 inches thick in some swales and near the base of more sloping areas. The surface layer, and in some places the upper part of the subsoil, formed in a mixture of loess and glacial till.

Included with this soil in mapping are small areas of well-drained, nearly level Vienna soils. Also included in narrow drainageways are areas of somewhat poorly drained Hidewood soils.

This soil is well suited to corn, small grain, and alfalfa. It has no serious limitations to use for intensive farming. Capability unit I-1; windbreak suitability group 1; Overflow range site.

Marsh

Marsh (Ma) consists of undrained, closed depressions and ponds that, except in dry years, are generally covered by 1 to 3 feet of water. Scattered areas of cattails, reeds, sedges, and other water-tolerant plants grow in the open water. Most areas of Marsh are in the northeastern part of Pipestone County. Marsh provides habitat for wildlife. Capability unit VIIIw–1; windbreak suitability group 8; not placed in a range site.

Moody Series

The Moody series consists of well-drained, nearly level to gently sloping soils on uplands. These soils formed under prairie vegetation in moderately fine textured or medium-textured loess deposits.

In a representative profile the surface layer is silty clay loam about 10 inches thick. It is very dark brown in the upper 7 inches and mixed very dark brown and dark yellowish brown in the lower 3 inches. The subsoil is friable silty clay loam about 25 inches thick. It is dark yellowish brown in the upper part, brown in the middle part, and dark grayish brown in the lower part. The underlying material is brown silt loam that has thin layers of very fine sandy loam.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of these soils are used for crops, but a few areas are in pasture or range. All crops commonly grown in the county grow well on these soils. The gently sloping areas are susceptible to erosion, which is the major limitation to the use of these soils.

Representative profile of Moody silty clay loam, 2 to 4 percent slopes, in a cultivated field, 900 feet east and 40 feet south of the northwest corner of NE¼ sec. 15, T. 105 N., R. 46 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silty clay loam; cloddy; friable; neutral; clear, smooth boundary.

A3—7 to 10 inches, mixed very dark brown (10YR 2/2) and dark yellowish-brown (10YR 3/4) silty clay loam, very dark grayish brown (10YR 3/2) crushed; weak, fine and medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; neutral; clear, smooth boundary.

B21—10 to 18 inches, dark yellowish-brown (10YR 3/4) silty clay loam; moderate, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; few, very dark gray (10YR 3/1) worm casts and root channels; few, thin, discontinuous clay films on vertical faces of prisms; few pores, less than 1 millimeter in diameter; neutral; gradual smooth boundary.

B22—18 to 30 inches, brown (10YR 4/3) silty clay loam; moderate, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, discontinuous clay films on vertical faces of prisms; few pores, mostly less than 1 millimeter in diameter; neutral; gradual, smooth boundary.

B3—30 to 35 inches, dark grayish-brown (10YR 4/2) silty clay loam; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few pores mostly less than 1 millimeter in diameter; neutral; abrupt, smooth boundary.

Cca—35 to 60 inches, brown (10YR 5/3) silt loam; friable; few thin layers of very fine sandy loam; few segregated limy masses and few white, hard, limy concretions 5 to 15 millimeters in diameter; strongly and violently effervescent; moderately alkaline.

The solum is typically silty clay loam, but in a few places the lower part ranges to silt loam. The A1 horizon ranges from 6 to 10 inches in thickness and from very dark brown to very dark grayish brown or dark brown in eroded areas. The B horizon ranges from 18 to 28 inches in thickness and typically ranges from dark yellowish brown and dark brown to brown. The C horizon commonly is silt loam, but it ranges to silty clay loam. The C horizon ranges from light yellowish brown to light olive brown and brown. Thin strata of material ranging from fine sand to fine sandy loam are in the C horizon in places. Depth to free lime, in the form of hard concretions and soft accumulations, ranges from 30 to 40 inches in most places. The mantle of loess is 42 to 70 inches thick and is underlain by glacial till of loam or clay loam texture.

In Pipestone County, Moody silty clay loam, 3 to 6 percent slopes, eroded, has a thinner dark-colored surface layer than is defined as within the range for the series. This difference, however, does not greatly alter its usefulness or behavior.

Moody soils are near Trent soils, and they have a profile that is similar to that of Kranzburg and Vienna soils. They have a brighter colored B horizon and a slightly thinner A horizon than Trent soils. They formed in thicker deposits of loess than Kranzburg soils. They formed in loess, whereas Vienna soils formed in glacial till.

Moody silty clay loam, 0 to 2 percent slopes (MoA).—This soil has long, smooth slopes and is in areas of deep loess. It generally is free of stones. In many places this soil has a thin sandy layer in the lower part of the subsoil or in the underlying material that helps to improve natural drainage. This soil has a profile similar to that described as representative of the series, but the surface layer is a few inches thicker.

Included with this soil in mapping are a few small areas of Kranzburg soils. Also included are areas of eroded soils in which the surface layer is thinner and browner than that of this soil.

The hazard of erosion is not a concern on this soil, but fall plowing increases the hazard of soil blowing. Nearly all areas of this soil are used for crops. This soil is well suited to corn, small grain, and alfalfa, and it has no major limitations to use for intensive farming. Capability unit I–1; windbreak suitability group 1; Silty range site.

Moody silty clay loam, 2 to 4 percent slopes (MoB).—This soil has long, smooth slopes. It has the profile described as representative of the series. Included in mapping are a few small areas of Kranzburg soils.

The hazard of erosion is slight. Areas that have been plowed in fall are subject to soil blowing.

Most areas of this soil are cropped, but some are used for pasture or range, and most of the farmsteads are on this soil. If fertility is adequate and erosion is controlled, this soil is well suited to corn, small grain, and alfalfa. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Moody silty clay loam, 3 to 6 percent slopes, eroded (MoB2).—This soil has long, smooth slopes. It is on the highest and most steeply sloping parts of the deep loess areas. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and lighter colored because of erosion.

Included with this soil in mapping are a few small areas of Kranzburg soils. Also included are a few areas of soils that have steeper slopes than this soil.

The hazard of erosion is moderate because of the long slopes. The main management needs are control of erosion and maintenance of fertility. Almost all areas are used for crops. If erosion-control measures are used, this soil is well suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Quam Series

The Quam series consists of very poorly drained, nearly level soils. These soils formed under sedge and reed vegetation in material that is free of stones to a depth of 3 feet or more. This stone-free material consists of silt and clay from the loam and clay loam glacial till that was washed and blown into the depressions and drainageways from the surrounding hillsides. These soils are in closed depressions and in very wet drainageways on glaciated uplands in the northeastern part of the county. The depressions are saucer shaped, and most of them are only a few acres in size.

In a representative profile the surface layer is black silty clay loam about 23 inches thick. Below this, to a depth of about 42 inches, is friable, silty clay loam that is black to very dark gray in the upper part and dark gray mottled with yellowish brown in the lower part. The underlying material is mottled, gray and light-gray clay loam.

Permeability is moderately slow, and available water capacity is high. Runoff is ponded or very slow. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is very high. The seasonal high water table is at or near the surface in spring and during periods of wetness.

Most areas of these soils are drained and are used for crops. The soils are well suited to corn, soybeans, small grain, and alfalfa. Undrained areas are marshy. If surface drainage is used, these soils are suited to pasture or to crops in dry years. The major limitation to the use of these soils is wetness.

Representative profile of Quam silty clay loam, in a drained depression, 220 feet south and 75 feet west of the northeast corner sec. 11, T. 108 N., R. 45 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; cloddy; hard, mildly alkaline; abrupt, smooth boundary.

A11g—8 to 16 inches, black (N 2/0) heavy silty clay loam; moderate, very fine, subangular blocky structure; friable; vertical breakage; mildly alkaline; gradual smooth boundary.

A12g—16 to 23 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure parting to moderate, very fine, subangular blocky; friable; vertical breakage; neutral; gradual, smooth boundary.

ABg—23 to 34 inches, black (N 2/0) grading to very dark gray (N 3/0) silty clay loam; moderate, very fine and fine, subangular blocky structure; friable; vertical breakage; olive gray (5Y 5/2) in lower part; neutral; clear, irregular boundary.

B2g—34 to 42 inches, dark-gray (5Y 4/1) silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak and moderate, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

IIC1g—42 to 47 inches, gray (5Y 5/1) clay loam; many, coarse, distinct, brown (7.5YR 4/4) mottles; massive; friable; neutral; clear, smooth boundary.

IIC2g—47 to 60 inches, gray (5Y 5/1) clay loam; few, medium, distinct, brown (7.5YR 4/4) mottles; massive; friable; few manganese oxide concretions; about 2 percent coarse fragments; mildly alkaline; gradual, smooth boundary.

IIC3g—60 to 70 inches, light-gray (5Y 6/1) clay loam; many, medium, distinct, brown (7.5YR 4/4) and yellowish-brown (10YR 5/8) mottles; massive; friable; about 5 percent coarse fragments; slightly effervescent; mildly alkaline.

The A1 horizon ranges from 16 to 36 inches in thickness and from light silty clay loam to heavy silty clay loam. The A3 or AB horizon ranges from 10 to 20 inches in thickness, from black to very dark gray and to gray in color, and from light silty clay loam to heavy silty clay loam in texture. The B2 horizon, where present, is very dark gray or dark gray and is as much as 18 inches thick. The C horizon is glacial till of silty clay loam or clay loam texture. It ranges from gray and light gray to dark olive gray and olive gray in color. Depth to free lime ranges from 40 to 70 inches.

Quam soils are near Flom and Roliss soils, and they formed in similar materials. They are more poorly drained than Flom and Roliss soils, and they are at lower elevations, are more deeply leached, and have a thicker A horizon.

Quam silty clay loam (0 to 2 percent slopes) (Qu).—This soil generally is in depressions, but some areas are in very wet drainageways. Generally, depth to free lime is 4 to 5 feet, but in some areas free lime is at or near the surface.

Wetness is the major limitation to the use of this soil. Some of the areas have been adequately drained and can be row cropped intensively. Most drained areas are used for crops in dry years. In wet years the growth of crops is either poor in inadequately drained areas, or the areas are too wet for crops. Capability unit IIIw–1; windbreak suitability group 2; Wetland range site.

Rauville Series

The Rauville series consists of very poorly drained, nearly level soils. These soils formed in moderately fine textured alluvium. They are in old stream channels and in other low, wet places along rivers and creeks, and in wet, marshy drainageways that dissect steep, sloping uplands. Most areas of these soils have a hummocky surface.

In a representative profile the surface layer is silty clay loam about 32 inches thick. It is black in the upper 5 inches and very dark gray in the lower 27 inches. The next layer is transitional to the underlying material. It is dark-gray clay loam about 14 inches thick. The underlying material is dark-gray and dark greenish-gray silty clay loam.

Permeability is moderate, and available water capacity is very high or high. The content of organic matter is very high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at or near the surface most of the time except during long dry periods.

These soils generally are not suited to crops, because they are too low to be drained and are subject to frequent flooding. Some areas of Rauville soils provide grazing or wild hay, but most areas are idle. The major limitations to the use of these soils are wetness and susceptibility to flooding.

Representative profile of Rauville silty clay loam, in a grassy glacial valley, 1,400 feet west and 40 feet south of the northeast corner sec. 2, T. 108 N., R. 46 W.:

A11g—0 to 5 inches, black (N 2/0) silty clay loam high in content of organic matter; weak and moderate, very fine, granular structure; friable, slightly sticky; few very dark brown (10YR 2/2) inclusions; many roots; violently effervescent; moderately alkaline; clear, smooth boundary.

A12g—5 to 17 inches, very dark gray (N 3/0) silty clay loam high in content of organic matter; weak, very fine, subangular blocky structure; friable, slightly sticky; violently effervescent; moderately alkaline; gradual, smooth boundary.

A13g—17 to 32 inches, very dark gray (N 3/0) silty clay loam; moderate, very fine and fine, angular and subangular blocky structure; friable; violently effervescent; moderately alkaline; gradual, smooth boundary.

ACg—32 to 46 inches, dark-gray (N 4/0) clay loam; common, coarse, distinct, very dark grayish-brown (10YR 3/2) mottles; sticky; strongly effervescent; moderately alkaline; clear; smooth boundary.

Cg—46 to 60 inches, dark-gray (5Y 4/1) and dark greenish-gray (5BG 4/1) silty clay loam; slightly sticky; thin strata of sand and gravel; weakly and strongly effervescent; moderately alkaline.

The A1 horizon ranges from 20 to 40 inches in thickness and from silty clay loam to silt loam. A transitional AC horizon, 10 to 24 inches in thickness, ranges from dark gray to very dark gray and from silty clay loam to clay loam. The C horizon ranges from silty clay loam to sand and gravel. Typically, these soils are moderately alkaline throughout,

but the upper part of the A horizon ranges from moderately alkaline to neutral in reaction.

Rauville soils are near Lamoure soils. Their profile is similar to that of Quam soils. They are on lower elevations on bottom lands and are more poorly drained than Lamoure soils. They have a thick A1 horizon similar to that of Quam soils on uplands, but they have a calcareous, more weakly developed solum.

Rauville silty clay loam (0 to 2 percent slopes) (Ra).—This soil is on the lowest parts of bottom lands.

Included with this soil in mapping are marshes and springs on bottom lands, and some areas of soils in which the surface layer is only slightly limy. Also included are some very wet drainageways that dissect adjacent steep slopes.

Susceptibility to flooding and wetness are the main limitations to use of this soil. If a major system for drainage and flood control is installed, some areas of this soil are suited to crops. In dry years this soil provides limited pasture and range. Capability unit VIw–2; windbreak suitability group 8; Wetland range site.

Renshaw Series

The Renshaw series consists of somewhat excessively drained, nearly level to moderately steep soils on uplands, on stream terraces, and on outwash plains. These soils formed under prairie vegetation in gravelly glacial outwash over sand and gravel.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsoil is friable, dark yellowish-brown loam about 7 inches thick. The underlying material, to a depth of 19 inches, is dark yellowish-brown gravelly coarse sandy loam. Below this depth it is yellowish-brown and light yellowish-brown gravelly coarse sand.

Permeability is moderately rapid above the sand and gravel and rapid in the sand and gravel. Available water capacity is low. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

These soils are used for crops or pasture. Small grain and hay are suitable crops. The growth of corn is restricted by periods of drought in most years. In some places gravel pits in these soils are a source of gravel.

Representative profile of Renshaw loam, 0 to 2 percent slopes, in a cultivated field, 1,520 feet south and 500 feet east of the northeast corner sec. 24, T. 108 N., R. 45 W.:

Ap—0 to 5 inches, very dark gray (10YR 3/1) loam; very weak, very fine, subangular blocky structure; friable; slightly acid; abrupt, smooth boundary.

A12—5 to 8 inches, very dark gray (10YR 3/1) loam; weak and moderate, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B2—8 to 15 inches, dark yellowish-brown (10YR 3/4) heavy loam; moderate, medium and coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; friable; neutral; abrupt, smooth boundary.

IIC1—15 to 19 inches, dark yellowish-brown (10YR 3/4) gravelly coarse sandy loam; single grained and weak, fine, subangular blocky structure; friable; about 35 percent gravel; neutral; clear, smooth boundary.

IIC2—19 to 60 inches, yellowish-brown (10YR 5/4) and light yellowish-brown (10YR 6/4) gravelly coarse sand; single grained; loose; slightly effervescent; moderately alkaline.

The A1 horizon ranges from black to very dark gray or very dark brown in eroded areas and from 5 to 10 inches in thickness. The solum ranges from 12 to 22 inches in thickness, and depth to the sandy and gravelly underlying material ranges from 12 to 22 inches. The B2 horizon ranges from loam to heavy silt loam and from 6 to 12 inches in thickness. The B horizon ranges from dark yellowish brown and dark brown to very dark grayish brown and very dark brown. The percentage of sand and gravel in the IIC horizon is extremely variable. Free lime has accumulated in the upper part of the IIC horizon or has been dispersed throughout the IIC horizon.

Renshaw soils are near Fordville, Sioux, and Sverdrup soils. They have a thinner solum than Fordville soils. They have a thicker, finer textured solum than Sioux soils. They have a loam solum and gravelly underlying material, whereas Sverdrup soils have a sandy loam solum and sandy underlying material.

Renshaw loam, 0 to 2 percent slopes (ReA).—This soil is somewhat excessively drained. It is mostly on stream terraces and outwash plains, but a few areas are on uplands. This soil has the profile described as representative of the series. Depth to sandy and gravelly underlying material ranges from 15 to 22 inches.

Included with this soil in mapping are areas of soils in which the brownish subsoil is exposed, some areas of gravelly Sioux soils, and some areas of soils where stones are on the surface and in the soils. Also included are areas where the gravel deposits are only a few feet thick over glacial till or silty alluvium, and a few areas of soils in which the surface layer and the subsoil are sandy loam. Some narrow wet drainageways are included.

Droughtiness is the main limitation to the use of this soil, but soil blowing can be a severe hazard, especially in spring. Some areas are used for crops. Small grain and alfalfa are suitable crops. The low available water capacity restricts the growth of corn, particularly during dry periods in midsummer. A large acreage is in native pasture or is used for range, and this soil is fairly well suited to these purposes. Conserving water and controlling grazing are major management needs. Capability unit IIIs–1; windbreak suitability group 4; Shallow range site.

Renshaw loam, 2 to 6 percent slopes (ReB).—This soil is on stream terraces and uplands. It has a profile similar to that described as representative of the series, but in many places depth to the underlying sandy and gravelly material is less. Depth to the sandy and gravelly underlying material generally ranges from 12 to 20 inches. The surface layer is about 6 inches thick in cultivated areas, and it is somewhat lighter in color as a result of erosion and loss of organic matter. In pastures and in other uncultivated areas the surface layer is darker and is a few inches thicker.

Included with this soil in mapping are areas of soils in which the brownish subsoil is exposed, areas of gravelly Sioux soils, and areas of soils where stones are on the surface and in the soils. Also included are areas of soils in which the gravel deposits are only a few feet thick over glacial till or silty alluvium and areas in which the surface layer and the subsoil are sandy loam.

Droughtiness as a result of low available water capacity is a limitation to use, and erosion is a hazard. This soil is fairly well suited to small grain and hay, especially when rainfall is timely during the growing season. Pastures are fairly productive until July, after which they dry up if rains are not frequent. Capability unit IIIe–2; windbreak suitability group 4; Shallow range site.

Renshaw loam, 6 to 12 percent slopes (ReC).—This soil is on uplands and terrace escarpments. It has a profile similar to that described as representative of the series, but the surface layer and the subsoil are a few inches thinner and, in many places, depth to the underlying sandy and gravelly material is less. The surface layer in cultivated areas generally is lighter in color and thinner than that in pastured areas and in other uncultivated areas. Depth to the sandy and gravelly underlying material generally ranges from 12 to 18 inches. A few stones are on the surface and in the soil.

Included with this soil in mapping are a few areas of soils in which the brown subsoil is exposed and a few areas of Sioux soils. Also included are some areas of soils in which the surface layer and the subsoil are sandy loam and a few areas of sloping Sverdrup soils. A few areas of soils in which the gravelly underlying material is only a few feet thick over glacial till or silty alluvium are included.

Droughtiness resulting from low available water capacity and rapid runoff is a major limitation to use. The hazard of erosion is severe. Most cultivated areas are too droughty for corn. Hay and small grain are suitable crops. Pastures usually dry up early in summer. Capability unit IVe–2; windbreak suitability group 4; Very Shallow range site.

Renshaw loam, 12 to 18 percent slopes (ReD).—This soil is on side slopes along some of the streams and drainageways in the county and on terrace escarpments.

This soil has a profile similar to that described as representative of the series, but the surface layer and the subsoil are thinner, and depth to sandy and gravelly underlying material is less. A few stones are on the surface. Depth to the gravelly underlying material generally ranges from 12 to 15 inches.

Included with this soil in mapping are a few areas of soils in which the surface layer and the subsoil are sandy loam and some areas in which the gravelly underlying material is only a few feet thick over glacial till or silty alluvium. Also included are some areas of cultivated soils in which the brown subsoil and the gravelly underlying material are exposed. Small areas of Sioux soils are included.

Susceptibility to erosion and droughtiness are very severe limitations to use of this soil. This soil is better suited to pasture or range than to most other uses. A few areas are cropped along with other less sloping and less droughty soils. Capability unit VIe–2; windbreak suitability group 8; Very Shallow range site.

Renshaw-Vienna-Buse loams, 2 to 6 percent slopes, eroded (RnB2).—This complex is on uplands. It is about 50 percent Renshaw soils, 35 percent Vienna soils, and 15 percent Buse soils. Renshaw soils formed on ridges, in pockets, or on knobs of gravelly material. Vienna soils formed in loess and glacial till on the less steep parts of side slopes. Buse soils formed in glacial till on the steeper, more convex parts of side slopes.

The Renshaw, Vienna, and Buse soils in this complex have a profile similar to the one described as representative of their respective series, but the plow layer is very dark brown, because tillage and erosion have mixed some of the material in the surface layer with that from the subsoil. Also, Vienna soils have a surface layer of loam instead of silty clay loam, and the Renshaw soils are shallower to the underlying sandy and gravelly materials.

Included with these soils in mapping are small areas of Sioux, Sverdrup, Darnen, and other soils. Also included are uneroded areas that are mostly in pasture.

The hazard of erosion is moderate. Droughtiness is a moderate limitation to use of Renshaw soils because of low available water capacity. Most areas of the soils in this complex are cultivated. The main management needs are controlling erosion, conserving water, and increasing fertility. Small grain and hay are suitable crops. In some places gravel suitable for driveways can be obtained from the Renshaw soils. All soils in capability unit IIIe–2; Renshaw soils in windbreak suitability group 4, Vienna soils in windbreak suitability group 1, and Buse soils in windbreak suitability group 5; Vienna and Buse soils in Silty range site, and Renshaw soils in Shallow range site.

Renshaw-Vienna-Buse loams, 6 to 12 percent slopes, eroded (RnC2).—The soils of this complex are on uplands. The complex is about 50 percent Renshaw soils, 25 percent Vienna soils, and 25 percent Buse soils. Vienna and Buse soils formed in glacial till, and Renshaw soils formed on knobs and ridges of gravelly material or in gravelly pockets in glacial till. Along some drainageways and in a few other places, Renshaw soils are on the crest of slopes, and Vienna and Buse soils are on the side slopes.

The soils of this complex have a profile similar to the one described as representative of their respective series, but the plow layer is very dark brown in some places and lighter colored in other places, because tillage and erosion have mixed material in the surface layer with that from the subsoil or the underlying material. Also, depth to underlying material is less.

Included with these soils in mapping are areas of Sioux soils. Also included are some noneroded areas that are in pasture and range.

The hazard of erosion is severe. Droughtiness is a severe limitation to use of Renshaw soils. The main management needs are controlling erosion, conserving water, and improving fertility. This soil is used for crops and pasture. Small grain and hay are suitable crops. Controlling grazing is a major management need where the areas are used for pasture and range. All soils in capability unit IVe–2; Renshaw soils in windbreak suitability group 4, Vienna soils in windbreak suitability group 1, Buse soils in windbreak suitability group 5; Vienna and Buse soils in Silty range site, Renshaw soils in Very Shallow range site.

Rock Outcrop

Rock outcrop consists of areas where Sioux quartzite crops out. More than 75 percent of each area is exposed bedrock. Soil material is thin or is absent. Most areas occur as narrow outcrop ridges, an example of which is the quartzite ridge near the Pipestone National Monument, where pipestone was formerly quarried. No quarries are presently active in the county, but many buildings that have outer walls of quartzite are still standing in Pipestone and Jasper. This land type is mapped only in a complex with Ihlen soils.

Rock outcrop-Ihlen complex, 6 to 12 percent slopes (RoC).—This complex consists of 50 to 76 percent Rock outcrop and exposed bedrock. The rest is mainly Ihlen soils that are generally between the outcrop. Ihlen soils have a profile similar to that described as representative of the series, but depth to bedrock is less.

Included with this complex in mapping are soils that formed in less than 20 inches of loess over bedrock. Also included are a few areas that are mostly quartzite stones and boulders, rather than Rock outcrop.

Most of the areas are in pasture, and erosion is not a hazard. Available water capacity is low because of the limited depth over bedrock. Areas that are not pastured have potential for wildlife habitat and recreational uses. The major management need is controlling grazing. Rock outcrop and Ihlen soils in capability unit VIIs–1 and windbreak suitability group 8; Rock outcrop in Very Shallow range site; Ihlen soils in Silty range site.

Roliss Series

The Roliss series consists of poorly drained, nearly level soils. These soils formed under wet prairie vegetation in medium-textured and moderately fine textured glacial material. They are on the edges of depressions, in wet drainageways, and on flats in areas of gently undulating glaciated uplands.

In a representative profile the surface layer is clay loam about 18 inches thick. It is very dark gray in the upper 12 inches and is mixed very dark gray, dark gray, and olive gray in the lower 6 inches. The lower 6 inches of the surface layer contains free lime. The subsoil is friable, mottled, very dark gray and dark-gray loam about 9 inches thick. The underlying material is mottled, gray loam.

Permeability is moderate to moderately slow, and available water capacity is high. Reaction of the surface layer ranges from mildly alkaline to strongly alkaline, because the content of lime is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is high. The seasonal high water table is at a depth of 2 feet or less.

Most areas of these soils are used for crops, but some areas that need drainage are used for pasture. Under good management, including corrective fertilization and adequate drainage, these soils are well suited to all crops commonly grown in the county. The major limitation to the use of these soils is wetness.

Roliss soils in this county are only mapped in an undifferentiated group with Flom soils.

Representative profile of Roliss clay loam in an area of Flom and Roliss clay loams, in a cultivated field, 160 feet south and 25 feet west of the northeast corner of SE¼ sec. 25, T. 108 N., R. 44 W.:

Ap—0 to 8 inches, very dark gray (N 3/0) grading to black (N 2/0) clay loam; weak, very fine, subangular blocky structure; friable, sticky; strongly effervescent; moderately alkaline; clear, smooth boundary.

A12—8 to 12 inches, very dark gray (N 3/0) clay loam, dark gray (N 4/0) dry; weak to moderate, very fine and fine, subangular blocky structure; friable, sticky; strongly effervescent.

A3ca—12 to 18 inches, mixed very dark gray (N 3/0), dark-gray (5Y 4/1), and olive-gray (5Y 5/2) clay loam, gray (N 5/0) dry; weak, fine, subangular blocky structure; friable, sticky; about 1 percent coarse fragments; violently effervescent; moderately alkaline; gradual, irregular boundary.

B2g—18 to 27 inches, very dark (N 3/0 and 5Y 3/1) and dark-gray (5Y 4/1) loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, fine, medium, subangular blocky structure; friable, sticky; about 5 percent coarse fragments; strongly effervescent; moderately alkaline; gradual, irregular boundary.

C1g—27 to 38 inches, gray (5Y 5/1) and olive-gray (5Y 5/2) loam; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; very weak, medium, subangular blocky structure; friable to firm; about 16 percent coarse fragments; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C2g—38 to 60 inches, gray (5Y 6/1 and 5Y 5/1) loam; many, coarse, prominent, light olive-brown (2.5Y 5/4) mottles; massive; firm; about 11 percent coarse fragments; strongly effervescent; moderately alkaline.

The A1 horizon is generally clay loam, but it ranges from loam to silty clay loam. It ranges from 10 to 16 inches in thickness, from black to very dark gray in color, and from slight to violent in effervescence. The A3 horizon ranges from 5 to 10 inches in thickness, and it is very dark gray, dark gray, olive gray, or very dark grayish brown. The B horizon is similar to the A3 horizon in thickness and in color, and it ranges from loam or clay loam to silty clay loam. The C horizon is glacial till of clay loam or loam texture, and it is gray, olive gray, light olive, or grayish brown.

Roliss soils are near Flom soils. They have a calcareous profile that is somewhat similar to that of Lamoure soils, but they have a thinner A horizon and more soil horizon development. They have free lime throughout the solum, but Flom soils do not.

Sioux Series

The Sioux series consists of excessively drained, undulating to very steep soils on terrace escarpments and uplands. These soils formed under prairie vegetation in gravelly glacial outwash.

In a representative profile (fig. 10) the surface layer is gravelly loamy coarse sand about 11 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The underlying material is yellowish-brown, pale-brown, and light yellowish-brown stratified sand and gravel.

Permeability is rapid, and the available water capacity is very low. The content of organic matter is medium, the content of phosphorus is very low, and the content of potassium is low. The seasonal high water table is at a depth of 5 to 10 feet or more.

These soils are not suited to crops. Some areas are used for pasture. They generally are a good source of sand and gravel. The major limitations to the use of

Figure 10.—**Profile of a Sioux soil shows a thin, dark-colored surface layer overlying sand and gravel.**

these soils are droughtiness and susceptibility to erosion.

Representative profile of Sioux gravelly loamy coarse sand, 2 to 40 percent slopes, in a road cut, about 1,750 feet north of the southwest corner sec. 31, T. 108 N., R. 46 W.:

A11—0 to 6 inches, very dark gray (10YR 3/1) gravelly loamy coarse sand; weak, fine and medium, subangular blocky structure; friable; mildly alkaline; clear, smooth boundary.

A12—6 to 11 inches, very dark grayish-brown (10YR 3/2) gravelly loamy coarse sand; weak, fine and medium, subangular blocky structure; friable; common roots; strongly effervescent; moderately alkaline; abrupt, wavy boundary.

C—11 to 60 inches, mixed yellowish-brown (10YR 5/4), pale-brown (10YR 6/3), and light yellowish-brown (10YR 6/4) stratified sand and gravel; single grained; loose; slightly effervescent; moderately alkaline.

The A horizon is 12 inches or less in thickness. It ranges from gravelly loamy coarse sand to gravelly loam and from black to very dark gray and very dark brown to very dark grayish brown. Depth to lime is variable. In some places free lime is present in the A1 horizon, but in other places there is no free lime above the C horizon. The percentage of sand, gravel, and cobbles in the C horizon is variable.

Sioux soils are near Renshaw and Fordville soils. They have a thinner and coarser textured solum than Renshaw and Fordville soils. They have a weakly developed profile that is somewhat similar to that of Buse soils, but they formed in gravelly glacial outwash, and Buse soils formed in glacial till.

Sioux gravelly loamy coarse sand, 2 to 40 percent slopes (SoE).—This soil is on terrace escarpments and on gravelly ridges in the uplands.

Some gravel pits that are an excellent source of gravel are in areas of this soil. In some places, however, the gravel is only a few feet thick over glacial till or silty alluvium. The gravelly underlying material is exposed in some eroded areas and is at a depth of as much as 12 inches in some uncultivated areas.

Droughtiness is a very severe limitation to use of this soil because available water capacity is very low. This soil generally is not used for crops. The hazard of erosion is very severe if the steep areas are cultivated. Some small areas are cropped along with other soils, because it is not practical to manage them separately. This soil provides some grazing in spring. Capability unit VIIs–1; windbreak suitability group 8; Very Shallow range site.

Svea Series

The Svea series consists of moderately well drained, nearly level to gently undulating soils on uplands in the northeastern part of the county. These soils formed under prairie vegetation in medium-textured and moderately fine textured glacial till. They are in nearly level areas, on the lower parts of side slopes, and on slight rises within areas of poorly drained soils on the glacial-till plains.

In a representative profile the surface layer is clay loam about 18 inches thick. It is black in the upper 13 inches and very dark gray in the lower 5 inches. The subsoil is friable clay loam about 16 inches thick. The upper part is dark grayish brown and contains many very dark gray worm casts; the middle part is olive brown; and the lower part is light olive brown. The underlying material is mottled, grayish-brown and gray glacial till of clay loam texture.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

These soils are well suited to all crops commonly grown in the county, and almost all of the acreage is cultivated. These soils have no major limitations to use.

Representative profile of Svea clay loam, 0 to 3 percent slopes, in a cultivated field, 1,380 feet west and 20 feet north of the southeast corner sec. 26, T. 108 N., R. 44 W.:

Ap—0 to 7 inches, black (10YR 2/1) clay loam; cloddy; friable, slightly sticky; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) clay loam; weak and moderate, very fine and fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—13 to 18 inches, very dark gray (10YR 3/1) clay loam, very dark gray (10YR 3/1) crushed; moderate, very fine and fine, subangular blocky structure; friable; few dark grayish-brown (2.5Y 4/2) worm casts; neutral; clear, irregular boundary.

B21—18 to 23 inches, dark grayish-brown (2.5Y 4/2) grading to olive-brown (2.5Y 4/4) clay loam; moderate, fine and medium, subangular blocky structure; friable; about 30 percent very dark gray (10YR 3/1) worm casts; mildly alkaline; clear, irregular boundary.

B22—23 to 29 inches, olive-brown (2.5Y 4/4) clay loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure parting to weak and moderate, fine and medium, subangular blocky; friable; few very dark gray (10YR 3/1) and dark grayish-brown (2.5Y 4/2) worm casts in upper part and light olive-brown (2.5Y 5/4) worm casts in lower part of horizon; about 4 percent coarse fragments; light olive-brown worm casts are slightly effervescent; mildly alkaline; clear, irregular boundary.

B3ca—29 to 34 inches, light olive-brown (2.5Y 5/4) clay loam; common, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable; about 6 percent coarse fragments; strongly effervescent; mildly alkaline; gradual, smooth boundary.

C1ca—34 to 44 inches, grayish-brown (2.5Y 5/2) clay loam; medium, coarse, distinct, light yellowish-brown (2.5Y 6/4) and strong-brown (7.5Y 5/8) mottles; very weak, medium, subangular blocky structure; friable; few lime accumulations on lower part of pebbles and stones; few hard lime concretions 5 to 10 millimeters in diameter; about 7 percent coarse fragments; strongly and violently effervescent; mildly alkaline; gradual, smooth boundary.

C2—44 to 60 inches, gray (5Y 6/1) clay loam; many, coarse, distinct, light olive-brown (2.5Y 5/4) and strong-brown (7.5YR 5/8) mottles; friable; about 8 percent coarse fragments; strongly effervescent; moderately alkaline.

The A1 horizon ranges from 8 to 16 inches in thickness. It typically is clay loam but ranges to loam, silt loam, or silty clay loam; silty clay loam texture is mainly on the Cary ground moraine. An A3 horizon as much as 6 inches thick and that is very dark gray or very dark grayish brown in color is present in most places. The B2 horizon ranges from 7 to 15 inches in thickness. Free lime in the form of hard concretions and soft accumulations is in the B3ca and C1ca horizons. Depth to free lime ranges from 24 to 33 inches. Content of clay in the solum is less than 30 percent. The C horizon consists of glacial till of clay loam or loam texture. It ranges from gray and grayish brown to light olive gray. The C horizon is distinctly mottled.

Svea soils are near Barnes soils, and they have a profile similar to that of Lismore soils. They have a thicker A horizon and a more olive, less brown B horizon than Barnes soils. They formed in glacial till, whereas Lismore soils formed in a mixture of loess and glacial till.

Svea clay loam, 0 to 3 percent slopes (SvA).—This is a moderately well drained soil. The surface layer typically is about 13 inches thick, but in some drainageways and near the base of steeper slopes it is as much as 22 inches thick.

Included with this soil in mapping are a few small areas of soils that have a silty clay loam surface layer and subsoil, similar to that of Brookings soils, and a few small areas that have a calcareous surface layer. These areas are indicated on the soil map by a special symbol. Also included are a few areas in which the subsoil has been churned by earthworm activity and the surface layer and the limy underlying material have been mixed into it. Small areas of Quam soils in depressions and small areas of Flom soils in narrow drainageways are included.

This soil has no major limitations to use. It can be cropped intensively. Capability unit I–1; windbreak suitability group 1; Overflow range site.

Sverdrup Series

The Sverdrup series consists of somewhat excessively drained, nearly level to gently sloping soils on uplands. These soils formed under prairie vegetation in moderately coarse textured and coarse textured glacial outwash.

In a representative profile the surface layer is very dark gray fine sandy loam about 7 inches thick. The upper part of the subsoil, about 16 inches thick, is friable, dark-brown and dark yellowish-brown sandy loam. The lower part of the subsoil, about 19 inches thick, is loose, dark yellowish-brown loamy sand. The underlying material is dark yellowish-brown and yellowish-brown loamy sand.

Permeability is moderately rapid in the uppermost 1 to 2 feet and rapid in the sandy material below this depth. Available water capacity is low or moderate. The content of organic matter is medium or high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Most areas of these soils are used for crops. Small grain and alfalfa are the main crops. These soils do not hold much water; consequently, small grain that matures early and that has a low moisture requirement is a suitable crop. The major limitation to the use of these soils is droughtiness.

Representative profile of Sverdrup fine sandy loam, 2 to 6 percent slopes, in a cultivated field, 1,450 feet north and 40 feet east of the southwest corner sec. 6, T. 108 N., R. 46 W.:

Ap—0 to 7 inches very dark gray (10YR 3/1) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak, fine, subangular blocky structure; very hard, friable; neutral; abrupt, smooth boundary.

B21—7 to 14 inches, dark-brown (10YR 3/3) sandy loam, dark yellowish brown (10YR 4/4) dry; weak, coarse, prismatic structure parting to weak, fine and medium, subangular blocky; hard, friable; neutral; gradual, smooth boundary.

B22—14 to 23 inches, dark yellowish-brown (10YR 4/4) sandy loam, yellowish brown (10YR 5/4) dry; weak, medium and coarse, subangular blocky structure; hard, friable; neutral; clear, smooth boundary.

B3—23 to 42 inches, dark yellowish-brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; single grained; loose; slightly acid; clear, smooth boundary.

C1—42 to 46 inches, dark yellowish-brown (10YR 4/4) loamy sand, light yellowish brown (10YR 6/4) dry; single grained; loose; slightly effervescent; mildly alkaline; clear, smooth boundary.

C2ca—46 to 60 inches, yellowish-brown (10YR 5/4) loamy sand, pale brown (10YR 6/3) dry; loose; strongly effervescent; moderately alkaline.

The A1 horizon commonly ranges from black to very dark gray or very dark brown, but in eroded areas it is very dark grayish brown. The A horizon ranges from sandy loam to fine sandy loam. The B2 horizon ranges from fine sandy loam to loamy sand. Depth to loamy sand or sand ranges from 12 to 24 inches. The B horizon is commonly dark yellowish brown, yellowish brown, and dark brown. The B horizon ranges from 20 to 36 inches in thickness. Depth from the surface to free lime ranges from 24 to 48 inches. The C horizon is loamy sand or sand.

Sverdrup soils are near Renshaw and Flandreau soils. They have a coarser textured solum than Renshaw soils, and their underlying material is sandy rather than gravelly. They are coarser textured than Flandreau soils, and their solum is thinner over sand.

Sverdrup fine sandy loam, 0 to 2 percent slopes (SwA).—This somewhat excessively drained soil is on uplands. It has a profile similar to that described as representa-

tive of the series, but the surface layer is slightly thicker. In most cropped areas the surface layer is brownish. Some organic matter has been lost through cropping and erosion, and some brownish material from the subsoil is mixed with that in the surface layer.

Included with this soil in mapping are a few areas of soils that have a surface layer and a subsoil of loamy sand and loam. Also included are some areas in which thin layers of silty material are in the sandy underlying material. Some areas in which glacial till or silty material is at a depth of 3 to 4 feet are included.

Available water capacity is low or moderate in this soil, and droughtiness is a major limitation. Soil blowing is a hazard, particularly after fall plowing. Corn, small grain, and alfalfa grow fairly well in years of adequate rainfall. Capability unit IIIs–1; windbreak suitability group 4; Shallow range site.

Sverdrup fine sandy loam, 2 to 6 percent slopes (SwB).—This soil is somewhat excessively drained. It has the profile described as representative of the series. In most cropped areas the surface layer has a brownish cast as a result of the loss of organic matter through tillage and erosion, and some of the brownish material from the subsoil is mixed with that in the surface layer.

Included with this soil in mapping are a few areas of soils in which the sandy material is only a few feet thick over glacial till or silty material, and a small acreage of soils that have a loamy sand surface layer and subsoil. Also included is a small acreage of soils that have a loam surface layer and subsoil. A few areas in which thin layers of silty material are in the underlying material are included.

The hazard of erosion is moderately severe, and droughtiness is a moderately severe limitation. This soil is sandy and easy to work, but it is subject to soil blowing if it is not protected. Corn, small grain, and alfalfa are fairly well suited to this soil, especially in years of adequate rainfall. Capability unit IIIe–2; windbreak suitability group 4; Shallow range site.

Swenoda Series

The Swenoda series consists of well-drained, nearly level to gently sloping soils on outwash plains and uplands. These soils formed under prairie vegetation in medium-textured wind- or water-deposited sediment over glacial till.

In a representative profile the surface layer is loam about 15 inches thick. It is black in the upper 10 inches and very dark gray in the lower 5 inches. The subsoil, about 20 inches thick, is friable, dark grayish-brown loam in the upper part and very friable, yellowish-brown sandy loam in the lower part. The underlying material, to a depth of 38 inches, is calcareous, yellowish-brown and gray silty clay loam. Below this depth it is calcareous, grayish-brown glacial till of clay loam texture.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is low, and the content of potassium is medium. The seasonal high water table generally is at a depth of 5 to 10 feet or more. These soils are free of stones and are easy to work.

Most areas of these soils are used for crops. Because of the underlying finer textured material below a sandy subsoil, alfalfa and other deep-rooted crops grow better than shallow-rooted crops such as small grain. The major limitations to the use of these soils are susceptibility to erosion and droughtiness.

Representative profile of Swenoda loam, 0 to 2 percent slopes, in a cultivated field, 35 feet west and 45 feet north of the southeast corner sec. 11, T. 108 N., R. 47 W.:

Ap—0 to 10 inches, black (10YR 2/1) loam; cloddy; friable; neutral; abrupt, smooth boundary.

A3—10 to 15 inches, very dark gray (10YR 3/1) loam; weak, fine and medium, subangular blocky structure; friable; few black (10YR 2/1) and very dark grayish-brown (10YR 3/2) worm casts; neutral; clear, smooth boundary.

B21—15 to 23 inches, dark grayish-brown (10YR 4/2) light loam, very dark grayish brown (10YR 3/2) crushed; weak, medium, subangular blocky structure; friable; some inclusions of dark grayish brown (10YR 3/2) in upper part and dark brown (10YR 4/3) in lower part; neutral; clear, smooth boundary.

B22—23 to 35 inches, yellowish-brown (10YR 5/4) light sandy loam; weak, medium, subangular blocky structure; very friable; loamy sand layer in middle part; moderately alkaline; clear, smooth boundary.

IIC1—35 to 38 inches, yellowish-brown (10YR 5/4) and gray (10YR 5/1) silty clay loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; about 1 percent coarse fragments; slightly effervescent in spots; moderately alkaline; clear, smooth boundary.

IIIC2ca—38 to 60 inches, grayish-brown (2.5Y 5/2) clay loam; many, coarse, prominent, light olive-brown (2.5Y 5/4) mottles; massive; friable; few sandy seams and wedges; common white lime concretions 5 to 25 millimeters in diameter; about 7 percent coarse fragments; strongly effervescent; moderately alkaline.

The A1 horizon ranges from 6 to 12 inches in thickness and from black or very dark brown to very dark gray. The B21 horizon ranges from 5 to 12 inches in thickness and from loam to silt loam. It is typically grayish brown, dark grayish brown, or dark brown. The B22 horizon ranges from 6 to 16 inches in thickness and from sandy loam to sand. The IIC horizon, at a depth of 30 to 40 inches, is loam, silt loam, or silty clay loam. Glacial till of loam or clay loam texture is at a depth of 36 inches or more. Free lime has been leached from a depth of 30 to 60 inches in the profile.

Swenoda soils mapped in Pipestone County are dominantly well drained rather than moderately well drained as defined for the series, but this difference does not affect their use and behavior.

Swenoda soils are near Kranzburg and Flandreau soils. They formed in medium-textured to coarse-textured outwash over glacial till, but Kranzburg soils formed in medium-textured or moderately fine textured loess. They have a sandy B horizon that Kranzburg soils lack. They have a profile somewhat similar to that of Flandreau soils, but they have a loamy profile over sand, which is underlain by finer materials, whereas Flandreau soils are underlain by sand.

Swenoda loam, 0 to 2 percent slopes (SyA).—This soil is in swales and on flats on uplands. It has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils in which soil blowing has exposed the brownish subsoil and a few areas where the surface layer is lighter colored than that of this soil because tillage and erosion have mixed material from the subsoil with that in the surface layer. Also included are some areas of soils that have a surface layer of sandy loam. Areas

of soils in which free lime has been leached from the surface layer and the subsoil and deposited in the underlying silty material and glacial till are included.

Droughtiness is a slight limitation to use of this soil. Soil blowing is a hazard after fall plowing. This soil is fairly well suited to small grain and corn, and it is well suited to alfalfa. Capability unit IIs–1; windbreak suitability group 1; Silty range site.

Swenoda loam, 2 to 6 percent slopes (SyB).—This soil is in gently sloping areas and in the saddles of slopes. It has a profile similar to that described as representative of the series, but the surface layer is a few inches thinner.

Included with this soil in mapping are a few areas of soils in which the surface layer or the plow layer is only about 6 inches thick and is light colored because erosion and tillage have mixed material from the subsoil with that in the surface layer. Also included are areas of soils in which free lime has been leached from the upper layers and deposited in the underlying silty material and glacial till.

Susceptibility to erosion is the main limitation to use of this soil. Some areas are subject to soil blowing, especially after fall plowing. If protective measures that control erosion and conserve moisture are used, this soil is fairly well suited to all crops commonly grown in the county. Capability unit IIe–2; windbreak suitability group 1; Silty range site.

Tonka Series

The Tonka series consists of poorly drained, nearly level soils in shallow closed depressions on uplands. These soils formed under wet vegetation in medium-textured to fine-textured, stone-free glacial material.

In a representative profile the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is mottled, very dark gray to dark gray silt loam about 7 inches thick. The subsoil, about 31 inches thick, is firm, mottled silty clay and clay. It is gray in the upper 24 inches and light olive gray in the lower 7 inches. The underlying material is mottled, light olive-gray silty clay loam.

Permeability is moderately slow or slow, and available water capacity is high. These soils are medium acid or slightly acid to a depth of 5 feet or more. The content of organic matter is high, and the content of phosphorus and potassium is very high. The availability of phosphorus is low. The seasonal high water table is at or near the surface.

Most areas of these soils are used for crops. Adequately drained areas are well suited to cultivation. The major limitation to the use of these soils is wetness.

Representative profile of Tonka silt loam, in a drained depression, 1,380 feet north and 55 feet east of the southwest corner sec. 22, T. 106 N., R. 45 W.:

A1—0 to 10 inches, very dark gray (10YR 3/1) silt loam; moderate, very fine and fine, subangular blocky structure; friable, slightly sticky; medium acid; abrupt, smooth boundary.

A2g—10 to 17 inches, very dark gray (N 3/0) grading to dark-gray (N 4/0) silt loam; common, medium, distinct, very dark brown (7.5YR 3/2) mottles; weak, vertical cleavage parting to moderate, thin, platy structure; friable; many tubular pores less than 1 millimeter in diameter; gray (N 6/0) ped coatings in some parts; medium acid; clear, smooth boundary.

B21tg—17 to 23 inches, gray (5Y 5/1) silty clay, olive gray (5Y 5/2) crushed; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium and coarse, prismatic structure parting to moderate and strong, very fine, angular and subangular blocky; firm; moderately thick, continuous clay films on vertical and horizontal faces of peds; few tubular pores less than 1 millimeter in diameter; slightly acid; clear, smooth boundary.

B22tg—23 to 41 inches, gray (5Y 5/1) clay, olive gray (5Y 5/2) crushed; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, fine and medium, prismatic structure parting to moderate and strong, fine and medium, angular blocky; very firm; moderately thick, continuous clay films on vertical and horizontal faces of peds; medium acid; clear, smooth boundary.

B3g—41 to 48 inches, light olive-gray (5Y 6/2) silty clay; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; firm; slightly acid; gradual, smooth boundary.

Cg—48 to 60 inches, light olive-gray (5Y 6/2) silty clay loam; common, coarse, prominent, strong-brown (7.5YR 5/8) mottles; firm; slightly acid.

The A1 horizon ranges from 10 to 15 inches in thickness. It is either silt loam or silty clay loam that is very dark gray or black. The A2 horizon ranges from 6 to 14 inches in thickness and from dark gray and very dark gray to dark grayish brown. The B2 horizon ranges from 20 to 30 inches in thickness and from heavy silty clay loam to clay. The B2 horizon ranges from gray and grayish brown to olive gray and light olive gray. The C horizon is mottled gray or light olive gray. It is typically silty clay loam but ranges to gravel, sand, or glacial till of clay loam texture. Free lime is leached to a depth of more than 6 feet.

Tonka soils are near Hidewood soils, and they formed in depressions similar to those occupied by Quam soils. They have a thicker solum, a finer textured B horizon, and a more deeply leached, acid profile than Hidewood soils. They have a gray, platy A2 horizon, a fine-textured B horizon that Quam soils lack. In addition, they have a more acid solum than Quam soils.

Tonka silt loam (0 to 2 percent slopes) (To).—This soil is in closed, very shallow depressions, most of which are only a few acres in size. In uncultivated areas the surface layer is black, but in cultivated areas it is very dark gray because some of the grayish subsurface material has been mixed with that in the surface layer.

Included with this soil in mapping are a few areas of soils in which the grayish subsurface layer is no longer evident because it has been mixed with the surface layer.

Wetness is the main limitation to use. The slowly permeable subsoil reduces the effectiveness of subsurface drainage. This soil is among the most acid soils in the county. If adequately drained and fertilized, it is well suited to corn, small grain, and alfalfa. Capability unit IIIw–1; windbreak suitability group 2; Wetland range site.

Trent Series

The Trent series consists of moderately well drained, nearly level and very gently sloping soils on uplands. These soils formed under prairie vegetation in moderately fine textured or medium-textured loess that is 40 to 72 inches thick and is underlain in most places by glacial till but in some places by bedrock. Most areas

of this soil are in the southwestern part of Pipestone County.

In a representative profile the surface layer is silty clay loam about 21 inches thick. It is black in the upper 16 inches and very dark gray in the lower 5 inches. The subsoil is friable silty clay loam about 10 inches thick. It is dark grayish brown in the upper part and light olive brown in the lower part. The underlying material is mottled, light olive-brown and grayish-brown silt loam.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 2 to 5 feet.

Most areas of these soils are used for crops. The soils are well suited to corn, small grain, and alfalfa. Trent soils have no major limitations to use.

Representative profile of Trent silty clay loam, 0 to 3 percent slopes, in a cultivated field, 400 feet east of the northwestern corner sec. 29, T. 105 N., R. 46 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam; cloddy; friable; neutral; abrupt, smooth boundary.

A12—6 to 16 inches, black (10YR 2/1) silty clay loam; moderate, very fine and fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

A3—16 to 21 inches, very dark gray (10YR 3/1) silty clay loam; moderate, fine, subangular blocky structure; few olive-brown (2.5Y 4/4) worm casts; neutral; clear, smooth boundary.

B21—21 to 26 inches, dark grayish-brown (2.5Y 4/2) grading to olive-brown (2.5Y 4/4) silty clay loam; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; mildly alkaline; gradual, smooth boundary.

B22—26 to 31 inches, light olive-brown (2.5Y 5/4) grading to olive-brown (2.5Y 4/4) silty clay loam; moderate, medium, prismatic structure parting to weak, medium, subangular blocky; friable; mildly alkaline; gradual, smooth boundary.

C1ca—31 to 37 inches, light olive-brown (2.5Y 5/4) silt loam; weak, very fine, subangular blocky structure; friable; common lime concretions less than 5 millimeters in diameter; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C2—37 to 60 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) silt loam; few, fine, faint, light olive-brown (2.5Y 5/6) mottles; massive; friable; strongly effervescent; moderately alkaline.

Thickness of the solum and depth to free lime range from 30 to 42 inches. The mantle of loess generally is more than 40 inches thick, but it ranges to 72 inches. It is underlain by glacial till in most places, but in some places it is underlain by bedrock. The A1 horizon ranges from 12 to 18 inches in thickness, but the average is about 14 inches. It is dominantly silty clay loam but ranges to silt loam. The B horizon ranges from 10 to 24 inches in thickness. The C horizon is silty clay loam or silt loam and commonly is light olive brown, grayish brown, or light grayish brown.

Trent soils are near Whitewood and Moody soils, and they have a profile similar to that of Brookings soils. They have a thicker A1 horizon and a more olive colored B horizon than well-drained Moody soils. They are better drained and have a less mottled, brighter colored B horizon than Whitewood soils in shallow drainageways. They formed in loess deposits more than 40 inches thick, whereas Brookings soils formed in loess deposits less than 40 inches thick over glacial till.

Trent silty clay loam, 0 to 3 percent slopes (TrA).—This soil is moderately well drained. Included in mapping are a few areas of soils in which the surface layer is limy. Also included are a few areas of Brookings soils.

The hazard of erosion is not severe on this soil, and wetness is not a limitation to use. This soil is suited to intensive cropping. Capability unit I–1; windbreak suitability group 1; Overflow range site.

Trosky Series

The Trosky series consists of somewhat poorly drained and poorly drained, nearly level soils. These soils formed under wet prairie vegetation in moderately fine textured, calcareous, water-laid or wind-deposited materials that are 24 to 40 inches thick over calcareous sand and gravel. These soils are on stream terraces and outwash plains and in glacial outwash valleys.

In a representative profile the surface layer is silty clay loam about 20 inches thick. It is black in the upper 14 inches and mixed very dark gray, dark gray, and olive in the lower 6 inches. The subsoil is mottled, olive and olive-gray silty clay loam about 15 inches thick. The underlying material, to a depth of about 38 inches, is mottled, olive-gray loam. Below this depth it is mottled, olive-gray and light olive-gray sand and gravel.

Permeability is moderate or moderately slow, and available water capacity is moderate. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at or near the surface in spring and during periods of wetness.

Most areas of these soils are used for crops, but some areas are in grassy drainageways and are used for meadow, pasture, and range. The major limitation to the use of these soils is wetness.

Representative profile of Trosky silty clay loam, in a cultivated field, 1,250 feet east and 40 feet north of the southwest corner of NW¼ sec. 28, T. 107 N., R. 46 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; cloddy; friable, sticky; very slightly effervescent in spots; mildly alkaline; abrupt, smooth boundary.

A12—8 to 14 inches, black (N 2/0) silty clay loam; moderate, very fine, subangular blocky structure; friable; very slightly effervescent; moderately alkaline; clear, smooth boundary.

A3—14 to 20 inches, very dark gray (N 3/0), dark-gray (5Y 4/1), and olive (5Y 5/3) silty clay loam, olive in lower part; weak, very fine, subangular blocky structure; friable; slightly effervescent; moderately alkaline; clear, irregular boundary.

B21g—20 to 28 inches, olive (5Y 5/3) silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/6) mottles; weak, fine and medium, subangular blocky structure; few, white, limy masses 5 to 10 millimeters in diameter; slightly and strongly effervescent; moderately alkaline; gradual, smooth boundary.

B22g—28 to 35 inches, olive-gray (5Y 5/2) silty clay loam; few, medium, distinct, light olive-brown (2.5Y 3/6) mottles; weak, very fine and fine, subangular blocky structure; friable, slightly effervescent; moderately alkaline; clear, smooth boundary.

C1g—35 to 38 inches, olive-gray (5Y 5/2) loam; common, medium, distinct, light olive-brown (2.5Y 5/6) mottles; very weak, fine and medium, subangular blocky structure; friable; moderately alkaline; clear, smooth boundary.

IIC2g—38 to 60 inches, olive-gray (5Y 5/2) and light olive-gray (5Y 6/2) sand and gravel; common, medium,

distinct, yellowish-brown (10YR 5/4) mottles; single grained; slightly effervescent; moderately alkaline.

The thickness of the solum and the depth to the IIC horizon range from 24 to 40 inches but are generally about 30 to 40 inches. The A1 horizon ranges from 12 to 24 inches in thickness and is black to very dark gray. It generally is silty clay loam, but it is silt loam in places. The B horizon is generally silty clay loam, but it ranges to silt loam. It ranges from 5 to 24 inches in thickness. The B horizon is typically olive, olive gray, light olive gray, or dark grayish brown. The C1 horizon is sandy loam, loam, or clay loam. The percentage of sand and gravel in the IIC horizon is extremely variable.

Trosky soils are near Estelline and Fordville soils. They have a thicker A1 horizon and are at lower elevations than the better drained Estelline and Fordville soils. Trosky soils are more silty throughout than Fordville soils.

Trosky silty clay loam (0 to 2 percent slopes) (Ts).—This soil is on stream terraces, on outwash plains, and in broad glacial outwash valleys.

Included with this soil in mapping are a few areas of soils that have a very limy surface layer and subsoil and of soils that have a nonlimy surface layer. Also included in drainageways are some areas of soils that have a surface layer that is more than 24 inches thick and some areas that are very wet.

Wetness is the major limitation to use of this soil. In some places the lime content is excessive, and special fertilizer is needed. If adequately drained and properly fertilized, this soil can be cropped intensively. Capability unit IIw–2; windbreak suitability group 3; Subirrigated range site.

Vienna Series

The Vienna series consists of well-drained, nearly level to moderately steep soils on uplands. These soils formed under prairie vegetation in medium-textured and moderately fine textured glacial material. Slopes generally are long, smooth, and uniform. The drainage pattern of these soils is well defined, and there are no depressions or potholes.

In a representative profile the surface layer is silty clay loam about 16 inches thick. It is black in the upper 11 inches and very dark gray and very dark grayish brown in the lower 5 inches. The subsoil is about 11 inches thick. It is friable, dark grayish-brown clay loam in the upper part and friable, dark yellowish-brown and yellowish-brown loam in the lower part. The underlying material is yellowish-brown and grayish-brown loam and clay loam.

Permeability is moderate, and available water capacity is high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is at a depth of 5 to 10 feet or more.

Almost all areas of these soils are cultivated. Some of the steeper slopes are pastured. The major limitation to the use of these soils is susceptibility to erosion.

Representative profile of Vienna silty clay loam, 2 to 4 percent slopes, in a meadow, 840 feet west and 200 feet north of the southeast corner sec. 10, T. 106 N., R. 44 W.:

A1—0 to 11 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3—11 to 16 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silty clay loam, very dark grayish brown (10YR 3/2) crushed; moderate, very fine and fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

IIB2—16 to 22 inches, dark grayish-brown (10YR 4/2) clay loam, brown (10YR 4/3) crushed; weak, medium, prismatic structure parting to weak and moderate, fine, subangular blocky; friable; many very dark gray (10YR 3/1) worm casts; about 2 percent coarse fragments; mildly alkaline; clear, irregular boundary.

IIB3ca—22 to 27 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) loam; weak, medium, subangular blocky structure; friable; about 7 percent coarse fragments; strongly effervescent; moderately alkaline; gradual, wavy boundary.

IIC1ca—27 to 40 inches, yellowish-brown (10YR 5/4) loam; very weak, medium, subangular blocky structure; friable; many, white, limy masses and concretions 10 to 25 millimeters in diameter; about 6 percent coarse fragments; strongly effervescent; moderately alkaline; gradual, smooth boundary.

IIC2—40 to 60 inches, yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) clay loam; common, medium, distinct, strong-brown (7.5YR 5/8) mottles; firm; few, white, limy masses and concretions 10 to 25 millimeters in diameter; about 5 percent coarse fragments; strongly effervescent; moderately alkaline.

The A1 horizon ranges from 7 to 12 inches in thickness and from silty clay loam and clay loam to silt loam and loam. The loam and clay loam are in the steeper areas. The A1 horizon ranges from black in uneroded areas to very dark gray or very dark brown in eroded areas. A loess layer, as much as 20 inches thick in some places, overlies the glacial till. The A3 horizon is similar to the A1 horizon in texture, but it is dominantly loam and clay loam. The A3 horizon ranges from 3 to 6 inches in thickness and typically is very dark gray, very dark brown, or very dark grayish brown. The B horizon ranges from 8 to 14 inches in thickness and typically is loam or clay loam. The C horizon typically is grayish brown, yellowish brown, or light olive brown and is loam or clay loam. Carbonates have been leached to a depth of 15 to 30 inches, depending on the steepness of slope. Less leaching has occurred on the steeper slopes.

Vienna soils are near Kranzburg soils and they have a profile similar to that of Barnes soils. Their solum formed mainly in glacial till, but the solum of Kranzburg soils formed in stone-free loess. The upper part of the solum of Vienna soils is loess or a mixture of glacial till that is mixed with loess, and that of Barnes soils is glacial till.

Vienna loam, 6 to 12 percent slopes (VaC).—This well-drained soil is along the sides and around the head of drainageways. This soil has a profile similar to that described as representative of the series, but the surface layer is about 8 inches thick and the subsoil is about 5 inches thinner.

Included with this soil in mapping are some areas of soils that have a surface layer and a subsoil of clay loam. Also included are small areas of Buse soils.

If this soil is plowed, the hazard of erosion is severe. Most areas of this soil are used for pasture and range. The major management need is control of grazing. Capability unit IIIe–1; windbreak suitability group 1; Silty range site.

Vienna loam, 6 to 12 percent slopes, eroded (VaC2).—This soil is in areas that grade toward drainageways. This soil has a profile similar to that described as representative of the series, but the subsoil is about 5 inches thinner. The surface layer is about 6 inches thick. It is a mixture of yellowish-brown material from the subsoil and the remaining dark-colored material in

the original surface layer. The surface layer in most places is loam, but in some places it is clay loam.

Included with this soil in mapping are small areas of light-colored Buse soils on some hillsides and a few areas of Kranzburg soils.

The hazard of further erosion is severe. The main management needs are control of erosion and runoff and improvement of fertility. If measures are used to help control further erosion, this soil is fairly well suited to corn, small grain, and alfalfa. Capability unit IIIe–1; windbreak suitability group 1; Silty range site.

Vienna silty clay loam, 0 to 2 percent slopes (VbA).—This soil is well drained. It has a profile similar to that described as representative of the series, but the subsoil is somewhat thicker, and thin sandy or gravelly layers are common in the underlying material.

Included with this soil in mapping are a few small areas of Kranzburg and Lismore soils. Also included are some areas of soils that have a surface layer of silt loam, loam, or clay loam.

This soil has few limitations to use. Under good management, it is well suited to corn, small grain, and alfalfa. Capability unit I–1; windbreak suitability group 1; Silty range site.

Vienna silty clay loam, 2 to 4 percent slopes (VbB).—This well-drained soil has long, smooth slopes. It is on the sides and top of ridges. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Kranzburg soils. Also included are some areas of soils that have a surface layer of silt loam, loam, or clay loam.

Susceptibility to erosion is the main limitation to use. This soil is suitable for intensive farming if erosion is controlled and good farming methods are used. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Vienna silty clay loam, 3 to 6 percent slopes, eroded (VbB2).—This well-drained soil has long, smooth, gentle slopes. It has a profile similar to that described as representative of the series, but the surface layer is a few inches thinner and is somewhat grayer or browner because erosion and tillage have mixed material from the subsoil with that in the surface layer.

Included with this soil in mapping are small areas of Kranzburg soils and some areas of Buse soils. Also included are some areas of soils in which the surface layer is silt loam, loam, or clay loam.

Because this soil has long slopes, susceptibility to further erosion is the main limitation to use. Most areas of this soil are used for crops. The main management needs are control of further erosion and runoff and maintenance of fertility. If measures are used to protect this soil against erosion, it is well suited to corn, small grain, and alfalfa. Capability unit IIe–1; windbreak suitability group 1; Silty range site.

Whitewood Series

The Whitewood series consists of somewhat poorly drained, nearly level soils in drainageways and wet flats on uplands. These soils formed under prairie vegetation in moderately fine textured or medium-textured loess deposits.

In a representative profile the surface layer is silty clay loam about 24 inches thick. It is black in the upper 18 inches and mixed very dark gray, black, and olive gray in the lower 6 inches. The subsoil is friable, mottled, olive-gray silty clay loam about 8 inches thick. The underlying material, to a depth of 72 inches, is mottled, olive and light olive-gray silt loam. Below this depth it is mottled, light olive-gray glacial till of clay loam texture.

Permeability is moderate, and available water capacity is high or very high. The content of organic matter is high, the content of phosphorus is very low, and the content of potassium is medium. The seasonal high water table is within a depth of 2 feet or less in spring and during wet periods.

Most areas of these soils are used for crops, but some areas in drainageways are used for pasture or range. The soils are well suited to all crops commonly grown in the county, especially if drainage is adequate. The major limitation to use of these soils is wetness.

Representative profile of Whitewood silty clay loam, in a cultivated field, 1,720 feet south and 15 feet west of the northeast corner sec. 36, T. 105 N., R. 47 W.:

Ap—0 to 9 inches, black (10YR 2/1) silty clay loam; cloddy; firm, sticky; mildly alkaline; abrupt, smooth boundary.

A12—9 to 18 inches, black (N 2/0) silty clay loam; weak and moderate, very fine, subangular blocky structure; friable; moderately alkaline; clear, smooth boundary.

A3g—18 to 24 inches, mixed very dark gray (5Y 3/1), black (5Y 2/1), and olive-gray (5Y 5/2) silty clay loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, very fine, subangular blocky structure; friable; common, round, black manganese oxide concretions 1 to 2 millimeters in diameter; moderately alkaline: clear, smooth boundary.

B2g—24 to 32 inches, olive-gray (5Y 4/2 grading to 5/2) silty clay loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak and moderate, very fine, subangular blocky structure; friable; common, round, black manganese oxide concretions 1 to 2 millimeters in diameter; few very dark gray (5Y 3/1) worm casts; moderately alkaline; clear, smooth boundary.

C1gca—32 to 42 inches, olive (5Y 5/3) silt loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; very weak, very fine, subangular blocky structure; friable; few tubular pores less than 1 millimeter in diameter; common, round, black manganese oxide concretions 1 to 2 millimeters in diameter; few limy masses; slightly and strongly effervescent; moderately alkaline; clear, smooth boundary.

C2g—42 to 72 inches, light olive-gray (5Y 6/2) silt loam; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; massive; friable; common manganese oxide concretions, few limy masses; slightly effervescent; moderately alkaline.

IIC3—72 to 80 inches, light olive-gray (5Y 6/2) clay loam; many, coarse, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; slightly effervescent; moderately alkaline.

The A1 horizon ranges from 14 to 24 inches in thickness. The A3 horizon ranges from 5 to 12 inches in thickness. The B2 horizon ranges from 6 to 20 inches in thickness. The B horizon typically ranges from olive and olive gray to dark olive gray and dark grayish brown in color. The C horizon has distinct or prominent mottles and is olive, olive-gray, and light olive-brown silty clay loam or silt loam. The mantle of loess ranges from 40 to 80 inches in thickness and is

underlain by glacial till of clay loam or loam texture. Depth to free lime, which occurs in the form of soft masses or concretions, is variable but typically is 30 to 40 inches.

Whitewood soils are near Moody and Trent soils. They are similar to Hidewood soils, but they formed in a thicker mantle of loess than those soils. They formed in material similar to that in which Moody and Trent soils formed, but they are somewhat poorly drained and are at lower elevations.

Whitewood silty clay loam (0 to 2 percent slopes) (Wh).—This somewhat poorly drained soil is on wet flats and in drainageways. Natural soil drainage ranges to poor, especially towards the center of large drainageways.

Included with this soil in mapping are some soils in drainageways where the surface layer is more than 24 inches thick. Also included are some small areas of Trent soils on slight rises in broad areas of Whitewood soils.

The major limitation to the use of this soil is wetness. Gully erosion occurs in some drainageways. If adequate drainage is provided, this soil is nearly ideal for row crops. Capability unit IIw–1; windbreak suitability group 2; Subirrigated range site.

Use and Management of the Soils

The soils of Pipestone County are used mainly for growing crops, but some areas are used for grazing. This section describes how the soils in the county can be managed for these purposes and also for field and farmstead windbreaks and wildlife. The section also tells how the soils can be used for building roads and other engineering structures and as recreational sites. A table in this section lists predicted yields of the principal crops for the soils in the county.

Crops

This subsection discusses the capability classification of soils that is used by the Soil Conservation Service and describes the capability units in which the soils are placed. It also gives predictions of the yields to be expected when the different soils are used for crops and for rotation pasture.

The sloping soils are subject to water erosion if they are cultivated and not protected. Terracing, contour farming, stripcropping, minimum tillage practices, and management of crop residue are practices that help to control erosion and to increase the amount of water that enters the soil and is then available for growth of crops. The content of organic matter is likely to be low if crop residue is not returned to the soil or if erosion has occurred. Applying large amounts of manure and using crop rotations that include legumes and grasses help to restore organic-matter content.

Systems of waterways, because of the shape of the landscape, are extensive in the county. Waterways that have been properly shaped and grassed aid in control of erosion, removal of runoff, and performance of farming operations.

Soil blowing is a hazard on the silty and sandy soils. It can be reduced by keeping plant cover on the soil, by plowing in spring, and by leaving the plowed surface rough until time to prepare a seedbed.

Drainage is needed for extensive farming of the wet, nearly level or depressional soils. Tile drainage is commonly used for supplemental drainage. Open ditches are used in a few areas to remove surface water from low areas and closed depressions and to provide outlets for tile drainage systems. These soils are cold and wet in spring, so a starter fertilizer that includes nitrogen is needed for rapid initial crop growth. Fertilizer applied to a field that is not adequately drained cannot be fully used.

Applications of fertilizer and organic matter generally improve plant growth on wet soils in which excess lime causes an imbalance of fertility. Liberal amounts of potassium and adequate amounts of phosphorus are needed. Organic matter can be applied in the form of barnyard manure or by growing green-manure crops.

Crops on most of the soils in the county respond to fertilizer. Fertilizer as discussed in the description of soils refers to that of the subsoil. The soils are especially low in phosphorus. The need for fertilizer depends on the kind of soil, past and present management, and the kind of crop that is grown. Soil tests provide part of the information that is needed to choose the proper kinds and amounts of fertilizer.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

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

In the capability system, the kinds of soil are grouped at three levels: the capability class, subclass, and unit. These levels 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. (None in Pipestone County)

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. (None in Pipestone County)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Pipestone County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–2 or IIIe–1. 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 paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages the capability units represented in Pipestone County are described, and suggestions for use and management of the soils are given. The names of soil series represented in a capability unit are named in the description of the capability unit, but this does not mean that all the soils in a given series appear in the unit. To find the names of all the soils in any capability unit, refer to the "Guide to Mapping Units" at the back of this survey. Gravel pit was not placed in a capability unit.

CAPABILITY UNIT I–1

This unit consists of nearly level soils of the Estelline, Kranzburg, Moody, Vienna, Brookings, Lismore, Svea, and Trent series. Most of these soils are on uplands, but the Estelline soil is on stream terraces and outwash plains. The Estelline, Kranzburg, Moody, and Vienna soils are well drained, and the Brookings, Lismore, Svea, and Trent soils are moderately well drained. The surface layer and subsoil of the soils in this unit are either silty clay loam or clay loam. Permeability is moderate, and available water capacity is high or very high.

These soils have few limitations that restrict their use. The moderately well drained soils do not dry out so quickly in spring as the well-drained soils, and they cannot be worked so early.

These soils can be farmed intensively under a high level of management. Row crops can be grown several years in succession. Crop residue left on the surface of fall-plowed fields helps to control soil blowing. An occasional green-manure crop or sod crop helps to maintain good structure and tilth.

The soils of this unit are well suited to all crops commonly grown in the county. Most areas of these soils are used for crops. Some areas that are not accessible to farm machinery are in permanent pasture.

CAPABILITY UNIT IIe–1

The unit consists of gently sloping or undulating soils of the Barnes, Darnen, Kranzburg, Moody, and Vienna series. These soils are on uplands. The surface layer is loam or silty clay loam, and the subsoil is silty clay loam, clay loam, or loam. Most of these soils are well drained, but the Darnen soils are moderately well drained. Permeability is moderate, and available water capacity is high or very high.

The hazard of erosion is slight to moderate. Runoff is more rapid in areas where erosion and loss of organic matter have reduced the capacity of the soils to hold moisture. Stones are sometimes pushed to the surface of Barnes and Vienna soils by frost action and by tillage.

Practices to control erosion are generally needed. Some of the soils, especially the Barnes soils, have short, undulating slopes that are not well suited to terracing and contour farming. The Kranzburg, Moody, and Vienna soils generally have longer, smoother slopes that are better suited to contouring and terracing. Minimum tillage practices, such as plow planting, also help to control erosion on these soils, and these practices are particularly useful on those soils that are not suited to contour farming. Spring plowing helps to reduce soil blowing. If plowing is done in fall, leaving some crop residue on the surface and leaving a rough surface reduce soil blowing in winter and in spring. Areas that have been in sod 2 years or longer are usually plowed in fall. Plowing in fall allows time for moisture to be replenished and for the sod to decompose. If stones are removed periodically from the Barnes and Vienna soils, they are easier to till. Grassed waterways are needed where water collects and where terrace outlets cross these soils (fig. 11).

Figure 11.—Grassed waterway carries runoff from this gently sloping Moody soil.

If the soils in this unit are managed properly and erosion is controlled, they are suited to all crops commonly grown in the county.

CAPABILITY UNIT IIe-2

This unit consists of gently sloping, well-drained soils of the Estelline, Flandreau, Fordville, and Swenoda series. The Estelline and Fordville soils are mainly on stream terraces and outwash plains, whereas Flandreau, Ihlen, and Swenoda soils are mostly on uplands. In places erosion has thoroughly mixed the material in the surface layer with that from the subsoil. The surface layer and the subsoil of the soils in this unit generally range from loam and silt loam to silty clay loam, but Swenoda soils have a sandy loam subsoil. Most of the soils in this unit are underlain by sand, sand and gravel, or bedrock at a depth of 20 to 40 inches. Swenoda soils, however, are underlain by silt and glacial till of clay loam texture.

Permeability is moderate or moderately rapid. Available water capacity generally is moderate; it is high in Swenoda soils.

These soils are somewhat droughty; during and after prolonged droughts, crops on these soils are noticeably affected by a lack of moisture. The hazards of water erosion and soil blowing are slight to moderate on these soils.

A good seedbed is easy to prepare on these soils. Plowing in spring helps to reduce soil blowing and water erosion. Stubble or cornstalks left on the surface during winter hold snow and help to provide moisture for the next crop.

The moderate depth to the sandy and gravelly underlying material or to bedrock affects construction of terraces and waterways. If terraces are to cross these soils, the risk of exposing the underlying sand, gravel, or bedrock should be investigated. Grassed waterways help to prevent the formation of gullies that might cut into the sand or gravel. Drop inlet structures are needed in some places where waterways end on streambanks.

Under a high level of management that includes erosion-control measures, these soils are well suited to corn and small grain. These soils are well suited to irrigation. If water for irrigation is available, they can be row cropped intensively. If row crops are grown year after year, a high level of fertility and intensive erosion-control measures are needed.

CAPABILITY UNIT IIw-1

This unit consists of nearly level, poorly drained and somewhat poorly drained soils of the Flom, Hidewood, Whitewood, and Roliss series. The surface layer and the subsoil of Hidewood and Whitewood soils are silty clay

loam, and the Flom and Roliss soils have a clay loam surface layer and a clay loam and loam subsoil. Permeability is moderate or moderately slow, and available water capacity is high or very high.

These soils dry out and warm up slowly in spring. The main limitation to the use of these soils is wetness. In many places Roliss soils have a high content of lime that causes a fertility imbalance.

Large open areas are subject to soil blowing if soil structure deteriorates because they are used intensively for row crops and the return of crop residue to the soil surface is inadequate.

The ground water in some areas of the Flom and Roliss soils contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used.

Some areas of these soils are in shallow drainageways that carry runoff from the surrounding hillsides and uplands. Some of the drainageways need to be shaped and seeded to grasses to prevent formation of gullies. Tile drains installed before construction of grassed waterways or terrace outlets help to insure good grass growth.

Drainage of these soils generally is needed before they can be farmed intensively. If these soils are adequately drained, they are suited to all crops commonly grown in the county, especially corn. Tiling is needed to provide surface drainage. If the soils are worked when they are too wet, severe compaction and clodding of the surface layer are likely. In many places a tillage pan forms below the plowed layer. Fall plowing of these soils permits rapid preparation of seedbeds in spring.

CAPABILITY UNIT IIw-2

This unit consists only of Trosky silty clay loam. This nearly level, poorly drained and somewhat poorly drained soil is on stream terraces, on outwash plains, and in glacial outwash valleys. The surface layer and the subsoil are silty clay loam. This soil is underlain by sand and gravel at a depth of 24 to 40 inches. Permeability is moderate or moderately slow, and available water capacity is moderate.

The main limitation to the use of this soil is wetness. In some places the surface layer has a high content of lime that causes a fertility imbalance.

Fall plowing makes it possible to prepare a good seedbed quickly in spring. Hard clods are likely to form if this soil is plowed or worked when wet.

Drop-inlet structures are needed if waterways or terrace outlets empty into roadside ditches or drainage ditches. Grassed waterways are needed wherever water flows across this soil.

If this soil is adequately drained and fertilized, it is suitable for corn, soybeans, small grain, and alfalfa. Good growth of crops can be expected after installation of adequate tile drainage. Where possible, the tile should be placed partly in the gravelly underlying material. Open ditches are needed in places to provide outlets for tile systems.

CAPABILITY UNIT IIw-3

This unit consists only of Lamoure silty clay loam. This nearly level, poorly drained soil is on bottom lands. Permeability is moderate, and available water capacity is very high or high.

This soil is subject to occasional flooding, especially by melt water during spring runoff. In places it is also subject to flooding after heavy rains during the growing season, and crops are damaged. This soil is alkaline, and in places the surface layer has a high content of lime that causes a fertility imbalance. The major limitation to the use of this soil is wetness.

Tile drainage is difficult to install in most areas of this soil; outlets that have sufficient grade are difficult to establish on bottom lands. In many places where tiling is not practical, shallow random ditches are suitable for removing surface water. Dikes to protect the soil from flooding are practical in some places. If this soil is worked when it is too wet, clods form that are difficult to break up.

This soil provides suitable site for stockwater pits.

Under a high level of management, this soil is suited to row crops that can be grown several years in succession. This management includes returning all crop residue to the soil to help keep the surface layer loose and porous and to supply organic matter and nutrients. An occasional crop of a deep-rooted legume, such as alfalfa or sweet clover, helps to improve drainage through the soil. Some areas of this soil are used for permanent pasture or as range.

CAPABILITY UNIT IIw-4

This unit consists only of La Prairie loam. This soil is nearly level and moderately well drained. It is on bottom lands. This soil is subject to flooding in spring. Occasionally the slightly lower lying Lamoure soils also are flooded, thus making the areas of La Prairie soils inaccessible. Permeability is moderate, and available water capacity is high or very high. This soil has few or no limitations to use because of wetness or the hazard of erosion.

Grassed waterways are needed in some places to confine runoff from adjoining uplands. Stabilization of streambanks, by planting willow trees, for example, is needed in places where streams or creeks make sharp turns in areas of this soil.

Under proper management, this soil is excellent for corn. If a high level of fertility is maintained, this soil is suitable for growing corn year after year. An occasional crop of legumes and grasses helps to keep the surface layer loose and porous and the underlying layers permeable. Many areas are in permanent pasture, and they provide excellent grazing with a minimum of management.

CAPABILITY UNIT IIs-1

This unit consists of nearly level soils of the Athelwold, Estelline, Flandreau, Fordville, Ihlen, and Swenoda series. Except for the moderately well drained Athelwold soils, all the soils of this unit are well drained. Athelwold, Estelline, and Fordville soils formed mainly on stream terraces and outwash plains, and Flandreau, Ihlen, and Swenoda soils formed on uplands. The surface layer and the subsoil of the soils in this unit generally range from loam and silt loam to silty clay loam, but Swenoda soils have a sandy loam subsoil. Most of these soils are underlain by sand

or sand and gravel at a depth of 20 to 40 inches, but Ihlen soils are underlain by bedrock and Swenoda soils are underlain by silt and glacial till of clay loam texture. Permeability is moderate or moderately high. Available water capacity generally is moderate, but it is high in Swenoda soils.

These soils are somewhat droughty because they are underlain by coarse-textured material or by bedrock. Spring plowing reduces soil blowing. Crop residue left on the soil surface in winter helps to hold snow and to provide moisture for the next crop.

The surface layer of these soils is easy to work, and it makes a good seedbed. The moderately well drained Athelwold soils need more time to dry out in spring than the other soils in the unit.

Grassed waterways in the drainageways that cross these soils generally prevent gullying into the coarse-textured underlying material. Rock outcrop on or below the surface in Ihlen soils causes damage to farm machinery. Drop-inlet structures are used in some places where waterways terminate on streambanks.

If rainfall is adequate and timely, these soils are well suited to corn, small grain, and alfalfa. The soils respond well to irrigation. If these soils are irrigated and otherwise well managed, they can be used intensively for row crops.

CAPABILITY UNIT IIIe–1

This unit consists of sloping and rolling, well-drained soils of the Barnes, Buse, and Vienna series. These soils are on uplands. The soils generally have a surface layer and subsoil of loam. Permeability is moderate, and available water capacity is high.

Runoff is rapid; therefore, these soils tend to be more droughty than similar but less sloping soils. The hazard of erosion is severe if these soils are cultivated.

In some areas of these soils, slopes are too irregular to permit terracing and farming on the contour. A high level of management and a rotation that includes a meadow crop helps to control runoff and erosion. Spring plowing, heavy applications of manure, return of all crop residue to the soils, and disking, instead of plowing, for the small grain that follows corn in the rotation are included in the high level of management for these soils. Heavy applications of manure are especially needed on the severely eroded spots for good growth of crops to reduce runoff and erosion.

Grassed waterways are needed for terrace outlets and in other places where water collects. Gullies can be shaped and seeded to provide grassed waterways. Some of the gullies require engineering structures to stabilize them enough to permit grass to grow.

Under proper management that includes control of erosion, these soils are suited to corn, small grain, and meadow. In some areas of this unit, terracing is effective in the control of runoff and erosion. In other areas stripcropping is generally more suitable than terracing for control of erosion. In some places diversion terraces are built to reduce the effective length of slope, and contour farming is practiced.

CAPABILITY UNIT IIIe–2

This unit consists of gently sloping or undulating soils of the Buse, Renshaw, Sverdrup, and Vienna series. The surface layer and subsoil of Renshaw and Sverdrup soils are loam and sandy loam. They are underlain by gravel and sand at a depth of 2 feet or less. Permeability is moderately rapid, and available water capacity is low or moderate in all these soils except the Buse and Vienna soils. Permeability is moderate and available water capacity is high in Buse and Vienna soils. The hazard of erosion is moderate.

Farming on the contour and growing crops in a rotation help to control erosion and to conserve moisture. Where slopes are too irregular for contour farming, good management practices are needed that include keeping tillage to a minimum and returning all crop residue to the soil. Spring plowing helps to control erosion, particularly soil blowing. Leaving stubble on the surface in winter helps to trap snow and to conserve moisture. Where feasible, planting of row crops is a good practice. Disking of cornstalks, rather than plowing, is desirable when the next crop to be planted is small grain. A single-row shelterbelt of trees helps to control erosion and to conserve moisture. Wind stripcropping, in which close-growing crops and intertilled crops are grown in alternate narrow bands, reduce the loss of soil and moisture.

These soils are too droughty for corn, except in years when the rainfall is both adequate and timely. A meadow crop grown in a rotation on these soils for more than 1 year tends to use up moisture, so that there is not enough for next year's crop of corn or small grain. If these soils are used for long-term hay or pasture, the sod should be left as long as a good stand remains.

CAPABILITY UNIT IIIw–1

This unit consists of nearly level, very poorly drained and poorly drained soils of the Quam and Tonka series. These soils are mostly in closed depressions on uplands. The surface layer and subsoil of Quam soils are silty clay loam, and the Tonka soils have a silt loam surface layer and a silty clay and clay subsoil. Permeability is moderately slow or slow, and available water capacity is high.

The major limitation to the use of these soils is wetness. Practices are needed that reduce compaction and maintain good tilth. Crops are subject to slight frost heave.

Open ditches can be used to drain away surface water and in some places to provide outlets for tile drains. Grassed waterways are needed to control the flow of water from some closed depressions where slopes are steep and an uncontrolled flow of water into open ditches might cause gullying. Inlets are needed where water from a shallow grassed waterway flows into an open ditch. Diversion terraces or field terraces are built on some of the surrounding slopes to divert runoff and to permit these soils to be cropped successfully.

These soils are generally too wet to be plowed in spring. Leaving fields that are plowed in fall rough and leaving some residue on the surface help to control soil blowing. If these soils are worked when they are too wet, hard clods form that are difficult to break.

Drainage is needed before these soils can be cropped. If drained, the soils are suited to all crops commonly

grown in the county. In years when rainfall is below average, the growth of corn is good in areas that are drained only by open ditches. Tile drainage is needed for a good corn crop every year. If these soils are drained, adequately fertilized, and all crop residue is returned to the soils, row crops can be grown for several years in succession. An occasional sod crop or green-manure crop helps to maintain good tilth in the surface layer and good permeability in the subsurface layer.

Partly drained areas of these soils are used for pasture or meadow. Undrained areas provide excellent habitat for waterfowl and other wildlife.

CAPABILITY UNIT IIIs–1

This unit consists of nearly level, somewhat excessively drained soils of the Renshaw and Sverdrup series. These soils are on uplands, stream terraces, and outwash plains. The surface layer and subsoil of the Renshaw soils are loam, and those of the Sverdrup soils generally are fine sandy loam. These soils are underlain by sand or gravel at a depth of 12 to 24 inches. Permeability is moderately rapid, and available water capacity is moderate or low.

Droughtiness is a moderate limitation to use of these soils. If these soils are not managed properly, soil blowing is a hazard. Spring plowing reduces the risk of soil blowing. Stubble and stalks left on the surface during winter help to trap snow and to conserve moisture. Plow-planting of row crops is an excellent practice. Disking of cornstalks, rather than plowing, is desirable when the next crop to be planted is small grain. A single-row shelterbelt reduces the risk of soil blowing and the loss of moisture by evaporation and transpiration. Wind stripcropping, in which close-growing crops are grown in narrow bands, also reduces the loss of soil and moisture.

Fertilizer is used most efficiently if each crop, rather than the whole rotation, is fertilized. Heavy applications of barnyard manure and rotations that include legumes and grasses are needed to replenish the organic matter and to prevent soil blowing.

If these soils are adequately fertilized and all crop residue is returned to the soils, they can be used for row crops. Corn grows well, however, only in years when rainfall is both adequate and timely or if the soils are irrigated. In some cropping systems these soils are used mainly for hay and pasture, and in some systems small grain is grown several years in succession.

CAPABILITY UNIT IVe–1

This unit consists of moderately steep, well-drained soils of the Barnes, Buse, and Vienna series. The Barnes and Vienna soils are mapped in complexes with Buse soils. The surface layer and subsoil of these soils generally are loam. Permeability is moderate, and available water capacity is high.

The hazard of erosion is very severe, and droughtiness is a severe limitation because runoff is rapid on the moderately steep soils.

These soils are too steep for terracing. Contour stripcropping and plowing in spring help to control erosion. Diversion terraces, in addition to contour stripcropping, are needed where slopes are long. Waterways need to be maintained, and in some places new ones are needed. Gullies need to be shaped and seeded to form grassed waterways. Eroded areas can be made more productive with heavy applications of manure.

Where stripcropping is not practical, erosion can be controlled by growing hay or pasture crops. A nurse crop of small grain can be grown at intervals to reestablish the stand of hay or pasture.

Under proper management these soils are fairly well suited to small grain, alfalfa, and grasses.

CAPABILITY UNIT IVe–2

This unit consists of sloping, somewhat excessively drained and well-drained soils of the Renshaw, Buse, and Vienna series. Buse and Vienna soils are mapped in a complex with Renshaw soils. These soils generally have a loam surface layer and subsoil. Renshaw soils are underlain by gravelly material at a depth of less than 2 feet, and Buse and Vienna soils are underlain by glacial till of loam or clay loam texture. Permeability is moderately rapid in Renshaw soils and moderate in Buse and Vienna soils. Available water capacity is low in Renshaw soils and high in Vienna and Buse soils. The soils in this unit are slightly eroded or moderately eroded. The hazard of further erosion is severe. Droughtiness is a severe limitation. These soils are too droughty for many crops.

These soils generally are not suited to terraces, because they are too shallow to sand and gravel. In places waterways need to be maintained, and some need to be reestablished. Where erosion has exposed sand and gravel in waterways, the addition of a layer of soil promotes the growth of the grasses. Gullies need to be shaped and seeded to form grassed waterways. In some gullies engineering structures are needed to stabilize them enough to permit grass to grow.

These soils are better suited to hay and pasture than to corn and small grain. During short periods of drought, corn is likely to be damaged. If it is necessary to renew the stand of legumes or grasses, such small grain as oats or flax is grown as a nurse crop. Much of the acreage of these soils is in permanent pasture or range.

CAPABILITY UNIT VIe–1

The unit consists only of Buse loam, 18 to 25 percent slopes. This is a steep, well-drained soil on uplands. The surface layer is thin and is low to moderate in fertility. Stones and boulders are commonly on the surface. Permeability is moderate, and available water capacity is high.

The hazard of erosion is very severe on this soil. This soil is droughty because of steep slopes and very rapid runoff.

Gullies should be shaped and seeded to form grassed waterways. Diversion terraces can be built on some slopes above these soils to prevent or retard formation of gullies. Some gullies need to be established by engineering structures to permit the grasses to grow.

Areas of these soils can be developed for wildlife habitat by planting adapted shrubs and small trees.

This soil is suitable for pasture or for wildlife habitat. Almost all areas are in permanent pasture or range. A few small areas of less sloping soils are used for crops. Hay and pasture are the main crops. Oats are grown to help reestablish permanent hay or pasture.

CAPABILITY UNIT VIe-2

This unit consists of moderately steep, somewhat excessively drained and excessively drained soils and of moderately steep, well-drained soils that contain many pockets of sand and gravel. These soils are in the Renshaw, Sioux, and Buse series. The surface layer and subsoil of Renshaw soils are loam. In Buse soils the surface layer and underlying material are loam. Sioux soils have a surface layer of gravelly loamy coarse sand overlying sand and gravel. Renshaw soils are underlain by gravel at a depth of 12 to 24 inches, and Sioux soils are underlain by gravel at a depth of less than 12 inches. Permeability is rapid in Sioux soils, moderately rapid in Renshaw soils, and moderate in Buse soils. Available water capacity is very low in Sioux soils, low in Renshaw soils, and high in Buse soils.

Droughtiness is a very severe limitation to the use of these soils, because of the limited available water capacity and rapid runoff. The hazard of erosion is very severe, and fertility is low.

These soils are suitable for pasture and for wildlife habitat. They are used mainly for hay and pasture. A combination of adapted shrubs, grasses, and legumes can be planted in areas that are developed for wildlife habitat.

CAPABILITY UNIT VIw-1

This unit consists of nearly level, poorly drained and moderately well drained soils of the Lamoure and La Prairie series. These soils are on bottom lands. The surface layer of Lamoure soils is silty clay loam, and that of La Prairie soils is loam. Permeability is moderate, and available water capacity is very high or high.

Most areas of these soils are cut by stream meanders. The hazard of flooding is severe. Some small, sandy, somewhat droughty areas are present.

These soils are suitable for pasture (fig. 12) or for wildlife habitat. Most areas are not suitable for crops,

Figure 12.—**Pasture on Lamoure silty clay loam, frequently flooded. An intermittent meandering stream is in foreground.**

because they are frequently flooded, or are too dissected by streams or by old meanders. If the stream channels are improved as a major project, many areas are suitable for crops. These improved areas then would be suited to the crops and those practices given in capability unit IIw–3 and IIw–4. These soils are capable of producing good growth of wild hay or pasture.

Stabilization of streambanks is needed in some places where creeks or rivers make a sharp turn and cut into an area of cropland or pasture.

CAPABILITY UNIT VIw–2

This unit consists only of Rauville silty clay loam. This is a nearly level, very poorly drained, calcareous, frequently flooded soil on bottom lands. Permeability is moderate, and available water capacity is high or very high.

The hazard of flooding is severe, and wetness is a severe limitation. This soil is difficult to manage or improve. If drainage can be accomplished, suggestions for use and management are similar to those given for the soils in capability unit IIIw–1.

This soil commonly is too low and too wet to be drained and used for crops. Some areas are used for pasture; and some provide food, water, and shelter for wildlife.

CAPABILITY UNIT VIs–1

This unit consists only of Ihlen-Rock outcrop complex, 0 to 6 percent slopes. The Ihlen soils are in small areas between the Rock outcrop. They generally are 20 to 40 inches of loess over bedrock, but in many places the loess is thinner. They are on uplands and generally have a silty clay loam surface layer and subsoil. Permeability is moderately rapid, and available water capacity ranges from very low to moderate, depending on the thickness of the mantle of silty clay loam loess.

The many areas of Sioux quartzite Rock outcrop make this unit unsuitable for crops. The hazard of drought ranges from slight to severe.

The soils in this unit are used for permanent pasture or as range (fig. 13). This unit has esthetic value, and some areas can be developed for wildlife habitat or for recreational activities.

CAPABILITY UNIT VIIe–1

This unit consists of steep and very steep, well-drained and excessively drained soils of the Buse and

Figure 13.—**Typical pasture in an area of Ihlen-Rock outcrop complex, 0 to 6 percent slopes.**

Sioux series. These soils are on uplands. Sand and gravel pockets are present where the Buse and Sioux soils occur in a complex. The surface layer and underlying material of the Buse soils are loam. The surface layer of Sioux soils is gravelly loamy coarse sand that is underlain by sand and gravel at a depth of 12 inches or less. Permeability is moderate and available water capacity is high in Buse soils. Permeability is rapid and available water capacity is very low in Sioux soils.

Runoff is rapid, and the soils are droughty. Fertility is low. Little soil development has occurred. The hazard of erosion is very severe.

Gullies should be shaped and seeded. Some of them should have engineering structures to stabilize them enough to permit grasses to grow.

These areas are used as range or for wildlife habitat. They are too steep and droughty for crops. Areas that are not used for pasture can be improved for wildlife habitat.

CAPABILITY UNIT VIIs–1

This unit consists of rocky and gravelly, undulating to very steep soils of the Sioux series and Rock outcrop-Ihlen complex. These soils are on uplands and terrace escarpments. Rock outcrop and bedrock are exposed in more than 50 percent of each area of Rock outcrop-Ihlen complex, and in many places the mantle of silty clay loam loess is very thin over bedrock. A few areas are mostly quartzite stones and boulders instead of outcrop. Sioux soils have a surface layer of gravelly loamy coarse sand less than 12 inches thick that is underlain by sand and gravel. These soils are excessively drained. Permeability is rapid, and available water capacity is very low.

The hazard of erosion is very severe on the very steep soils. All of the soils are low in fertility. Sioux soils are extremely droughty.

Gullies should be shaped and seeded to form grassed waterways. Some gullies need engineering structures to stabilize them enough to permit grasses to grow.

These soils are used for permanent pasture or to provide shelter for wildlife. Most of the forage is produced in spring and early in summer. A few small areas of Sioux soils are cropped along with adjacent soils.

CAPABILITY UNIT VIIIw–1

This unit consists only of Marsh. This land type is in depressions and ponds, and the areas generally are covered by 1 to 3 feet of water. Drainage of the areas either is not feasible or the feasibility of drainage has not been determined.

Marsh produces some pasture or wild hay in dry years. Cattails and other water-loving plants grow profusely along edges of the marshes and in scattered clusters in the open water.

Marsh provides good habitat for waterfowl and muskrat. Upland game birds find food, cover, and nesting places in and around the marshes.

Predicted yields

Table 2 gives predicted average acre yields for the principal crops grown in the county under two levels of management. Yields in columns A are obtained under an average level of management, and those in columns B are obtained under a high level of management.

Yields given in columns A are those obtained under the management most farmers in the county are using. Fertilizer is used but in insufficient amounts; drainage is provided, but it is not adequate; and erosion control is not complete.

Yields given in columns B are those obtained under management presently being used by many farmers in the county. Fertilizer is applied according to soil tests; drainage is adequate; and erosion-control measures are applied where needed.

The predictions of yields are based on information received from several sources. Records of yields and of soil management practices were reported by farmers for crops on some of the soils. Observations of crops were made and farmers were interviewed during the course of the soil survey. The predictions were judged in relation to soil properties that are known to affect growth of crops. The predictions were compared with those made for similar soils in other counties and were checked against average yields that are reported in data from the agricultural census.

The yields given in table 2 are those obtainable using present farming practices and varieties of crops. As agricultural technology advances, increased yields are possible. It is also possible that because of plant diseases and pests yields will be less than those predicted in the table.

The climate of Pipestone County, especially rainfall, varies from year to year, and the predicted yields are averages to be expected over a period of about 10 years. Some differences in yields are to be expected in different areas of the same soil, because some variations in a soil are allowable when soils are classified.

Yields were not predicted for crops on soils not suited to the crops. The major crops can be grown on soils that are poorly suited to them because of shallow depth to gravel, steep slope, poor drainage, or a hazard of flooding, but yields are not likely to be worth the effort. For several of the naturally wet soils, the yields are predicted on the basis of an adequately drained soil and an inadequately drained soil. For Gravel pit, yields are predicted only for level areas that are used for crops.

Range[2]

The original vegetation of Pipestone County was mainly tall and mid grasses, but short grasses, broadleaf plants (forbs), and many legumes also grow. The short and mid grasses were dominant on the droughty soils, and the tall grasses grew where the moisture supply was more favorable.

Most of the native grassland now in the county is in small tracts within farms. Some larger areas are on the hilly soils, particularly in the Barnes-Buse association, on soils along the streams, and on rocky soils of the Ihlen-Rock outcrop association.

[2] ELDOR P. MUELLER, conservation agronomist, Soil Conservation Service, helped to prepare this section.

TABLE 2.—*Predicted average annual yields per acre of principal crops under two levels of management*

[In columns A are average yields obtained under management commonly used; in columns B are average yields obtained under improved management. Absence of a yield figure indicates crop is not suitable for the soil or ordinarily is not grown on it]

Mapping unit	Corn		Soybeans		Oats		Flax		Rotation hay [1]		Rotation pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*	*AUD* [2]	*AUD* [2]
Athelwold silty clay loam	55	70	17	23	45	70	12	18	2.5	3.5	125	175
Barnes loam, 1 to 4 percent slopes	55	70	17	23	45	70	11	17	2.2	3.2	110	160
Barnes loam, 3 to 6 percent slopes, eroded	50	65	15	21	40	70	10	16	2.0	3.2	100	160
Barnes loam, 6 to 12 percent slopes, eroded	45	60	15	21	35	65	9	13	1.6	2.8	80	140
Brookings silty clay loam, 0 to 3 percent slopes	60	75	17	25	55	75	14	20	2.5	3.5	125	175
Buse loam, 18 to 25 percent slopes									1.0	1.5	50	75
Buse loam, 25 to 40 percent slopes												
Buse-Barnes loams, 6 to 12 percent slopes, eroded	35	55	13	19	30	65	8	13	1.6	2.8	80	140
Buse-Barnes loams, 12 to 18 percent slopes	30	45			25	45	5	10	1.5	2.2	75	110
Buse-Sioux complex, 12 to 18 percent slopes					15	25	4	8	1.0	1.5	50	75
Buse-Sioux complex, 18 to 40 percent slopes												
Buse-Vienna loams, 6 to 12 percent slopes	40	60	15	19	35	65	9	13	1.6	2.8	80	140
Buse-Vienna loams, 6 to 12 percent slopes, eroded	35	55	13	17	30	65	8	13	1.6	2.8	80	140
Buse-Vienna loams, 12 to 18 percent slopes	30	45			25	45	5	10	1.5	2.2	75	110
Buse-Vienna loams, 12 to 18 percent slopes, eroded	30	45			25	45	5	10	1.3	2.0	65	100
Darnen loam, 2 to 6 percent slopes	60	75	17	23	45	75	12	18	2.5	3.5	125	175
Estelline silty clay loam, 0 to 2 percent slopes	45	60	15	21	45	70	10	16	2.2	3.0	110	150
Estelline silty clay loam, 2 to 6 percent slopes	40	60	13	19	40	65	9	14	2.0	2.8	100	140
Estelline silty clay loam, 2 to 6 percent slopes, eroded	40	55	13	17	35	65	9	13	1.8	2.6	90	130
Estelline silty clay loam, deep, 0 to 2 percent slopes	55	70	17	23	45	75	12	18	2.2	3.2	110	160
Flandreau silt loam, 0 to 2 percent slopes	45	60	15	21	45	70	10	16	2.2	3.0	110	150
Flandreau silt loam, 2 to 6 percent slopes	40	60	13	19	40	65	9	14	2.0	2.8	100	140
Flandreau silt loam, 2 to 6 percent slopes, eroded	40	55	13	17	35	65	9	13	1.8	2.6	90	130
Flom and Roliss clay loams:												
Adequately drained	60	80	20	27	60	80	15	20	3.0	4.0	150	200
Inadequately drained	45	65	17	23	55	60	13	16	2.0	2.8	100	140
Fordville loam, 0 to 2 percent slopes	45	60	15	21	45	70	10	16	2.2	3.0	110	150
Fordville loam, 2 to 6 percent slopes, eroded	40	55	13	17	35	65	9	13	1.8	2.6	90	130
Gravel pit												
Leveled and used for crops	20	35	9	15	25	35	5	10	1.6	2.0	80	100
Hidewood silty clay loam:												
Adequately drained	65	80	20	27	60	80	15	20	3.0	4.0	150	200
Inadequately drained	50	65	17	23	55	60	13	17	2.0	3.0	100	150
Ihlen silty clay loam, 0 to 2 percent slopes	40	60	14	20	40	65	10	16	2.0	3.0	100	150
Ihlen silty clay loam, 2 to 6 percent slopes	40	60	13	19	36	65	9	14	2.0	2.8	100	140
Ihlen-Rock outcrop complex, 0 to 6 percent slopes												
Kranzburg silty clay loam, 0 to 2 percent slopes	55	70	17	23	45	70	12	18	2.2	3.2	110	160
Kranzburg silty clay loam, 2 to 4 percent slopes	55	70	17	23	45	70	11	17	2.2	3.2	110	160
Kranzburg silty clay loam, 3 to 6 percent slopes, eroded	50	65	15	21	40	70	10	16	2.0	3.2	100	160
Lamoure silty clay loam	55	75	18	23	55	75	15	19	3.0	4.0	150	200
Lamoure silty clay loam, frequently flooded												
Lamoure and La Prairie soils, frequently flooded												
La Prairie loam	60	75	20	25	55	75	15	21	3.0	4.0	150	200
Lismore silty clay loam, 0 to 3 percent slopes	60	75	17	25	55	75	14	20	2.5	3.5	125	175
Marsh												
Moody silty clay loam, 0 to 2 percent slopes	55	70	17	23	45	70	12	18	2.2	3.2	110	160
Moody silty clay loam, 2 to 4 percent slopes	55	70	17	23	45	70	11	17	2.2	3.2	110	160
Moody silty clay loam, 3 to 6 percent slopes, eroded	50	65	15	21	40	70	10	16	2.0	3.2	110	160
Quam silty clay loam:												
Adequately drained	50	75	18	25	65	75	13	18	3.0	4.0	150	200
Inadequately drained	35	50	15	21	40	50	10	13				
Rauville silty clay loam												
Renshaw loam, 0 to 2 percent slopes	30	45	10	16	35	45	7	11	2.0	2.5	100	125
Renshaw loam, 2 to 6 percent slopes	30	40	8	14	35	45	6	10	1.5	2.2	75	110
Renshaw loam, 6 to 12 percent slopes	20	30	5	10	20	35	4	9	1.1	1.8	55	90
Renshaw loam, 12 to 18 percent slopes					10	20	4	7	.5	1.0	25	50
Renshaw-Vienna-Buse loams, 2 to 6 percent slopes, eroded	25	40	10	15	35	50	9	13	1.8	2.5	90	125
Renshaw-Vienna-Buse loams, 6 to 12 percent slopes, eroded	20	35	8	13	25	45	7	11	1.5	2.0	75	100
Rock outcrop-Ihlen complex, 6 to 12 percent slopes												
Sioux gravelly loamy coarse sand, 2 to 40 percent slopes												
Svea clay loam, 0 to 3 percent slopes	60	75	17	25	55	75	12	18	2.5	3.5	125	175
Sverdrup fine sandy loam, 0 to 2 percent slopes	30	45	10	16	35	45	7	11	2.0	2.5	100	125
Sverdrup fine sandy loam, 2 to 6 percent slopes	30	40	8	14	35	45	6	10	1.5	2.2	75	110
Swenoda loam, 0 to 2 percent slopes	45	60	15	21	45	70	10	16	2.2	3.0	110	150
Swenoda loam, 2 to 6 percent slopes	40	60	13	19	40	65	9	14	2.0	2.8	100	140
Tonka silt loam:												
Adequately drained	50	75	17	25	65	75	13	18	3.0	4.0	150	200
Inadequately drained	35	55	15	23	40	50	10	13				

TABLE 2.—*Predicted average annual yields per acre of principal crops under two levels of management*—Continued

Mapping unit	Corn		Soybeans		Oats		Flax		Rotation hay [1]		Rotation pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*	*AUD* [2]	*AUD* [2]
Trent silty clay loam, 0 to 3 percent slopes	60	75	17	25	55	75	12	18	2.5	3.5	125	175
Trosky silty clay loam:												
Adequately drained	50	75	20	25	60	75	15	20	2.5	3.5	125	175
Inadequately drained	40	65	17	23	50	60	13	18	1.8	2.4	90	120
Vienna loam, 6 to 12 percent slopes	45	60	15	21	40	65	10	15	1.6	2.8	80	140
Vienna loam, 6 to 12 percent slopes, eroded	40	60	15	19	35	65	9	13	1.6	2.8	80	140
Vienna silty clay loam, 0 to 2 percent slopes	55	70	17	23	45	70	12	18	2.2	3.2	110	160
Vienna silty clay loam, 2 to 4 percent slopes	55	70	17	23	45	70	11	16	2.2	3.2	110	160
Vienna silty clay loam, 3 to 6 percent slopes, eroded	50	65	15	21	40	70	10	15	2.0	3.2	100	160
Whitewood silty clay loam:												
Adequately drained	65	80	20	27	60	80	15	20	3.0	4.0	150	200
Inadequately drained	50	65	17	23	55	60	13	17	2.0	3.0	100	150

[1] These yields are for a mixture of alfalfa and bromegrass. Yields are slightly less if alfalfa is grown alone.

[2] Animal-unit-days. A term used to express the carrying capacity of pasture. This value is obtained by multiplying the number of animal units carried per acre by the number of days the pasture can be grazed during a single grazing season without injury to the sod. One animal unit is 1,000 pounds of live animal.

Range management

The basic principle of range management is to control the grazing of livestock so that native grassland can be improved, maintained, and fully utilized.

To improve range, grazing must be controlled so as to favor the more desirable grasses in the plant community. This is done by early grazing so as to reduce the vigor of the less desirable species. Grazing is then deferred from June through August, when the more desirable grasses make their major growth.

To maintain range in good to excellent condition, the more desirable grasses should be permitted to become well established before they are grazed. The range should then be properly stocked in relation to the forage-producing capacity of the site. On a properly stocked pasture, about half of the seasonal growth of the more desirable grasses is removed by grazing.

To fully use the native pasture, grazing should be uniform over the entire pasture. The cool-season and warm-season grasses should be grazed during the season in which they make their major growth. For example, when range is dominated by cool-season plants, warm-season plants can be encouraged by early grazing.

Range sites and condition classes

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

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

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreasers are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax community for moisture, nutrients, and light. Invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

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

Four range condition classes are used to indicate the degree of departure of the range site from the potential, or climax, vegetation: excellent, good, fair, and poor. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

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

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

A primary objective of good range management is to keep range in excellent or good condition. If this is

done, water is conserved, yields are improved, and the soils are protected. The problem is recognizing changes that occur in the composition of the plant community on a range site. These changes take place gradually and can be easily misinterpreted or overlooked. An abundant growth of grass caused by favorable rainfall may lead to the conclusion that the range is in good condition, whereas actually the forage produced is mainly invaders and the long-term trend is toward lower production. On the other hand, a range that has been closely grazed for short periods may have a degraded appearance, but under good management it would still be in excellent condition. After a properly scheduled period of rest, it will be restored to its full productive potential.

Descriptions of the range sites

In this section, the range sites represented in Pipestone County are described, and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual production of air-dry herbage for each site when the site is in excellent condition. The names of the soil series represented are mentioned in the description of each site, but this does not mean that all the soils in a given series are in that range site. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey. Gravel pit and Marsh were not placed in a range site.

WETLAND RANGE SITE

This site consists of nearly level, moderately fine textured and medium-textured, poorly drained and very poorly drained soils of the Rauville, Quam, and Tonka series. Rauville soils are on bottom lands. Quam and Tonka soils are in potholes and depressions. The seasonal high water table is at or near the surface during at least part of the growing season. Surface drainage promotes the growth of grasses and limits the growth of bulrushes and cattails.

If this site is in excellent condition, prairie cordgrass, bluejoint reedgrass, and slough sedge are the dominant plants. The main increasers and invaders in overgrazed areas are saltgrass, fowl bluegrass, wild barley, redtop, rushes, and the smaller sedges. Some of these areas have been naturally seeded to reed canarygrass.

If this site is in excellent condition, the annual production of air-dry herbage ranges from 6,000 pounds per acre in unfavorable years to 7,000 pounds per acre in favorable years.

SUBIRRIGATED RANGE SITE

This site consists of nearly level, moderately fine textured, poorly drained and somewhat poorly drained soils of the Flom, Hidewood, Lamoure, Roliss, Trosky, and Whitewood series. The seasonal high water table is close to, but seldom above, the surface during spring and for short periods during the growing season. The seasonal high water table helps to maintain the grasses during droughty periods. This is potentially one of the most productive range sites in the county.

The climax vegetation is dominated by cordgrass, big bluestem, switchgrass, prairie sandreed, northern reedgrass, bluejoint reedgrass, and other tall grasses. The main increasers and invaders in areas that are overgrazed are bluegrass, redtop, saltgrass, and sedges.

If this site is in excellent condition, the annual production of air-dry herbage ranges from 5,400 pounds per acre in unfavorable years to 6,500 pounds per acre in favorable years.

OVERFLOW RANGE SITE

This site consists of nearly level and gently sloping, medium-textured and moderately fine textured, moderately well drained soils of the Athelwold, Brookings, Darnen, La Prairie, Lismore, Svea, and Trent series. These soils generally receive more than average moisture because of runoff from higher lying soils. La Prairie soils receive extra moisture from stream overflow.

The main decreasers on this site are big bluestem, prairie cordgrass, porcupinegrass, switchgrass, Indiangrass, and Canada wildrye. The main increasers and invaders are tall dropseed, prairie sandreed, side-oats grama, Kentucky bluegrass, and curlycup gumweed.

If this site is in excellent condition, the annual production of air-dry herbage ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds per acre in favorable years.

SILTY RANGE SITE

This site consists of nearly level to sloping, medium-textured and moderately fine textured, well-drained soils of the Barnes, Buse, Estelline, Flandreau, Fordville, Ihlen, Kranzburg, Moody, Vienna, and Swenoda series.

The climax vegetation is a mixture of tall and mid grasses, which are typical of the true prairie. Big bluestem dominates the less sloping sites, and little bluestem dominates the steeper sites. Other important decreasers are Indiangrass, porcupinegrass, and green needlegrass. Common increasers are needle-and-thread, side-oats grama, and blue grama. Kentucky bluegrass has invaded much of the range site.

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

THIN UPLAND RANGE SITE

This site consists of moderately steep to very steep, medium-textured, well-drained soils of the Buse, Barnes, and Vienna series. Runoff is more rapid and available water capacity is less on these soils than on those of the Silty range site. If the range is in excellent condition, the hazard of erosion is slight, but a decline in range condition results in a greater hazard of erosion as well as more runoff and droughtiness.

The climax vegetation is dominated by little bluestem, big bluestem, needle-and-thread, and side-oats grama. If this site is overgrazed, the bluestems and other tall grasses decrease; and needle-and-thread and side-oats grama increase. Continued overgrazing results in a major increase in the short grasses, blue grama, and Kentucky bluegrass.

If this site is in excellent condition, the annual production of air-dry herbage ranges from 2,600 pounds

per acre in unfavorable years to 3,500 pounds in favorable years.

SHALLOW RANGE SITE

This site consists of nearly level and gently sloping, medium-textured and moderately coarse textured, somewhat excessively drained soils of the Renshaw and Sverdrup series. These soils are underlain by sand or gravel at a depth of 12 to 24 inches. Runoff is slow. Moderately rapid permeability above the sand and gravel and low or moderate available water capacity make the productivity of these soils particularly dependent upon weather conditions.

The climax vegetation is dominated by mid grasses, but short grasses also are present. The main decreaser is needle-and-thread, but little bluestem, prairie dropseed, and side-oats grama are also important. Under continued overgrazing of this site, Kentucky bluegrass and blue grama increase.

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

VERY SHALLOW RANGE SITE

This site consists of gently sloping to very steep, coarse-textured to medium-textured, somewhat excessively drained and excessively drained soils of the Sioux and Renshaw series and of Rock outcrop. Most of these soils are underlain by sand, gravel, or bedrock at a depth of less than 12 inches, but depth to gravel is somewhat greater in the Renshaw soils. Renshaw soils tend to be droughty because runoff is rapid. Permeability is rapid to moderately rapid, and available water capacity is very low or low.

The climax vegetation is mid and short grasses. Mid grasses of importance are needle-and-thread and side-oats grama. Blue grama, sand dropseed, and sedges are the main increasers in areas that are overgrazed.

If this site is in excellent condition, the annual production of air-dry herbage ranges from 1,500 pounds per acre in unfavorable years to 2,200 pounds per acre in favorable years.

Field and Farmstead Windbreaks[3]

The total forest land in Pipestone County is only a few hundred acres, most of which consists of homestead tree claims planted by the early settlers. Green ash is the main species in these tree claims.

Trees and shrubs in Pipestone County are mainly used as farmstead windbreaks. Some field windbreaks are also planted. Windbreaks block out strong or cold winds, protect livestock in feedlots, reduce feed costs for livestock, reduce heating costs, control snow drifting, and protect orchards and gardens. Wildlife benefit, farmsteads look better, dust is reduced, outdoor living is more enjoyable, and wind damage is lessened.

The soils in Pipestone County have been placed in windbreak suitability groups. A windbreak suitability group is made up of soils that have similar characteristics that affect the growth of trees and shrubs. The names of the soil series represented in a woodland suitability group are named in the description of the group, but this does not mean that all of the soils in the series are in that group. The names of all of the soils in any given woodland suitability group can be found in the "Guide to Mapping Units" at the back of this survey.

The trees and shrubs suitable for field and farmstead windbreaks in Pipestone County are listed in table 3. Performance of each species on soils of the first 7 groups has been rated as preferred, acceptable, or not recommended. The species rated as *preferred* (1) are suggested for use on the soils of the group indicated. Species rated as *acceptable* (2) can be expected to grow but are not so desirable as the preferred species. Species rated as *not recommended* (3) are generally not suitable for soils of the group.

These performance ratings are based on soil characteristics that affect growth and survival of the trees and shrubs listed in the table. Texture, drainage, depth, reaction, stoniness, steepness, aspect, and position are important. The descriptions of windbreak suitability groups indicate how these characteristics affect performance of the trees and shrubs. Suggestions about the preparation of sites for planting are also given.

Seedling mortality refers to the expected loss of naturally occurring or planted seedlings as a result of unfavorable soil characteristics. Seedling mortality is *slight* if the expected loss is less than 25 percent, *moderate* if between 25 and 50 percent, and *severe* if more than 50 percent.

Plant competition refers to establishment problems of a desired species because of encroachment of competing vegetation. Competition is *slight* if competing vegetation does not cause mortality or restrict growth of seedlings, *moderate* if the plant invaders delay but do not prevent the establishment of a normal, fully stocked stand of desirable species, and *severe* if grass, brush, or undesirable trees prevent adequate regeneration.

Equipment limitation refers to the difficulty of using normal equipment in managing the windbreak. The limitation is *slight* if there are no restrictions on the type of equipment or on the time of year that the equipment can be used; *moderate* if the use of equipment is restricted by slope or wetness for no more than 3 months, or if the use of equipment damages tree roots to some extent; and *severe* if the use of normal equipment is restricted or limited for more than 6 months per year.

The erosion hazard is the degree of potential loss of soil by wind or water. Vegetation cover, slope, and soil properties are important factors. The hazard is *slight* if erosion is no problem, *moderate* if normal measures are needed to prevent unnecessary loss of soil, and *severe* if special care and methods are needed to minimize loss and deterioration of the soil.

WINDBREAK SUITABILITY GROUP 1

This group consists of medium-textured and moderately fine textured, moderately well drained and well drained, nearly level to sloping soils of the Athelwold.

[3] JOHN HULTGREN, woodland conservationist, Soil Conservation Service, helped to prepare this section.

TABLE 3.—*Performance ratings for various species of shrubs and trees by windbreak suitability groups*

[Performance ratings are 1, preferred; 2, acceptable; and 3, not recommended. The soils in Group 8 are too variable—rocky, gravelly, wet, or frequently flooded—to rate]

Species of trees and shrubs	Windbreak suitability groups							
	1	2	3	4	5	6		7
						North and east aspects	South and west aspects	
Conifers:								
Ponderosa pine	1	3	3	1	1	1	1	1
Eastern redcedar	2	2	3	1	1	2	1	1
Spruce	1	2	3	3	2	1	3	1
Northern white-cedar	1	1	2	3	2	2	3	1
Deciduous trees:								
Green ash	1	1	1	2	1	1	2	1
Siberian elm	2	1	1	2	1	1	2	2
Hackberry	1	1	2	2	2	3	3	1
Honey locust	1	2	2	2	1	1	2	1
Soft maple	1	1	1	3	2	2	3	2
Hybrid poplar	1	1	1	3	2	2	3	2
Golden willow	2	1	1	3	2	2	3	2
Small trees and shrubs:								
Buffaloberry	2	2	2	1	1	2	2	2
Caragana	2	2	2	1	1	1	2	1
Crabapple	1	2	3	1	2	2	3	1
Honeysuckle	1	1	1	1	1	1	2	1
Lilac, common or villosa	1	1	2	1	1	1	2	1
Ginnala maple	1	1	3	3	3	2	3	2
American plum	2	1	2	2	1	1	2	1
Russian-olive	2	2	1	1	1	2	1	2
Laurel willow	2	1	1	3	2	2	3	3
Purple-osier willow	2	1	1	3	2	2	3	2

Barnes, Brookings, Darnen, Estelline, Kranzburg, La Prairie, Lismore, Moody, Svea, Swenoda, Trent, and Vienna series. Most of these soils are on uplands, but the Estelline soils are on terraces and outwash plains, and the La Prairie soils are in high positions on bottom lands. The soils in this group have high or very high available water capacity. They hold enough moisture to permit trees to survive during short periods of drought. Reaction of the surface layer and subsoil ranges from slightly acid to mildly alkaline.

These soils have few characteristics that are detrimental to the growth and survival of the common trees and shrubs. The hazard of soil blowing is slight on most of the soils if they are cultivated, and the hazard of water erosion ranges from slight on the nearly level soils to severe on the sloping soils. Texture and drainage allow deep penetration of moisture and deep, uniform distribution of roots. Seedling mortality is slight. Plant competition is severe. Equipment limitations are slight.

WINDBREAK SUITABILITY GROUP 2

This group consists of medium-textured and moderately fine textured, somewhat poorly drained to very poorly drained, nearly level soils of the Flom, Hidewood, Quam, Tonka, and Whitewood series. These soils are in depressions and on upland flats.

Wetness limits the kinds of trees and shrubs that can be grown successfully on the soils in this group. Willow and poplar trees grow well, but pine trees do not. The texture of these soils is mostly favorable, but the subsoil of the Tonka soil is too fine textured to permit the good growth of even the most suitable woody plants. Other soil characteristics, especially reaction and available water capacity, are favorable. Plant competition is severe. Equipment limitations are moderate to severe. The hazard of erosion is slight. If the soils in this group have adequate subsurface drainage, species adaptability is similar to that of group 1.

WINDBREAK SUITABILITY GROUP 3

This group consists of moderately fine textured, somewhat poorly drained and poorly drained, calcareous, nearly level soils of the Lamoure, Roliss, and Trosky series. These soils are on flats and in depressions on uplands and bottom lands.

The combination of wetness and a high lime content in the soils of this group reduces the number of tree

and shrub species that grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis, generally caused by a deficiency of available iron, occurs in many trees and shrubs on the soils that have a high content of lime. The affected plants are yellowish and stunted. Seedling mortality is severe. Plant competition and equipment limitations are severe. The hazard of erosion is slight.

Drainage lowers the seasonal high water table and favors deeper rooting. If these soils are drained, their texture and available water capacity are more favorable for the growth of trees.

WINDBREAK SUITABILITY GROUP 4

This group consists of medium-textured and moderately coarse textured, somewhat excessively drained, nearly level, gently sloping and sloping soils of the Renshaw and Sverdrup series. These soils are on uplands, stream terraces, and terrace escarpments. They are underlain by sand or gravel at a depth of 12 to 24 inches. Available water capacity is low or moderate.

These soils are not well suited to many tree and shrub species. Seedling mortality is moderate. Windbreaks are likely to have a high mortality if drought occurs before the trees and shrubs are established. Trees planted on these soils generally grow slowly and are often stunted. They also tend to have a shorter life than the same species that grow on soils that are underlain by finer textured material. Plant competition is slight to moderate. Equipment limitations are slight.

The hazard of soil blowing is severe on some of these soils. Field windbreaks are effective in controlling soil blowing, but care is needed while the trees or shrubs are young to keep them from being damaged by windblown particles of soil. A cover of grass or crop residue from corn or sorghum reduces soil blowing.

WINDBREAK SUITABILITY GROUP 5

This group consists of medium-textured, well-drained, calcareous soils of the Buse series. These are undulating and sloping soils on uplands.

Many areas of these soils are droughty because a large part of the water is lost as runoff. In many places the surface layer is thin, fertility is low, and tilth is poor because organic matter and nutrients have been lost through erosion. Droughtiness, low fertility, and poor tilth cause moderate seedling mortality and slow growth of trees and shrubs.

Excessive lime generally affects the uptake of plant nutrients. Chlorosis, resulting from the lack of iron, occurs in plants growing on these soils.

The hazard of erosion is moderate to severe. Plant competition is severe. Equipment limitations are slight.

WINDBREAK SUITABILITY GROUP 6

This group consists of well-drained; medium-textured; moderately steep, steep, and very steep soils of the Barnes, Buse, and Vienna series. These soils are on uplands.

Seedling mortality is slight to severe, depending upon the aspect and position of slope. Conditions are less favorable on hot, dry south-facing and west-facing slopes. More species of trees and shrubs can be grown on the cooler, more moist, north-facing and east-facing slopes. Some of the north-facing and east-facing slopes along the streams in the county are naturally wooded, and south-facing and west-facing slopes are naturally grassed. Plant competition is severe. Most areas of these soils are in pasture. The hazard of erosion is severe if the surface layer is disturbed.

Equipment limitations are severe. The soils are too steep and erodible to permit plowing and fallowing of planted sites. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees or shrubs.

WINDBREAK SUITABILITY GROUP 7

This group consists of medium-textured and moderately fine textured, well-drained, nearly level and gently sloping soils of the Estelline, Flandreau, Fordville, and Ihlen series. These soils are on uplands and stream terraces. They are underlain by sand, gravel, or bedrock at a depth of 24 to 40 inches.

Available water capacity is moderate in these soils. During periods of drought, trees and shrubs on these soils are affected by a lack of moisture earlier than those on soils that are underlain by finer-textured materials, but later than those on soils that are more shallow to sand and gravel.

In some places these soils are intermingled with sandy soils, and in exposed areas, soil blowing is a hazard to young trees or shrubs. In most places the hazard of erosion is slight to moderate. Plant competition is moderate. Seedling mortality is slight to moderate. Weeds and grasses need to be controlled while the trees and shrubs are young, because competition for moisture generally is critical. Equipment limitations are slight.

WINDBREAK SUITABILITY GROUP 8

This group consists of soils that are either too variable to be rated or on which it is impractical to plant trees. In this group are soils of the Sioux, Ihlen, Lamoure, La Prairie, Rauville, and Renshaw series and the land types Gravel pit, Marsh, and Rock outcrop. The soils are rocky, gravelly, wet, frequently flooded, or steep. Each area needs onsite inspection to determine its suitability for windbreaks.

Wildlife[4]

The soils of Pipestone County can provide good habitat for various species of wildlife. Soils vary in their ability to produce wildlife habitat. There is a distinct relationship between the plants on various soils and the animals associated with those plants. For example, the Brookings-Hidewood soil association has good potential to produce habitat for ring-necked pheasant. Brookings soils can produce high-quality grain and seed crops for food, woody plants for escape and for winter cover, and grasses and legumes for nesting cover. Hidewood soils in natural condition produce good growth of water-tolerant grasses that also furnish

[4] JOHN W. BEDISH, biologist, Soil Conservation Service, helped to prepare this section.

cover for pheasant. If drainage is adequate, these soils also produce good-quality row crops, such as corn and soybeans, which provide excellent food for pheasant.

Although soils are an important habitat component for wildlife, other factors also influence the abundance of wildlife species. Changes in the land use pattern, for example, directly affect the population of wildlife species.

Pipestone County is in the heart of the Minnesota pheasant range. Land use changes to more intensive farming has limited population levels. Other small game are Hungarian partridge, rabbit, squirrel, fox, and beaver.

Waterfowl frequent the county, especially during the migration season. Because of the lack of permanent marsh and suitable habitat conditions, duck production in the county is very low.

Many of the numerous ponds and pits that have been constructed in the county, however, help to provide habitat for waterfowl and other species of wildlife (fig. 14). Some deer are in the county. Fish populations are low because of the lack of suitable streams and lakes.

Table 4 gives the potential of the seven soil associations in Pipestone County to provide habitat for five kinds of wildlife. It is assumed that habitat management is applied as required. The general soil map at the back of this survey shows the location of the soil associations. Upland wildlife includes ring-necked pheasant and Hungarian partridge; waterfowl and furbearers include mallard and muskrat; small game includes jackrabbit and fox squirrel; big game includes white-tailed deer; and songbirds include meadowlark.

Recreation

Pipestone County has a low potential for recreational enterprises for commercial purposes. A potential, however, exists for public and private recreational facilities for noncommercial purposes.

A knowledge of soils is necessary in planning, developing, and maintaining areas for recreation. In table 5 the soils of the county are rated according to limitations that affect their suitability for camp areas, play areas, picnic areas, and paths and trails.

In table 5 the soils are rated as having slight, moderate, or severe limitations for specified uses. For all these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally

***Figure 14.*—A farm pond in an area of Kranzburg soils provides habitat for waterfowl.**

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

Soil associations	Kinds of wildlife				
	Upland game	Waterfowl and furbearers	Small game	Big game	Songbirds
Estelline-Lamoure	Good	Fair [1]	Fair	Good	Good.
Brookings-Hidewood	Good	Poor	Good	Good	Good.
Kranzburg-Vienna	Good	Poor	Good	Good	Good.
Barnes-Buse	Fair	Fair [1]	Good	Fair	Good.
Barnes-Flom	Good	Fair [1]	Good	Good	Good.
Ihlen-Rock outcrop	Good	Very poor	Good	Poor	Good.
Moody-Trent-Whitewood	Good	Poor	Good	Good	Good.

[1] Undrained areas of poorly drained and very poorly drained soils have a high potential for wetland wildlife.

favorable and limitations are so minor that they can be easily overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required. A soil rated *severe* also may have some features that are rated moderate.

The soils have been considered in their natural state. A soil that has been effectively drained, for instance, could be considered to have a lesser degree of soil limitation. Moderately well drained soils that have a moderately fine textured surface layer have moderate limitations. Well-drained soils have only slight limitations.

Play areas are used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. They should have a nearly level surface free of coarse fragments and rock outcrop, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are needed, depth over bedrock is important.

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

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

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

Engineering Uses of the Soils [5]

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

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

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

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

[5] CLARENCE P. SIMONSEN, engineer, Soil Conservation Service, helped to prepare this section.

TABLE 5.—*Degree and kind of limitations that affect use of the soils for recreation*

Soils series and map symbols	Play areas	Picnic areas	Paths and trails	Camp areas
Athelwold: At	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Barnes:				
BaB, BaB2	Moderate: slope	Slight	Slight	Slight.
BaC2	Severe: slope	Moderate: slope	Slight	Moderate: slope.
Brookings: BrA	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Buse:				
BuE, BxE	Severe: slope	Severe: slope	Moderate: slope	Severe: slope.
BuF	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
BwC2, ByC, ByC2	Severe: slope	Moderate: slope	Slight	Moderate: slope.
BwD, BxD, ByD, ByD2	Severe: slope	Severe: slope	Slight	Severe: slope.
Darnen: DaB	Moderate: slope	Slight	Slight	Slight.
Estelline:				
EsA, EtA	Slight	Slight	Slight	Slight.
EsB, EsB2	Moderate: slope	Slight	Slight	Slight.
Flandreau:				
FaA	Slight	Slight	Slight	Slight.
FaB, FaB2	Moderate: slope	Slight	Slight	Slight.
Flom: Fm	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained; seasonal high water table.
Fordville:				
FoA	Slight	Slight	Slight	Slight.
FoB2	Moderate: slope	Slight	Slight	Slight.
Gravel pit: Gp	Severe: gravelly surface.	Severe: gravelly surface.	Severe: too sandy	Severe: too sandy.
Hidewood: Hd	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Severe: somewhat poorly drained; moderseasonal high water table.
Ihlen:				
IhA	Slight	Slight	Slight	Slight.
IhB	Moderate: slope; 20 to 40 inches deep over bedrock.	Slight	Slight	Slight.
IrB	Severe: shallow to bedrock; rocky surface.	Moderate: rocky surface.	Moderate: rocky surface.	Severe: rocky surface.
Kranzburg:				
KrA	Slight	Slight	Slight	Slight.
KrB, KrB2	Moderate: slope	Slight	Slight	Slight.
Lamoure:				
La	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained; occasional flooding.
Lb	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.
Lc	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
La Prairie: Lp	Moderate: occasional flooding.	Moderate: occasional flooding.	Moderate: occasional flooding.	Severe: occasional flooding.

TABLE 5.—*Degree and kind of limitations that affect use of the soils for recreation*—Continued

Soils series and map symbols	Play areas	Picnic areas	Paths and trails	Camp areas
Lismore: LsA	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Marsh: Ma	Severe	Severe	Severe	Severe.
Moody:				
MoA	Slight	Slight	Slight	Slight.
MoB, MoB2	Moderate: slope	Slight	Slight	Slight.
Quam: Qu	Severe: very poorly drained; very high seasonal water table.	Severe: very poorly drained; very high seasonal water table.	Severe: very poorly drained; very high seasonal water table.	Severe: very poorly drained; frequent flooding or ponding.
Rauville: Ra	Severe: very poorly drained; frequent flooding or ponding.	Severe: very poorly drained; frequent flooding or ponding.	Severe: very poorly drained.	Severe: very poorly drained; frequent flooding or ponding.
Renshaw:				
ReA	Slight	Slight	Slight	Slight.
ReB, RnB2	Moderate: slope	Slight	Slight	Slight.
ReC	Severe: slope	Moderate: slope	Slight	Moderate: slope.
ReD	Severe: slope	Severe: slope	Moderate: slope	Severe: slope.
RnC2	Severe: slope	Moderate: slope	Slight	Slight.
Rock outcrop: RoC	Severe: shallow to bedrock; rocky surface; slope.	Moderate: rocky surface; slope.	Moderate: rocky surface.	Severe: rocky surface.
Rollis. Mapped only with Flom soils.				
Sioux: SoE	Severe: gravelly surface layer.	Moderate: gravelly surface. Severe: if slope is more than 15 percent.	Moderate: gravelly surface. Severe: if slope is more than 25 percent.	Moderate: gravelly surface. Severe: if slope is more than 15 percent.
Svea: SvA	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Sverdrup:				
SwA	Slight	Slight	Slight	Slight.
SwB	Moderate: slope	Slight	Slight	Slight.
Swenoda:				
SyA	Slight	Slight	Slight	Slight.
SyB	Moderate: slope	Slight	Slight	Slight.
Tonka: To	Severe: poorly drained; very high seasonal water table.	Severe: poorly drained; very high seasonal water table.	Severe: poorly drained; very high seasonal water table.	Severe: poorly drained; frequent flooding or ponding.
Trent: TrA	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.	Moderate: moderately fine textured surface layer.
Trosky: Ts	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Severe: somewhat poorly drained; seasonal high water table.
Vienna:				
VaC, VaC2	Severe: slope	Moderate: slope	Slight	Moderate: slope.
VbA	Slight	Slight	Slight	Slight.
VbB, VbB2	Moderate: slope	Slight	Slight	Slight.
Whitewood: Wh	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Severe: somewhat poorly drained; seasonal high water table.

Most of the information in this section is presented in tables 6 and 7, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

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

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

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The glossary defines many of these terms as they are commonly used in soil science.

Soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*9*), used by SCS engineers, the Department of Defense, and others, and the AASHO systems (*1*), adopted by the American Association of State Highway Officials. These systems are explained briefly in the following paragraphs (*5*).

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

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHO classification, without group index numbers, is given in table 6 for all soils mapped in the survey area.

Soil properties significant to engineering

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

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

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

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

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6.

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

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

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

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indi-

TABLE 6.—*Estimated soil*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. carefully the instructions for referring to other series that appear in the first

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Ft	*Ft*	*In*			
Athelwold: At	[1]>10	2–5	0–17	Silty clay loam	OL	A–7
			17–31	Silty clay loam	ML or CL	A–7 or A–6
			31–60	Sand and gravel	SM-SW or GM-GW	A–1
Barnes: BaB, BaB2, BaC2	>100	5–10+	0–9	Loam	OL, ML, or CL	A–6 or A–7
			9–21	Loam	ML or CL	A–6 or A–7
			21–60	Loam	ML or CL	A–6 or A–4
Brookings: BrA	[1]>10	2–5	0–16	Silty clay loam	OL	A–7
			16–29	Silty clay loam	CL	A–7 or A–6
			29–60	Loam	CL	A–6
*Buse: BuE, BuF, BwC2, BwD, BxD, BxE, ByC, ByC2, ByD, ByD2 For Barnes part of BwC2 and BwD, see Barnes series. For Sioux part of BxD and BxE, see Sioux series. For Vienna part of ByC, ByC2, ByD, and ByD2, see Vienna series.	>100	5–10+	0–7	Loam	ML	A–7 or A–6
			7–60	Loam	CL	A–6 or A–4
Darnen: DaB	> 10	2–5	0–27	Loam	OL	A–4, A–6 or A–7
			27–46	Loam	ML or CL	A–4, A–6 or A–7
			46–66	Silty clay loam	CL	A–6 or A–7
Estelline:						
EsA, EsB, EsB2	[1]>10	5–10+	0–10	Silty clay loam	CL or OL	A–6 or A–7
			10–30	Silty clay loam	CL	A–4 or A–6
			30–60	Sand and gravel	SM–SW or GM-GW	A–1
EtA	[1]>10	5–10+	0–8	Silty clay loam	CL or OL	A–6 or A–7
			8–42	Silty clay loam	CL	A–6 or A–7
			42–60	Sand and gravel	SM-SW or GM-GW	A–1
Flandreau: FaA, FaB, FaB2	[1]>10	5–10+	0–14	Silt loam	ML or OL	A–4
			14–30	Silt loam and loam	ML or CL	A–4 or A–6
			30–60	Fine sand	SM	A–2
*Flom: Fm For Roliss part of Fm, see Roliss series.	>100	0–2	0–20	Clay loam	OL	A–7
			20–35	Clay loam	CL	A–7
			35–60	Clay loam	CL or ML	A–6 or A–7
Fordville: FoA, FoB2	[1]>10	5–10+	0–14	Loam	ML	A–4 or A–6
			14–27	Loam and light clay loam	ML or CL	A–4 or A–6
			27–60	Sand and gravel	SM-SW or GM-GW	A–1
Gravel pit: Gp. No valid estimates can be made.						
Hidewood: Hd	[1]>10	0–2	0–17	Silty clay loam	OL or OH	A–7
			17–37	Silty clay loam	CL	A–7
			37–60	Clay loam	CL	A–6
Ihlen: IhA, IhB, IrB	<5	([3])	0–8	Silty clay loam	ML or CL	A–7 or A–6
			8–31	Silty clay loam	CL	A–6 or A–7
No valid estimates can be made for Rock outcrop part of IrB.			31	Bedrock.		
Kranzburg: KrA, KrB, KrB2	[1]>10	5–10+	0–10	Silty clay loam	OL or CL	A–7
			10–27	Silty clay loam	CL	A–6 or A–7
			27–60	Clay loam	CL	A–6

properties significant in engineering

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

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
Pct					*Pct*		*In per hr*	*In per in of soil*	*pH*			
0	100	100	90–100	85–95	40–50	10–15	0.63–2.0	0.21–0.23	6.6–7.3	Moderate	High	Low.
0	100	95–100	90–100	70–80	35–45	10–20	0.63–2.0	0.18–0.20	6.6–8.4	Moderate	High	Low.
0–25	40–70	35–45	25–35	5–12	[2]NP	[2]NP	>6.3	0.02–0.04	7.4–8.4	Low	Low	Low.
0	100	90–100	80–90	55–70	35–45	10–15	2.0–6.3	0.20–0.22	6.6–7.3	Low	Low	Low.
0–10	95–100	90–100	85–95	55–75	35–45	10–20	2.0–6.3	0.17–0.19	6.6–7.8	Moderate	Low	Low
0–20	95–100	80–95	80–90	55–70	25–35	5–15	0.63–2.0	0.17–0.19	7.4–8.4	Low to moderate	Low	Low.
0	100	95–100	95–100	90–95	40–50	10–25	0.63–6.3	0.21–0.23	6.6–7.3	Moderate	High	Low.
0	100	95–100	95–100	85–95	30–50	15–25	2.0–6.3	0.18–0.20	6.6–8.4	Moderate	High	Low.
0–20	95–100	90–100	90–100	70–80	30–40	10–20	0.63–2.0	0.17–0.19	7.4–8.4	Moderate	High	Low.
0–10	95–100	90–100	85–95	55–70	35–45	10–15	0.63–6.3	0.20–0.22	7.4–8.4	Moderate	Low	Low.
0–20	95–100	90–100	85–95	55–70	25–40	5–20	0.63–2.0	0.17–0.19	7.4–8.4	Low to moderate	Low	Low.
0–10	95–100	95–100	90–100	85–95	30–45	5–20	0.63–2.0	0.20–0.22	6.6–7.3	Moderate	Moderate	Low.
0–10	95–100	90–100	90–100	70–80	30–45	5–20	0.63–2.0	0.17–0.19	6.6–8.4	Moderate	Moderate	Low.
0–10	95–100	95–100	90–100	70–80	35–45	10–20	0.63–2.0	0.18–0.20	7.4–8.4	Moderate	Moderate	Low.
0	100	100	95–100	85–95	30–45	10–20	2.0–6.3	0.21–0.23	6.1–7.3	Low to moderate	Moderate	Low.
0	100	100	90–100	80–90	20–40	5–15	0.63–2.0	0.18–0.20	6.1–7.3	Low to moderate	Moderate	Low.
0–25	40–70	35–45	25–35	5–12	NP	NP	>6.3	0.02–0.04	7.4–8.4	Low	Low	Low.
0	100	100	90–100	85–95	35–50	10–20	2.0–6.3	0.21–0.23	6.1–7.3	Low	Moderate	Low.
0	100	100	95–100	85–95	30–40	10–20	0.63–2.0	0.18–0.20	6.1–7.3	Low to moderate	Moderate	Low.
0–25	40–70	35–45	25–35	5–12	NP	NP	>6.3	0.02–0.04	7.4–8.4	Low	Low	Low.
0	100	95–100	90–100	55–65	25–40	5–10	0.63–6.3	0.22–0.24	6.1–7.3	Low to moderate	Low	Low.
0	100	95–100	90–100	50–60	25–40	5–15	0.63–2.0	0.20–0.22	6.1–7.3	Low to moderate	Low	Low.
0	95–100	95–100	50–70	12–30	NP	NP	>6.3	0.05–0.07	7.4–8.4	Low	Low	Low.
0	95–100	95–100	90–100	75–85	40–50	15–20	0.63–6.3	0.17–0.19	6.6–8.4	Moderate	High	Low.
0	95–100	95–100	90–95	75–85	35–45	15–25	0.63–2.0	0.15–0.19	7.4–8.4	Moderate	High	Moderate.
0–10	90–100	85–95	90–95	65–75	30–45	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate	High	Moderate.
0–10	95–100	90–100	80–90	60–70	25–35	5–15	0.63–6.3	0.20–0.22	6.1–7.3	Low	Low	Low.
0–10	90–100	90–100	70–80	50–60	20–40	5–20	2.0–6.3	0.17–0.19	6.1–7.3	Low	Low	Low.
0–25	40–70	35–50	25–35	5–12	NP	NP	>6.3	0.02–0.04	7.4–8.4	Low	Low	Low.
0	100	100	95–100	85–95	40–60	10–20	0.63–6.3	0.21–0.23	6.6–7.8	Moderate	High	Low.
0	100	100	95–100	85–95	40–50	15–25	0.63–2.0	0.18–0.20	6.6–8.4	Moderate	High	Low.
0–20	95–100	90–100	90–100	70–80	30–40	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate to high	High	Moderate.
0	100	100	95–100	90–95	35–50	10–20	0.63–6.3	0.21–0.23	6.1–7.3	Moderate	Moderate	Low.
0	100	100	95–100	90–95	35–45	15–25	2.0–6.3	0.18–0.20	6.1–8.4	Moderate	Moderate	Low.
0	100	95–100	90–100	85–95	40–50	10–15	0.63–6.3	0.21–0.23	6.1–7.3	Moderate	Moderate	Low.
0–10	95–100	95–100	90–100	85–95	35–45	10–20	2.0–6.3	0.18–0.20	6.6–7.8	Moderate	Moderate	Low.
0–20	95–100	90–100	90–95	70–80	30–40	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate to high	Moderate	Low.

TABLE 6.—*Estimated soil*

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Ft	*Ft*	*In*			
*Lamoure: La, Lb, Lc	[1]>10	0–2	0–30	Silty clay loam	OL or OH	A–5 or A–7
			30–60	Silty clay loam	CL or ML	A–6 or A–7
For La Prairie part of Lc, see La Prairie series.						
La Prairie: Lp	[1]>10	2–5	0–24	Loam	OL or ML	A–4
			24–60	Loam	ML or CL	A–4 or A–6
Lismore: LsA	[1]>10	2–5	0–17	Silty clay loam	OL or OH	A–7
			17–26	Clay loam	ML or CL	A–6 or A–7
			26–60	Clay loam	CL	A–6
Marsh: Ma.						
Material variable; no estimates were made.						
Moody: MoA, MoB, MoB2	[1]> 5	5–10+	0–10	Silty clay loam	ML or CL	A–7
			10–35	Silty clay loam	CL	A–7 or A–6
			35–60	Silt loam	CL or ML	A–6 or A–7
Quam: Qu	>100	0–2	0–23	Silty clay loam	OL or OH	A–7
			23–42	Silty clay loam	CL	A–7
			42–70	Clay loam	CL	A–7
Rauville: Ra	[1]>10	0–2	0–32	Silty clay loam	OL or OH	A–7 or A–5
			32–60	Clay loam and silty clay loam	CL	A–7
*Renshaw: ReA, ReB, ReC, ReD, RnB2, RnC2.	[1]>10	5–10+	0–8	Loam	ML	A–4 or A–6
			8–15	Loam	ML	A–4 or A–6
			15–60	Gravelly coarse sand	GM-GW or SM-SW	A–1
For Vienna and Buse parts of RnB2 and RnC2, see their respective series.						
*Rock outcrop: RoC.						
No valid estimates can be made for Rock outcrop; for Ihlen part of RoC, see Ihlen series.						
Roliss	>100	0–2	0–12	Clay loam	CL	A–7
			12–27	Loam and clay loam	CL	A–7
			27–60	Loam	ML or CL	A–6 or A–7
Mapped only in undifferentiated group with Flom soils.						
Sioux: SoE	[3]>10	5–10+	0–11	Gravelly loamy coarse sand	SM	A–2
			11–60	Gravelly coarse sand	SM–SW or GM-GW	A–1
Svea: SvA	>100	2–5 +	0–18	Clay loam	OL	A–7 or A–5
			18–29	Clay loam	ML or CL	A–6 or A–7
			29–60	Clay loam	ML or CL	A–6 or A–7
Sverdrup: SwA, SwB	[1]>10	5–10+	0–7	Fine sandy loam	SM	A–2
			7–23	Sandy loam	SM	A–2
			23–60	Loamy sand	SM	A–2
Swenoda: SyA, SyB	>10	5–10+	0–23	Loam	ML	A–4
			23–35	Sandy loam	SM	A–2
			35–60	Silty clay loam and clay loam	ML or CL	A–6
Tonka: To	>10	0–2	0–10	Silt loam	ML or OL	A–7 or A–6
			10–17	Silt loam	ML or CL	A–4
			17–48	Silty clay and clay	CH	A–7
			48–60	Silty clay loam	CL	A–7
Trent: TrA	[1]> 5	2–5	0–16	Silty clay loam	OL	A–7
			16–31	Silty clay loam	CL	A–7 or A–6
			31–60	Silt loam	CL or ML	A–6 or A–7

properties significant in engineering—Continued

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
Pct					*Pct*		*In per hr*	*In per in of soil*	*pH*			
0	100	100	95–100	85–95	40–60	5–25	0.63–2.0	0.21–0.23	7.4–8.4	Moderate	High	Low.
0	100	100	95–100	85–95	35–50	10–25	0.63–2.0	0.18–0.20	7.4–8.4	Moderate	High	Moderate.
0	100	95–100	85–95	65–75	20–40	5–10	0.63–2.0	0.20–0.22	6.6–8.4	Moderate to low	High	Low.
0	100	95–100	85–95	65–75	20–35	5–15	0.63–2.0	0.17–0.19	7.4–8.4	Moderate	High	Low.
0–10	95–100	95–100	90–100	80–90	40–60	10–20	0.63–6.3	0.21–0.23	6.6–7.3	Moderate	High	Low.
0–10	95–100	95–100	90–100	70–80	30–45	15–25	0.63–2.0	0.15–0.19	7.4–8.4	Moderate	High	Low.
0–25	95–100	90–100	90–100	65–75	30–40	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate	High	Low.
0	100	100	95–100	85–95	35–50	10–20	0.63–6.3	0.21–0.23	6.1–7.3	Moderate	Moderate	Low.
0	100	100	95–100	90–100	35–45	15–25	2.0–6.3	0.18–0.20	6.6–7.3	Moderate to high	Moderate	Low.
0	100	95–100	90–100	85–95	30–45	10–15	0.63–2.0	0.20–0.22	7.4–8.4	Low to moderate	Moderate	Low.
0	100	95–100	95–100	85–95	40–50	15–25	0.63–2.0	0.21–0.23	6.6–7.3	Moderate to high	High	Low.
0	100	95–100	90–100	80–90	40–50	20–35	0.20–0.63	0.18–0.20	6.6–7.3	Moderate to high	High	Low.
0–10	95–100	90–100	90–100	70–80	20–40	10–20	0.63–2.0	0.14–0.16	6.6–8.4	Moderate	Moderate	Low.
0	100	100	100	95–100	40–60	5–15	0.63–2.0	0.21–0.23	7.4–8.4	Moderate	High	Moderate.
0	95–100	90–100	90–100	70–80	40–45	10–15	0.63–2.0	0.15–0.19	7.4–8.4	Moderate	Moderate	Moderate.
0–10	90–100	85–95	70–85	50–60	25–35	5–15	2.0–6.3	0.20–0.22	6.1–7.3	Low	Low	Low.
0–25	90–100	85–95	80–90	50–55	20–35	5–15	2.0–6.3	0.17–0.19	6.1–7.3	Low	Low	Low.
0–25	40–70	35–50	25–35	5–12	NP	NP	>6.3	0.02–0.04	7.4–8.4	Low	Low	Low.
0	95–100	95–100	90–100	75–85	40–50	15–20	0.63–6.3	0.17–0.19	7.4–8.4	Moderate	High	Moderate.
0	95–100	95–100	90–100	70–80	35–45	10–20	0.63–2.0	0.17–0.19	7.9–8.4	Moderate	High	High.
0–10	95–100	95–100	85–95	60–70	30–45	10–20	0.20–2.0	0.17–0.19	7.4–8.4	Moderate	High	Moderate.
0–25	60–70	45–55	35–45	12–20	0–10	0–5	6.3–20.0	0.07–0.09	6.6–7.8	Low	Low	Low.
0–25	40–70	35–45	25–35	5–12	NP	NP	6.3–20.0	0.02–0.04	7.4–8.4	Low	Low	Low.
0	95–100	95–100	90–100	70–80	40–50	5–15	0.63–6.3	0.17–0.19	6.6–7.3	Moderate	High	Low.
0–10	95–100	95–100	90–100	70–80	35–45	10–20	0.63–2.0	0.15–0.19	6.6–7.8	Moderate	High	Low.
0–20	90–100	85–95	80–90	65–75	30–45	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Low to moderate	High	Low.
0	95–100	95–100	60–70	25–35	0–20	0–5	2.0–6.3	0.16–0.18	6.1–7.3	Low	Low	Low.
0	95–100	95–100	60–70	25–35	0–15	0–5	2.0–6.3	0.12–0.14	6.1–7.3	Low	Low	Low.
0	95–100	95–100	50–70	12–30	NP	NP	>6.3	0.08–0.10	7.4–8.4	Low	Low	Low.
0	100	95–100	85–95	60–75	25–40	5–10	2.0–6.3	0.20–0.22	6.1–7.3	Low	Low	Low.
0	100	95–100	50–75	12–30	0–15	0–5	>6.3	0.12–0.14	6.6–7.8	Low	Low	Low.
0–20	95–100	90–100	90–100	65–85	30–40	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate	Moderate	Low.
0	100	100	100	90–100	35–45	10–20	2.0–6.3	0.22–0.24	5.6–6.5	Moderate	High	Low.
0	100	100	100	90–100	25–35	5–10	0.63–2.0	0.20–0.22	5.6–6.5	Moderate	High	Low.
0	100	100	100	90–100	55–70	30–40	0.06–0.63	0.11–0.13	5.6–6.5	High	High	Moderate.
0	100	100	100	90–100	40–50	20–30	0.63–2.0	0.18–0.20	6.1–7.3	Moderate to high	High	Moderate.
0	100	100	100	90–100	35–50	10–20	0.63–6.3	0.21–0.23	6.1–7.3	Moderate	High	Low.
0	100	100	100	90–100	35–45	15–25	0.63–2.0	0.18–0.20	6.6–7.8	Moderate to high	High	Low.
0	100	95–100	95–100	85–95	30–45	10–15	0.63–2.0	0.20–0.22	7.4–8.4	Low to moderate	Moderate	Low.

TABLE 6.—*Estimated soil*

Soil series and map symbols	Depth to—		Depth from surface	Dominant USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Ft	*Ft*	*In*			
Trosky: Ts	[1]>10	0–2	0–20	Silty clay loam	OL	A–7
			20–38	Silty clay loam	ML or CL	A–7 or A–6
			38–60	Sand and gravel	SM-SW or GM-GW	A–1
Vienna: VaC, VaC2, VbA, VbB, VbB2.	>10	5–10+	0–16	Silty clay loam	OL or ML	A–4 or A–6
			16–27	Clay loam and loam	CL	A–6 or A–7
			27–60	Clay loam and loam	CL	A–6
Whitewood: Wh	[1]> 5	0–2	0–18	Silty clay loam	OL or OH	A–7
			18–32	Silty clay loam	CL	A–7
			32–72	Silt loam	CL or ML	A–6

[1] In areas where these soils are closely associated with Ihlen soils and Rock outcrop, depth to bedrock is less and rocks crop out.
[2] NP = nonplastic.

cates a hazard to the maintenance of structures built in, on, or of material having this rating.

Corrosivity, as used in table 6, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations of the soils

The interpretations in table 7 are based on the estimated engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Pipestone County. In table 7, ratings are used to summarize limitations or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, pond reservoir areas, embankments, and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

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

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

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

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

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

properties significant in engineering—Continued

Coarse fraction greater than 3 inches	Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
	No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)							Uncoated steel	Concrete
Pct					*Pct*		*In per hr*	*In per in of soil*	*pH*			
0	100	100	90–100	85–95	40–50	10–15	0.63–6.3	0.21–0.23	6.6–7.8	Moderate	High	Low.
0	95–100	95–100	90–100	80–90	35–45	10–20	0.20–2.0	0.18–0.20	6.6–7.8	Moderate	High	Low.
0–25	40–70	35–45	25–35	5–12	NP	NP	>6.3	0.02–0.04	7.4–8.4	Low	High	Moderate.
0–10	95–100	95–100	95–100	80–90	30–45	10–20	0.63–6.3	0.21–0.23	6.1–7.3	Low to moderate	Low	Low.
0–10	95–100	95–100	90–100	70–80	30–45	15–25	2.0–6.3	0.17–0.19	6.6–8.4	Moderate	Low	Low.
0–25	95–100	90–100	90–100	65–75	30–40	10–20	0.63–2.0	0.14–0.16	7.4–8.4	Moderate	Low	Low.
0	100	100	100	90–95	40–60	10–20	0.63–6.3	0.21–0.23	6.6–7.8	Moderate	High	Low.
0	100	100	100	95–100	40–50	15–25	0.63–2.0	0.18–0.20	6.6–8.4	Moderate	High	Low.
0	100	100	95–100	90–100	30–40	10–20	0.63–2.0	0.20–0.22	7.4–8.4	Moderate	High	Low.

[3] A seasonal high water table generally is not significant in these soils. Bedrock is at a depth of 20 to 40 inches.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example, excavations for pipelines, sewerlines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 7, are not more than three stories high, have a basement, and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Engineers and others, however, should not apply specific values to the estimates given for bearing capacity. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth over bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 7 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

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

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

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is above a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

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

TABLE 7.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Athelwold: At	Moderate: seasonal high water table for a short period.[3]	Severe: rapid permeability below a depth of 24 to 40 inches.	Moderate: seasonal high water table at a depth of 2 to 5 feet; sand and gravel below a depth of 30 to 40 inches.	Moderate: moderately well drained; high bearing capacity; low shrink-swell potential.	Severe: seasonal high water table; rapid permeability in underlying material.	Moderate: moderate to high susceptibility to frost action to depth of 2½ to 4 feet, low susceptibility below.
Barnes:						
BaB, BaB2	Slight	Moderate: moderate permeability; slope.	Slight	Slight: low to moderate shrink-swell potential; high bearing capacity.[4]	Slight	Moderate: fine grained; moderate susceptibility to frost action.
BaC2	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Slight	Moderate: slope; fine grained.
Brookings: BrA	Moderate: seasonal high water table for a short period.	Moderate: moderate permeability; high organic-matter content; seasonal high water table.	Generally moderate: seasonal high water table at a depth of 2 to 5 feet. Severe in some areas of dense till.	Generally moderate: seasonal high water table above a depth of 60 inches; moderate shrink-swell potential; high bearing capacity.[4] Severe in some areas of dense till: high shrink-swell potential.	Severe: seasonal high water table.	Moderate: fine grained; moderate to high susceptibility to frost action.

interpretations of the soils

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

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to poor in subsoil, good in material below.	Good to fair: thickness of overburden ranges from 2½ to 4 feet.	Fair: moderately fine textured.	Moderate permeability to a depth of 2½ to 4 feet, rapid permeability below.	Medium to low shear strength and compacted permeability to a depth of 2½ to 4 feet; medium to high shear strength, high permeability, and good compaction below.	Moderately well drained.	Moderate available water capacity; medium intake rate; sand and gravel at a depth of 24 to 40 inches; moderately well drained.	Not needed.
Fair: low to moderate shrink-swell potential.	Unsuited: no sand or gravel.	Good to fair: surface layer thin and eroded in some places; stony in some areas.	Moderate permeability; low storage potential in most places.	Medium to low shear strength and compacted permeability; fair to good compaction characteristics.	Well drained.	High available water capacity; medium intake rate; moderate erosion hazard.	Some irregular slopes; needs cuts and fills for good alinement; some areas stony.
Fair: low to moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: surface layer thin and eroded in many places; some areas stony.	Moderate permeability; low to moderate permeability in most places.	Medium to low shear strength and compacted permeability; fair to good compaction.	Well drained.	High available water capacity; medium intake rate; severe erosion hazard.	Some irregular slopes; needs cuts and fills for good alinement; some areas stony.
Fair: moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair: moderately fine textured.	Moderate permeability; low storage potential in most places.	Medium to low shear strength; low permeability; fair to good compaction.	Moderately well drained.	High or very high available water capacity; medium intake rate; moderately well drained.	Moderately well drained; slight grade essential; good slope pattern.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
*Buse: BwC2, ByC, ByC2. For Barnes part of BwC2, see Barnes series. For Vienna part of ByC and ByC2, see Vienna series.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope; low to moderate shrink-swell potential; high bearing capacity; [4] well drained.	Slight	Moderate: slope; fine grained.
BwD, BxD, ByD, ByD2. For Barnes part of BwD, see Barnes series. For Sioux part of BxD, see Sioux series. For Vienna part of ByD and ByD2, see Vienna series.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
BuE, BxE, BuF For Sioux part of BxE, see Sioux series.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Moderate if slope is less than 25 percent; severe if more than 25 percent.	Severe: slope.
Darnen: DaB	Moderate: seasonal high water table for a short period.	Moderate: moderate permeability; high organic-matter content; seasonal high water table; slope.	Moderate: seasonal high water table at a depth of 2 to 5 feet.	Moderate: moderately well drained; moderate shrink-swell potential; medium bearing capacity; [4] seasonal high water table above a depth of 60 inches.	Severe: seasonal high water table.	Moderate: fine grained; moderate to high susceptibility to frost action; sidehill seepage in some sites.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential.	Unsuited: no sand or gravel; few, very small, sandy or gravelly pockets.	Poor: thin surface layer; stony or eroded in many places.	Moderate permeability; pockets or lenses of sand and gravel in places.	Medium to low shear strength; low compacted permeability; fair to good compaction.	Well drained.	High available water capacity; medium to low intake rate; severe erosion hazard.	Many irregular slopes; needs cuts and fills for good alinement; some areas stony.
Fair: slope; moderate shrink-swell potential.	Unsuited: no sand or gravel; few, very small, sandy or gravelly pockets.	Poor: thin surface layer; stony or eroded in many places; slope.	Moderate permeability; pockets or lenses of sand and gravel in places.	Medium to low shear strength; low compacted permeability; fair to good compaction.	Well drained.	High available water capacity; medium to low intake rate; severe erosion hazard.	Moderately steep; some areas stony; some areas suitable for diversions.
Fair if slope is less than 25 percent; poor if more than 25 percent.	Unsuited: no sand or gravel; few, very small, sandy or gravelly pockets.	Poor: slope; thin surface layer; stony in many places.	Moderate permeability; lenses of sand and gravel in places; good storage potential in many places.	Medium to low shear strength; low compacted permeability; fair to good compaction.	Well drained.	High available water capacity; low intake rate; steep and very steep slopes; suitability doubtful.	Too steep.
Poor to a depth of 2 feet, fair to poor below.	Unsuited: no sand or gravel.	Good: very thick surface layer.	Moderate permeability; high organic-matter content to a depth of 2 to 3 feet.	Suitable for low embankments to a depth of 2 to 3 feet; medium shear strength and compressibility in layers deeper than 2 to 3 feet.	Moderately well drained.	High or very high available water capacity; medium intake rate; moderately well drained.	Moderately well drained; slight grade essential; good slope pattern.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Estelline: EsA, EsB, EsB2, EtA.	Slight [3]	Severe: rapid permeability below a depth of 2 to 5 feet.	Moderate: sidewall instability.	Slight: high bearing capacity; well drained.	Severe: rapid permeability in underlying material.	Moderate: moderate susceptibility to frost action to a depth of 2 to 5 feet and low susceptibility below; good drainage.
Flandreau: FaA, FaB, FaB2.	Slight [3]	Severe: rapid permeability at a depth of 24 to 40 inches.	Severe: sidewall instability.	Slight: high bearing capacity; well drained.	Severe: rapid permeability in underlying material.	Moderate: moderate susceptibility to frost action to a depth of 24 to 40 inches, low susceptibility below.
*Flom: Fm. For Roliss part of Fm, see Roliss series.	Severe: seasonal high water table for an extended period.	Severe: seasonal high water table at a depth of less than 2 feet.	Severe: seasonal high water table above a depth of 2 feet.	Severe: poorly drained; medium to high bearing capacity where drained.	Severe: seasonal high water table.	Severe: poorly drained; high susceptibility to frost action.
Fordville: FoA, FoB2.	Slight [3]	Severe: rapid permeability at a depth of 24 to 40 inches.	Moderate: sidewall instability.	Slight: high bearing capacity; well drained.	Severe: rapid permeability in underlying material.	Moderate: moderate susceptibility to frost action above a depth of 24 to 40 inches, low susceptibility below.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to poor in subsoil; good in underlying material.	Good to fair: thickness of overburden ranges from 2 to 5 feet.	Fair: moderately fine textured; limited thickness of suitable material.	Permeability moderate to a depth of 2 to 5 feet and rapid below.	Medium to low shear strength; low permeability, and fair to good compaction in subsoil. Medium to high shear strength, high permeability, and good compaction in underlying material.	Well drained.	Moderate or high available water capacity; medium intake rate; sand and gravel at a depth of 2 to 5 feet.	Droughty and highly erodible in gravelly underlying material, if exposed; good slope pattern.
Fair to poor in subsoil; good in underlying material.	Fair to poor for sand.	Fair: limited thickness of suitable material; suitable texture.	Rapid permeability below a depth of 24 to 40 inches.	Medium to low shear strength and permeability in subsoil. Medium shear strength, medium to high permeability, and susceptibility to piping in underlying material.	Well drained.	Moderate available water capacity; medium intake rate; sand at a depth of 24 to 40 inches.	Droughty and highly erodible in sandy underlying material, if exposed; good slope pattern.
Poor: seasonal high water table.	Unsuited: no sand or gravel.	Poor: poorly drained.	Moderate permeability; seasonal high water table.	Medium to low shear strength; low permeability; fair compaction.	Seasonal high water table; moderate permeability; natural surface drainage normally adequate; needs subsurface drainage for best growth.	High available water capacity; medium intake rate; seasonal high water table above a depth of 2 feet.	Not needed.
Fair in subsoil; good in underlying layers.	Good to fair: thickness of overburden ranges from 24 to 40 inches.	Fair: limited thickness of suitable material; suitable texture.	Rapid permeability below a depth of 24 to 40 inches.	Medium to low shear strength and fair compaction in subsoil; medium to high shear strength, high permeability, and good compaction in underlying layers.	Well drained.	Moderate or low available water capacity; medium intake rate; sand and gravel at a depth of 24 to 40 inches.	Droughty and highly erodible in gravelly underlying material, if exposed; fair slope pattern.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Gravel pit: Gp. No interpretations given; severe limitations for most uses.						
Hidewood: Hd	Severe: seasonal high water table for an extended period.	Severe: seasonal high water table at a depth of less than 2 feet.	Severe: seasonal high water table above a depth of 2 feet.	Severe: somewhat poorly drained; medium to high bearing capacity where drained.	Severe: seasonal high water table.	Severe: high susceptibility to frost action; somewhat poorly drained.
*Ihlen: IhA, IhB, IrB. For Rock outcrop part of IrB, see Rock outcrop.	Severe: bedrock at a depth of less than 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of less than 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of less than 40 inches.	Moderate: bedrock at a depth of 20 to 40 inches; moderate susceptibility to frost action.
Kranzburg: KrA, KrB, KrB2.	Slight	Moderate: moderate permeability; moderate in areas where slopes are more than 2 percent.	Slight in most places; severe in some areas of dense till.	Moderate in most areas; moderate shrink-swell potential; high bearing capacity; [4] severe in some areas of dense till; high shrink-swell potential; well drained.	Moderate: workability.	Moderate: fine grained; moderate susceptibility to frost action.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to poor: seasonal high water table; moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: somewhat poorly drained; moderately fine textured.	Moderate permeability; seasonal high water table.	Medium to low shear strength and susceptibility to piping; medium compressibility.	Seasonal high water table; moderate permeability; natural surface drainage normally adequate; needs subsurface drainage for best growth.	High available water capacity; medium intake rate; seasonal high water table above a depth of 2 feet.	Not needed.
Poor: rock outcrop; bedrock at a depth of 20 to 40 inches.	Unsuited: no sand or gravel.	Fair: moderately fine textured; rock outcrop in some places.	Moderately rapid permeability above a depth of 20 to 40 inches over fractured bedrock.	Medium to low shear strength; low permeability; fair to good compaction characteristics.	Well drained.	Moderate or low available water capacity; medium intake rate; bedrock at a depth of 20 to 40 inches.	Terrace lines need careful checking to avoid rock outcrops and underlying bedrock; good slope pattern.
Fair to poor in subsoil; fair in underlying layers.	Unsuited: no sand or gravel.	Fair: moderately fine textured; limited thickness of suitable material.	Moderate permeability; poor storage potential in most places.	Medium to low shear strength; low permeability; medium compressibility; low to medium susceptibility to piping; fair to good compaction characteristics.	Well drained.	High available water capacity; medium intake rate; slight to moderate erosion hazard.	Soil features favorable; good slope pattern.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
*Lamoure: La, Lb, Lc. For La Prairie part of Lc, see La Prairie series.	Severe: flooding; seasonal high water table for an extended period.	Severe: flooding; seasonal high water table at a depth of less than 2 feet.	Severe: flooding; seasonal high water table at a depth of 2 feet.	Severe: flooding; poorly drained.	Severe: occasional or frequent flooding; seasonal high water table.	Severe: flooding; poorly drained; moderate to high susceptibility to frost action.
La Prairie: Lp	Severe: flooding; seasonal high water table for a short period.	Severe: flooding.	Severe: flooding; seasonal high water table at a depth of 2 to 5 feet.	Severe: flooding; seasonal high water table at a depth of less than 5 feet.	Severe: flooding; seasonal high water table.	Severe: flooding; moderate to high susceptibility to frost action.
Lismore: LsA	Moderate: seasonal high water table for a short period.	Moderate: moderate permeability; high organic-matter content; seasonal high water table.	Moderate: seasonal high water table at a depth of 2 to 5 feet.	Moderate: moderately well drained; moderate shrink-swell potential; medium to high bearing capacity.[4]	Severe: seasonal high water table.	Moderate: fine grained; moderate to high susceptibility to frost action.
Marsh: Ma. No interpretations given; severe limitations for most uses.						
Moody: MoA, MoB, MoB2.	Slight	Moderate: moderate permeability; moderate in areas where slopes are more than 2 percent.	Slight	Slight: low to moderate shrink-swell potential; well drained; medium to high bearing capacity.	Slight	Moderate: fine grained; moderate susceptibility to frost action.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor above a depth of 2½ feet; fair to poor in lower layers; seasonal high water table.	Unsuited: no sand or gravel.	Poor: poorly drained; thick, moderately fine textured surface layer.	Moderate permeability; seasonal high water table; flooding.	Material above a depth of 2½ feet suitable for low embankment; material below has medium to low shear strength; medium compressibility; fair compaction.	Seasonal high water table; occasional or frequent flooding; natural drainage normally adequate; needs subsurface drainage for assured growth; good outlets not available in many areas.	Very high or high available water capacity; medium intake rate; occasional or frequent flooding; seasonal high water table above a depth of 2 feet.	Not needed.
Poor above a depth of 2 feet; fair to poor in underlying layers.	Unsuited: no sand or gravel.	Good: thick surface layer.	Moderate permeability; flooding.	Thick surface layer; high organic-matter content and high compressibility in surface layer; suitable for temporary impoundment.	Moderately well drained; occasional flooding.	High or very high available water capacity; medium intake rate; occasional overflow; moderately well drained.	Not needed.
Fair: moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair: moderately fine textured.	Moderate permeability; poor storage potential in most places.	Medium to low shear strength; low permeability; fair to good compaction.	Moderately well drained.	High available water capacity; medium intake rate; moderately well drained.	Moderately well drained; slight grade essential; good slope pattern.
Fair: moderate susceptibility to frost action; low to moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair: moderately fine textured; thin and eroded in some areas.	Moderate permeability; poor storage potential in most places.	Medium to low shear strength and permeability; medium susceptibility to piping; fair compaction characteristics.	Well drained.	High or very high available water capacity; medium intake rate; slight to moderate erosion hazard.	Soil features favorable; good slope pattern.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Quam: Qu	Severe: seasonal high water table for an extended period; ponding.	Severe: ponding; seasonal high water table at or near surface.	Severe: seasonal high water table at or near surface; ponding.	Severe: very poorly drained; ponding.	Severe: seasonal high water table; ponding.	Severe: very poorly drained; high susceptibility to frost action; ponding.
Rauville: Ra	Severe: flooding; seasonal high water table for an extended period.	Severe: flooding; seasonal high water table at or near surface.	Severe: flooding; seasonal high water table at or near surface.	Severe: flooding; seasonal high water table at or near surface.	Severe: flooding; seasonal high water table.	Severe: flooding; high susceptibility to frost action; very poorly drained.
*Renshaw: ReA, ReB, RnB2 For Vienna and Buse parts of RnB2, see their respective series.	Slight [3]	Severe: rapid permeability at a depth of 12 to 24 inches.	Moderate: sidewall instability.	Slight	Severe: rapid permeability.	Slight
ReC, RnC2, ReD For Vienna and Buse parts of RnC2, see their respective series.	Moderate if slope is less than 15 percent. Severe if slope is more than 15 percent.[3]	Severe: slope; rapid permeability.	Severe: slope	Moderate if slope is less than 15 percent. Severe if slope is more than 15 percent.	Severe: rapid permeability.	Moderate if slope is less than 15 percent. Severe if slope is more than 15 percent.
*Rock outcrop: RoC. For Ihlen part of RoC, see Ihlen series.	Severe: shallow to rock.	Severe: shallow to rock.	Severe: shallow to rock.	Severe: shallow to rock.	Severe: shallow to rock.	Severe: shallow to rock.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor above a depth of 2 feet; deeper material poor to fair in underlying layers; moderate to high shrink-swell potential.	Unsuited: no sand or gravel.	Poor: very poorly drained.	Moderately slow permeability; seasonal high water table; ponding.	Medium to low shear strength; medium to high compressibility; fair compaction characteristics.	Seasonal high water table; moderately slow permeability; needs surface and subsurface drainage.	High available water capacity; slow intake rate; seasonal high water table at or near surface.	Not needed.
Poor: seasonal high water table; high organic-matter content above a depth of 2½ feet.	Unsuited: no sand or gravel.	Poor: very poorly drained; commonly waterlogged.	Moderate permeability; seasonal high water table; flooding.	High organic-matter content; seasonal high water table; high compressibility; not suitable for embankments.	Frequent flooding; seasonal high water table; needs surface and subsurface drainage; good outlets not available in most places.	Frequent flooding; seasonal high water table at or near surface; suitability for irrigation doubtful.	Not needed.
Fair to good in subsoil; good in underlying material.	Good to fair; desired material only a few feet thick in some places.	Fair: surface layer about 8 inches thick.	Rapid permeability.	Medium permeability above a depth of 2 feet; medium to high shear strength and rapid permeability in underlying sand and gravel.	Somewhat excessively drained.	Low available water capacity; rapid intake rate; sand and gravel at a depth of 1 to 2 feet.	Sand and gravel at a depth of 1 to 2 feet; droughty and erodible in terrace channel; fair slope pattern; low fertility; suitability doubtful.
Fair to good in subsoil; good in underlying material.	Good to fair: desired material only a few feet thick in some places.	Poor: very limited thickness of surface layer; slope.	Rapid permeability.	Medium permeability above a depth of 2 feet; medium to high shear strength and rapid permeability in underlying sand and gravel.	Somewhat excessively drained.	Low available water capacity; rapid intake rate; sand and gravel at a depth of 1 to 2 feet; severe erosion hazard.	Sand and gravel at a depth of 1 to 2 feet; droughty and erodible in terrace channel; suitability doubtful.
Poor: shallow to rock; limited thickness of materials.	Unsuited: no sand and gravel.	Poor: rocky; limited thickness of surface layer.	Shallow to rock.	Limited thickness of materials; shallow to rock.	Shallow to rock.	Shallow to rock; rocky.	Not needed.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Roliss Mapped only in undifferentiated group with Flom soils.	Severe: seasonal high water table for an extended period.	Severe: seasonal high water table at a depth of less than 2 feet.	Severe: seasonal high water table above a depth of 2 feet.	Severe: poorly drained; medium to high bearing capacity where drained.	Severe: seasonal high water table.	Severe: poorly drained soil; high susceptibility to frost action.
Sioux: SoE	Slight if slope is less than 8 percent. Moderate if slope is 8 to 15 percent. Severe if slope is more than 15 percent.[3]	Severe: rapid permeability.	Severe: sidewall instability.	Slight if slope is less than 8 percent. Moderate if slope is 8 to 15 percent. Severe if slope is more than 15 percent.	Severe: rapid permeability.	Slight if slope is less than 8 percent. Moderate if slope is 8 to 15 percent. Severe if slope is more than 15 percent.
Svea: SvA	Moderate: seasonal high water table for a short period.	Moderate: moderate permeability; high organic-matter content; seasonal high water table.	Moderate: seasonal high water table at a depth of 2 to 5 feet.	Moderate: moderately well drained; low to moderate shrink-swell potential.	Severe: seasonal high water table.	Moderate: susceptibility to frost action; fine grained.
Sverdrup: SwA, SwB.	Slight [3]	Severe: rapid permeability at a depth of less than 24 inches.	Severe: sidewall instability.	Slight	Severe: rapid permeability.	Slight

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Poor: seasonal high water table.	Unsuited: no sand and gravel.	Poor: poorly drained.	Moderate to moderately slow permeability; seasonal high water table.	Medium compressibility; low permeability; low to medium susceptibility to piping.	Seasonal high water table; natural surface drainage adequate in most places; subsurface drainage for best growth; high content of magnesium sulfate in some ground water.	High available water capacity; medium intake rate; seasonal high water table above a depth of 2 feet.	Not needed.
Good if slope is less than 15 percent. Fair if slope is 15 to 25 percent. Poor if slope is more than 25 percent.	Good: desired material only a few feet thick in some areas.	Poor: thin and gravelly surface layer.	Rapid permeability.	High shear strength; low compressibility; high permeability; good compaction.	Excessively drained.	Very low available water capacity; sand and gravel at a depth of less than 1 foot; suitability very doubtful.	Sand and gravel at a depth of less than 1 foot; droughty; low fertility; suitability very doubtful.
Fair: moderate susceptibility to frost action.	Unsuited: no sand or gravel.	Fair: moderately fine textured.	Moderate permeability; low storage potential in most sites.	Medium shear strength and compressibility; low permeability; fair compaction.	Moderately well drained.	High available water capacity; medium intake rate; moderately well drained.	Moderately well drained; slight grade essential; fair slope pattern; stones and boulders in some areas.
Good	Fair to poor for sand.	Fair: sandy surface layer; eroded and thin in some places.	Rapid permeability.	Medium shear strength; medium to high permeability and susceptibility to piping; fair to good compaction.	Somewhat excessively drained.	Low or moderate available water capacity; rapid intake rate; loamy sand and sand at a depth of 1 to 2 feet.	Loamy sand and sand at a depth of 1 to 2 feet; droughty and highly erodible in channel; fair to good slope pattern; low fertility.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Swenoda: SyA, SyB.	Slight	Moderate: moderate permeability; also moderate in areas where slopes are more than 2 percent.	Slight	Moderate: moderate shrink-swell potential; well drained.	Moderate: workability.	Moderate: moderate to high susceptibility to frost action; well drained.
Tonka: To	Severe: ponding; moderately slow or slow permeability; seasonal high water table for an extended period.	Severe: seasonal high water table at or near surface.	Severe: seasonal high water table at or near surface; fine textured.	Severe: poorly drained; ponding; moderate to high shrink-swell potential.	Severe: seasonal high water table.	Severe: poorly drained; moderate to high susceptibility to frost action.
Trent: TrA	Moderate: seasonal high water table for a short period.	Moderate: moderate permeability; high organic-matter content; seasonal high water table.	Moderate: seasonal high water table at a depth of 2 to 5 feet.	Moderate: moderately well drained; seasonal high water table below a depth of 2 to 5 feet; medium to high bearing capacity.[4]	Severe: seasonal high water table.	Moderate: fine-grained soil; moderate to high susceptibility to frost action.
Trosky: Ts	Severe: seasonal high water table for an extended period.[3]	Severe: rapid permeability below a depth of less than 40 inches; seasonal high water table at a depth of less than 2 feet.	Severe: seasonal high water table above a depth of 2 feet; sand and gravel below a depth of 24 to 40 inches.	Severe: poorly drained or somewhat poorly drained; high bearing capacity; low shrink-swell potential.	Severe: seasonal high water table; rapid permeability in underlying material.	Severe: poorly drained; moderate to high susceptibility to frost action above a depth of 24 to 40 inches; low susceptibility below.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair to good above a depth of 3 feet if mixed; fair below a depth of 3 feet.	Unsuited: fair to poor for sand in a few places.	Fair to good; limited thickness of suitable material.	Sandy above a depth of 40 inches; moderate permeability below a depth of 40 inches.	Medium shear strength and permeability to a depth of 40 inches if mixed and compacted; low permeability if compacted below a depth of 40 inches.	Well drained.	High available water capacity and medium intake rate above sandy subsoil at a depth of 2 to 3 feet; slight to moderate erosion hazard.	Sandy subsoil; subsoil droughty and highly erodible if exposed; good slope pattern.
Poor: seasonal high water table; moderate to high shrink-swell potential.	Unsuited: no sand or gravel.	Poor: poorly drained.	Moderate permeability below a depth of 4 feet; seasonal high water table.	Medium to low shear strength; high compressibility; low susceptibility to piping; fair to poor compaction.	Seasonal high water table; moderately slow or slow permeability; needs surface and subsurface drainage.	High available water capacity; slow intake rate; seasonal high water table at a depth of less than 2 feet.	Not needed.
Fair: moderate to high susceptibility to frost action; low to moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair: moderately fine textured.	Moderate permeability; storage potential in most places.	Medium to low shear strength and permeability; medium susceptibility to piping; fair compaction.	Moderately well drained.	High or very high available water capacity; medium intake rate; moderately well drained.	Moderately well drained; slight grade essential; good slope pattern.
Fair to poor in subsoil, good in underlying layers: seasonal high water table.	Good to fair: seasonal high water table; thickness of overburden ranges from 24 to 40 inches.	Fair to poor: poorly drained; moderately fine textured.	Moderate to moderately slow permeability; above a depth of 24 to 40 inches; rapid permeability below.	Medium to low shear strength and permeability in subsoil; high shear strength and permeability in underlying sand and gravel.	Seasonal high water table; occasional flooding in a few areas; natural surface drainage adequate in most places; needs subsurface drainage for best growth.	Moderate available water capacity; medium intake rate; seasonal high water table above a depth of 2 feet; sand and gravel at a depth of 24 to 40 inches.	Not needed.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill [1]	Local roads and streets
Vienna: VaC, VaC2	**Moderate: slope.**	**Severe: slope.**	**Moderate: slope.**	**Moderate: slope; moderate shrink-swell potential; high bearing capacity; [4] well drained.**	**Moderate: workability.**	**Moderate: slope; fine grained; moderate susceptibility to frost action; well drained.**
VbA, VbB, VbB2	**Slight**	**Moderate: moderate permeability.**	**Slight**	**Moderate: moderate shrink-swell potential; high bearing capacity; well drained.**	**Moderate: workability.**	**Moderate: fine grained; moderate susceptibility to frost action; well drained.**
Whitewood: Wh	**Severe: seasonal high water table for an extended period.**	**Severe: seasonal high water table at a depth of less than 2 feet.**	**Severe: seasonal high water table at a depth of less than 2 feet.**	**Severe: somewhat poorly drained; medium to high bearing capacity where drained.**	**Severe: seasonal high water table.**	**Severe: high susceptibility to frost action; somewhat poorly drained.**

[1] Onsite studies of the underlying strata, water table, and hazard of aquifer pollution need to be made for landfill deeper than 5 or 6 feet.

[2] The interpretations for road fill refer to material below the surface layer unless otherwise specified.

interpretations of the soils—Continued

Suitability as a source of—			Soil features affecting—				
Road fill [2]	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: moderately fine textured; limited thickness of suitable material; slopes.	Moderate permeability; low to moderate storage potential in most places.	Medium to low shear strength; low permeability; fair to good compaction characteristics.	Well drained.	High available water capacity; medium intake rate; severe erosion hazard.	Good slope pattern; some areas stony.
Fair: moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair: moderately fine textured; limited thickness of suitable material.	Moderate permeability; low storage potential in most places.	Medium to low shear strength; low permeability; fair to good compaction characteristics.	Well drained.	High available water capacity; medium intake rate; slight to moderate erosion hazard.	Good slope pattern; some areas stony.
Fair to poor; seasonal high water table; moderate shrink-swell potential.	Unsuited: no sand or gravel.	Fair to poor: somewhat poorly drained; moderately fine textured.	Moderate permeability; seasonal high water table.	Medium to low shear strength; low permeability; fair to good compaction characteristics.	Seasonal high water table; natural surface drainage in most places adequate; needs subsurface drainage for best growth.	High available water capacity; medium intake rate; seasonal high water table above a depth of 2 feet.	Not needed.

[3] Pollution of water supplies is a hazard in some places because of the rapid permeability of the underlying sand and gravel.

[4] The rating for bearing capacity is based on the assumption that the soil is at or below optimum moisture content.

plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material. Many pits have been dug in the poorly drained soils (fig. 15).

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

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

Irrigation of a soil (fig. 16) is affected by such factors as slope; susceptibility to stream overflow, water erosion, or soil blowing; texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

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

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 Pipestone County. The second explains the system of soil classification currently used and places each soil series in the classes of that system.

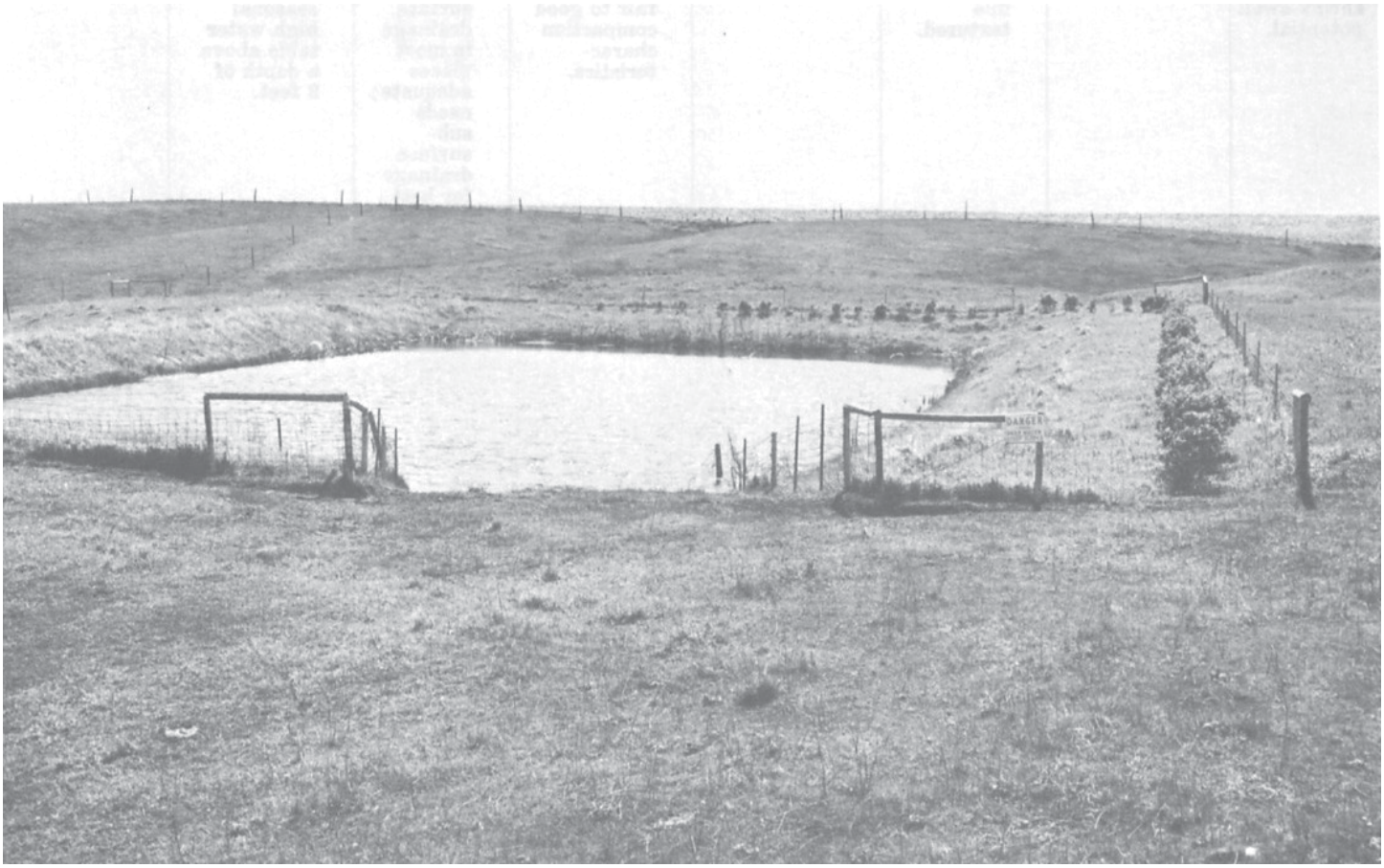

***Figure 15.*—Livestock pit on a Lamoure soil. Lamoure soils have a seasonal high water table and are subject to flooding.**

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 (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors in soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

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

Parent material

The soils of Pipestone County formed in a number of different kinds of parent material, all of glacial origin. The major parent materials in the county are loess, glacial till, glacial outwash, alluvium, and colluvium. The glacial till exposed in the county is from the Wisconsin Glaciation (*4*). In that glaciation there were several substages. Till from the Tazewell and Cary substages is present in the county. About 75 percent of the soils in the county formed in loess, about 15 percent formed in glacial till, and about 10 percent formed in other kinds of parent material. In the following paragraphs, the parent materials are discussed in the order of their deposition.

Glacial till, Tazewell substage.—This glacial till is the oldest in the county. It lies south and west of the Bemis moraine. Most of this till has been covered by loess. Where the loess is very thin or the till is exposed,

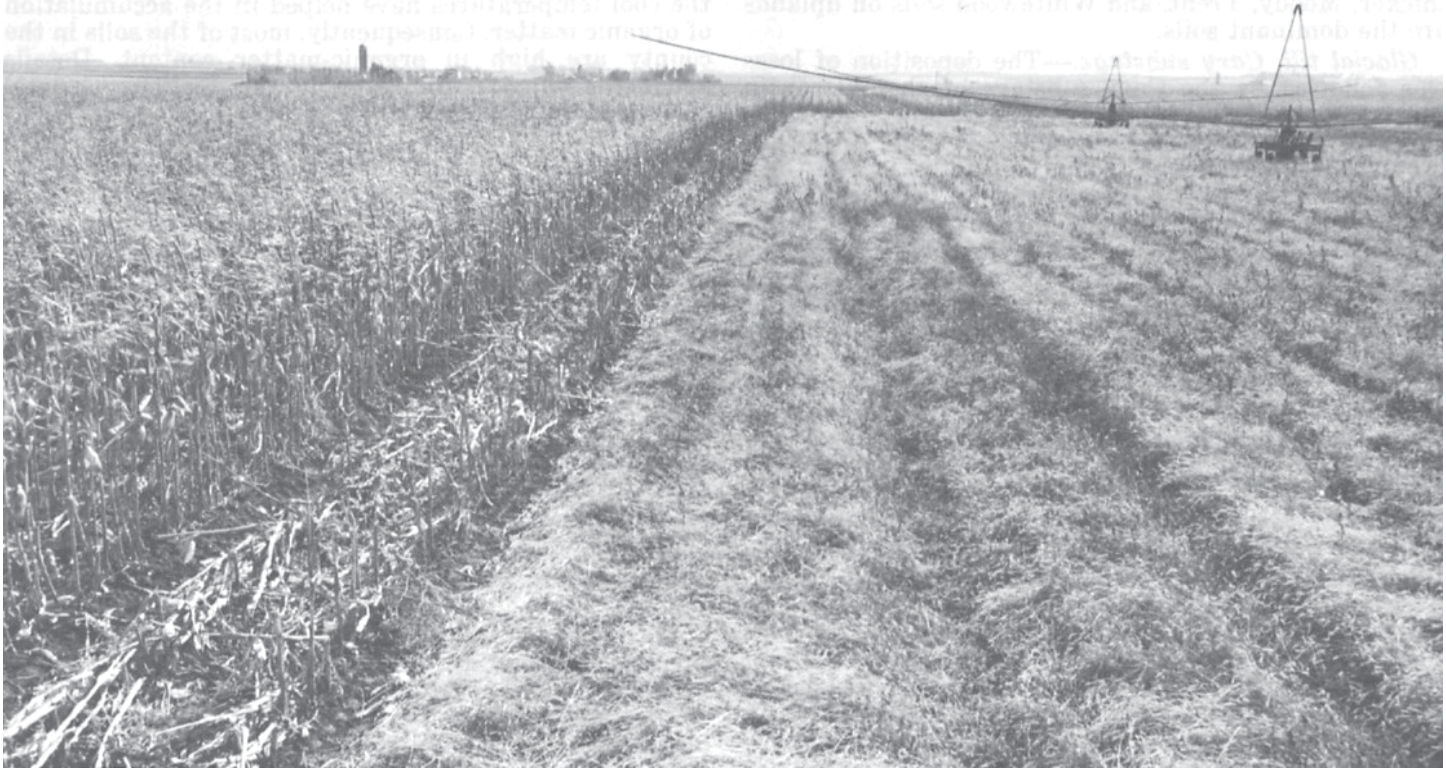

***Figure 16.*—Estelline soils are well suited to sprinkler irrigation.**

gently sloping Vienna soils or steeper Buse soils formed.

On the south side of the city of Pipestone, and in scattered places throughout the county, the Tazewell till is very firm, heavy clay loam. Its shrink-swell potential is high enough that the soils will move and crack basement walls. Septic tank drain fields work poorly because the till has slow permeability. Ground water moves slowly. Wells in this till have a low water yield.

Loess.—After the Tazewell substage of the Wisconsin Glaciation, the fine particles of glacial outwash sediments were blown off the flood plains and stream terraces of the valley of the Big Sioux River and were deposited on the glacial till plains. This silty material, called loess, is silty clay loam in texture. It is nearly homogeneous and does not have the stones and pebbles that are common in glacial till. The loess mantle is as thick as 40 inches in the Kranzburg-Vienna association; and the loess typically is 40 to 72 inches thick in the Moody-Trent-Whitewood association. It is somewhat thicker in level areas and is thinner in sloping areas. In most places a thin sandy, gravelly, or pebbly layer is present between the loess and the till. The deposition of loess tended to smooth and fill in irregularities in the surface of the glacial ground moraine. The slopes are longer, smoother, and more regular in the parts covered by loess than in the more recently glaciated northeastern part of the county that is not covered by loess. The major soils that formed where the loess is moderately thick are Kranzburg and Brookings soils on uplands and Estelline soils on stream terraces and outwash plains. Where the loess mantle is thicker, Moody, Trent, and Whitewood soils on uplands are the dominant soils.

Glacial till, Cary substage.—The deposition of loess was followed by the Cary substage of the Wisconsin Glaciation. In Pipestone County this includes the Bemis moraine (Barnes-Buse association) and the Cary ground moraine (Barnes-Flom association). The Cary till typically is loam or clay loam in texture. In the Bemis moraine, where the relief is more hilly and rolling, the till is loam. In some places the till has numerous pockets of silt. This silt may be post-Tazewell loess. Barnes, Buse, and associated soils formed in the till of the Bemis moraine. The Cary ground moraine is gently undulating. The till resembles loess in some places, but normally it is clay loam and has some stones in it. This silty till was probably left by the glacier that moved across the loess-mantled surface (*3*). Barnes, Flom, and Svea soils are the major soils on the Cary ground moraine.

Glacial outwash.—Outwash material consisting of sand and gravel has been deposited on stream terraces along most of the major streams in the county. Extensive deposits of outwash have been mapped along Rock River and Pipestone Creek. Less extensive areas of outwash are in pockets or in layers over the glacial till on uplands throughout the county. Soils that formed in outwash mostly have from 1 to 4 feet of silty clay loam or loam over the sand and gravel. Estelline, Renshaw, and Fordville soils are the principal soils. Outwash materials have been mapped in about 20 percent of the county.

Alluvium.— Alluvial material has been deposited along the streams in the county. These sediments in most places are many feet thick, dark colored, and calcareous. Their texture is medium and moderately fine. Lamoure, Rauville, and La Prairie soils formed in alluvial materials.

Colluvium.—In drainageways, on alluvial fans, and near the base of steeper slopes, colluvium has accumulated. Colluvial material is similar to alluvial material, but it generally is not calcareous. Darnen soils, which formed in colluvium, are moderately well drained. Hidewood, Whitewood, Flom, and Quam soils formed wholly or partly in colluvium in places and are more poorly drained.

Climate

Pipestone County has a subhumid, continental climate that is characterized by cold winters and hot summers. The climate has had a pronounced effect on soil formation. Freezing of the soil during winter slows the soil-forming processes. The alternate freezing and thawing, especially in spring, plays a part in the development of soil structure. Freezing and thawing also help to disintegrate parts of the glacial debris, and frost heaving helps to mix the soil material. Rainfall in the area has affected the leaching of lime. Thickness of the soil from which free lime has been leached has largely determined the thickness of the solum.

The climate of the county was responsible to a large degree for the native vegetation of grasses instead of trees. The grass vegetation has produced soils that have a dark-colored surface layer. The grass vegetation and the cool temperatures have helped in the accumulation of organic matter. Consequently, most of the soils in the county are high in organic-matter content. Details about the climate are given in the section "General Nature of the County."

Plants and animals

The growth of plants in the freshly deposited loess and in the glacial till was the start of soil formation in Pipestone County. Plant roots loosened the soil and brought minerals up from the parent material. The plants died and decayed, returning organic matter and plant nutrients to the soil. The native vegetation in this county consisted mainly of tall and mid prairie grasses, depending on the soil, the drainage, and other site factors.

Earthworms have also had a major influence on soil formation in Pipestone County. The subsurface horizon contains many worm casts filled with material from the surface layer and subsoil. Burrowing animals have also mixed the soil materials from the various horizons and have brought fresh parent material up to the surface.

Man has also influenced soil formation in Pipestone County. Farming has affected most of the soil-forming processes and has increased the action of some of them. Accelerated erosion of the surface layer has occurred on some of the sloping soils. Some of the lower lying soils have gained deposits of eroded material. The strong, granular structure has been weakened or destroyed in the surface layer of many of these soils. The

color of the surface layer of most of the well-drained soils has become browner as a result of mixing with the subsoil and reduction of the amount of organic matter. Leaching of many of the soils has been slowed as a result of increased runoff and reduced infiltration. Man's activities, particularly in altering the drainage condition, maintaining fertility, and changing the kinds of vegetation, continues to have an important effect upon the rate and direction of soil formation.

Relief

In Pipestone County relief ranges from nearly level to very steep. Relief is the most important factor in the development of different soils in uniform parent materials. Soils that have fairly mature soil profiles, in which the horizons are distinct, developed wherever drainage is good and the slope is gentle. Steep soils show little soil development mostly because they are subject to excessive runoff. Runoff reduces the amount of water that can leach the soil and the amount that plants can use. Many steep soils, therefore, are droughty, have indistinct horizons, and support a poor cover of plants.

Topographic position is a partial key to the kind of soil and the soil drainage class at any place on the landscape. For example, the location of Buse, Barnes, Svea, Flom, and Quam soils, which make up the Barnes drainage sequence, can be predicted in a general way. Each of these soils is on a particular part of the landscape. The excessively drained, steep Buse soils are on convex side slopes; the well-drained, gently undulating Barnes soils are on more gentle slopes and on hilltops; the moderately well drained, nearly level Svea soils are at lower elevations than Barnes soils or in slightly concave, nearly level areas surrounded by Barnes soils; the poorly drained Flom soils are in drainageways and on nearly level wet flats; and the very poorly drained Quam soils are in closed depressions and very wet drainageways.

Time

The time required for soil formation depends to a large extent on the other factors. Wherever favorable relief and drainage exist in Pipestone County, there has been enough time for soils to develop mature profiles. The steep soils have immature or thin profiles because the soil-forming processes there have not been effective. Soils in alluvium along the streams are immature or weakly developed because the material is young. Fresh deposits are added to the alluvium almost annually; and distinct, mature horizons have not had time to form.

In the geological sense, all of the soil materials in the county are very young. The oldest soil materials are in the loess-covered parts of the county, and they are at least 15,000 to 25,000 years old. In the most recently glaciated part of the county, soil-forming processes have been active for only about 8,000 to 15,000 years.

Classification of the Soils

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

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

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

The current system of classification has six categories. Beginning with broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Pipestone County are placed in three categories of the current system. Some classes of the current system are briefly defined in the following paragraphs.

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

SUBORDER: Each order is subdivided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu,* meaning water or wet, and *oll,* from *Mollisol*).

GREAT GROUP: Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequences of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of

[6] UNITED STATES DEPARTMENT OF AGRICULTURE. SOIL TAXONOMY OF THE NATIONAL COOPERATIVE SOIL SURVEY. [Unpublished]

TABLE 8.—*Classification of soils series*

Series	Family	Subgroup	Order
Athelwold [1]	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Barnes	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Brookings	Fine-silty, mixed	Pachic Udic Haploborolls	Mollisols.
Buse	Fine-loamy, mixed	Udorthentic Haploborolls	Mollisols.
Darnen	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Estelline [2]	Fine-silty over sandy or sandy-skeletal, mixed	Pachic Udic Haploborolls	Mollisols.
Flandreau	Fine-loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Flom	Fine-loamy, mixed, frigid	Typic Haplaquolls	Mollisols.
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed	Pachic Udic Haploborolls	Mollisols.
Hidewood	Fine-silty, mixed, frigid	Typic Haplaquolls	Mollisols.
Ihlen	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Kranzburg	Fine-silty, mixed	Udic Haploborolls	Mollisols.
Lamoure	Fine-silty, mixed, (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
La Prairie	Fine-loamy, mixed	Cumulic Udic Haploborolls	Mollisols.
Lismore	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Moody [3]	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Quam	Fine-silty, mixed, frigid	Cumulic Haplaquolls	Mollisols.
Rauville	Fine-silty, mixed, (calcareous), frigid	Cumulic Haplaquolls	Mollisols.
Renshaw	Fine-loamy over sandy or sandy-skeletal, mixed	Udic Haploborolls	Mollisols.
Roliss	Fine-loamy, mixed, (calcareous), frigid	Typic Haplaquolls	Mollisols.
Sioux	Sandy-skeletal, mixed	Udorthentic Haploborolls	Mollisols.
Svea	Fine-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Sverdrup	Sandy, mixed	Udic Haploborolls	Mollisols.
Swenoda [4]	Coarse-loamy, mixed	Pachic Udic Haploborolls	Mollisols.
Tonka	Fine, montmorillonitic, frigid	Argiaquic Argialbolls	Mollisols.
Trent	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Trosky	Fine-silty over sandy or sandy-skeletal, mixed, (calcareous), frigid.	Typic Haplaquolls	Mollisols.
Vienna	Fine-loamy, mixed	Udic Haploborolls	Mollisols.
Whitewood	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.

[1] These soils are taxadjuncts to the Athelwold series because Athelwold soils, as mapped in Pipestone County, typically are 30 to 40 inches deep to sand and gravel. Soils that are underlain by sand and gravel at a depth of 40 to 48 inches are within the defined range of the Athelwold series.

[2] The soils mapped as Estelline soils that have 2 to 6 percent slopes are taxadjuncts to the Estelline series because they have a mollic epipedon that is too thin for the soils to be pachic. Soils mapped as Estelline silty clay loam, deep, are taxadjuncts to the Estelline series because these soils are typically more than 40 inches deep to sand and gravel.

[3] The soils mapped as Moody soils that have 3 to 6 percent slopes include soils that are either too thin or too light colored to be mollic and are therefore taxadjuncts to the Moody series.

[4] These soils are taxadjuncts to the Swenoda series because Swenoda soils, as mapped in Pipestone County, typically are well drained rather than moderately well drained, as is defined for the series.

great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is *Haplaquoll* (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *oll,* from Mollisols).

SUBGROUP: Great groups are 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 name of the great group. An example is *Typic Haplaquoll* (a typical Haplaquoll).

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae, (see table 8). An example is the fine-loamy, mixed, (calcareous) frigid family of Typic Haplaquolls.

General Nature of the County

In this section the physiography, relief, and drainage of Pipestone County are discussed. Information is also given about climate, history and development, transportation and markets, farming, and water supply.

Physiography, Relief, and Drainage

The elevation of Pipestone County is among the highest in Minnesota. Only in the southeastern part, where the Rock River flows out of the county, is the elevation less than 1,600 feet. The highest area in the county—about 1,950 feet—is along the Bemis moraine, which is a ridge that crosses the northeastern part of the county from northwest to southeast.

From the top of the Bemis moraine to the northeastern corner of the county, the elevation drops about 250 feet in 5 miles. From the top of the moraine to the southwestern corner of the county the elevation drops only about 325 feet in about 25 miles. The gradual descent is due to the elevation of the underlying Sioux quartzite bedrock. The elevation in the southwestern corner of the county is about 1,600 feet, and in the northeastern corner about 1,700 feet.

The area northeast of the moraine is gently undulating. Slopes are short and irregular, and closed depressions are common. The soils formed in glacial till. South and west of the moraine are broad ridgetops and long side slopes that end in drainageways. There are no closed depressions. Loess has filled the irregularities of the glacial till plain.

The crest of the Bemis moraine forms the divide between the Mississippi and Missouri River basins. Water flows into the Redwood and Des Moines Rivers on the northeastern side and into Flandreau Creek and Rock River on the southwestern side. The Rock River flows south in a wide valley along the eastern side of the county. Just before it leaves the county it is joined by Chanarambie Creek from the east. Flandreau, Pipestone, and Split Rock Creeks drain the western half of the county. They all flow southwest.

In most of the county, Sioux quartzite is directly under the till or loess. It crops out in many places from Jasper in the southwestern part of the county to about 1 mile north of the National Monument near the center of the county.

Climate[7]

The location of Pipestone County, near the center of the North American Continent, is the chief factor that influences its climate. In summer the sun shines for long periods at a high altitude. Southerly winds bring warm, moist air from the Gulf of Mexico; consequently, the greatest precipitation is in summer. In winter the climate cools rapidly because solar insolation is reduced and the prevailing winds are northerly. Because the airmasses are relatively dry, winter is the season of least precipitation. As the county has no sharply marked differences in topography, the climate is quite uniform.

Approximately 78 percent of the annual precipitation, or almost 19.9 inches, falls in April through September. Measurable precipitation of 0.01 inch can be expected on about 100 days per year, 5 of which will have 1 inch or more. About 1½ inches of rain per hour can be expected to fall once in 2 years. Annual precipitation ranged from 14.28 inches in 1910 to 35.45 inches in 1942. The greatest at Pipestone in any month was 10.85 inches in May of 1942. An average of about 42 thunderstorms occur each year. Some are accompanied by hail and damaging winds. During the period 1916–71, 10 tornadoes were reported in Pipestone County. Precipitation data are given in table 9.

Periods of drought occur whenever the supply of water for crops becomes inadequate. Each day in which moisture in the root zone is inadequate is defined as a drought day. Severe drought conditions occurred in 7 of the years between 1931 and 1970 in southwestern Minnesota; 1931 and 1934 were the worst, and other severe drought years were 1933, 1940, 1955, 1956, and 1959.

The first measurable snowfall is about the middle of October in 2 years in 10, and the last snowfall is in April or later in 3 years out of 10. The average annual snowfall is 35.5 inches. The extreme seasonal snowfall since 1935 ranged from 4.5 inches in 1967–68 to 59.9 inches in 1945–46. Information on snow cover and average depths is given in table 9.

The average temperature in December, January, and February is 16.1° F. One of the coldest winters was during 1935–36, when the average temperature was 6.1°. Most winters will have 4 or 5 days with a temperature of –20° or lower.

[7] By EARL L. KUEHNAST, climatologist for Minnesota, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation data*

[All data from Pipestone; period of record, 1941–70]

Month	Temperature					Precipitation			
	Daily high	Daily low	Monthly high	Monthly low	Average total	One year in 10 will have [1]—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	In	In	In	Number	In
January	21.7	1.0	43	−21	0.48	0.08	1.22	25	4
February	26.9	5.8	47	−16	.79	.09	1.68	22	8
March	37.0	16.7	60	− 4	1.24	.12	2.31	17	11
April	55.1	31.6	80	18	2.21	.66	3.96	2	1
May	68.1	43.7	88	27	3.60	1.28	6.50	([2])	0
June	77.3	54.5	92	40	4.62	2.00	6.37	0	0
July	83.7	59.0	96	48	3.35	1.08	6.01	0	0
August	82.5	57.8	95	44	2.96	1.26	5.34	0	0
September	71.6	46.4	89	31	3.20	.78	5.79	0	0
October	61.1	35.9	82	20	1.73	.29	3.52	([2])	0
November	41.4	20.8	64	− 1	.80	.11	2.21	4	1
December	27.4	8.3	47	−13	.64	.08	1.31	18	4
Year	54.4	31.8	[3]98	[4]−23	25.62	18.57	31.34	88	

[1] Based on period 1888–1970.
[2] Less than one-half day.
[3] Average annual highest temperature.
[4] Average annual lowest temperature.

The average temperature in June, July, and August is 69.6°. The daily high ranges from the midseventies to the mideighties, and the daily low ranges from the midfifties to the midsixties. Temperatures of 100° or higher occur about 1 year in 3, and temperatures of 90° or higher occur about 18 times a year.

The wide range of temperatures to be expected is shown in table 9. These columns show the probability of very high and very low temperatures. The highest recorded temperature was 108° on August 4, 1930; May 31, 1934; and July 6 and 16, 1936. The lowest recorded temperature was –40° on January 12, 1912.

The freeze-free period is long enough for the staple crops of the county to reach maturity. The probability of certain temperatures occurring in spring and in fall is shown in table 10 (*2*). For example, 5 years out of 10, or in 50 percent of the years, in spring a temperature of 32° or lower can be expected after May 10. In fall the probability is 50 percent that a temperature of 32° will occur by September 30.

Long-term records of humidity, cloudiness, and winds are available from Sioux Falls, South Dakota. The average windspeed and the prevailing direction in winter is 11 miles per hour from the northwest, and in summer it is 10 miles per hour from the south. Humidity at noon averages 55 percent in summer and 63 percent in winter. An average of 104 clear days, 105 partly cloudy days, and 156 cloudy days will occur each year.

History and Development

Pipestone County was created in 1857. Permanent settlements, however, were not made until 1874. The population increased significantly in the late 1870's, 1880's, and 1890's. The population was 2,092 in 1880, 9,264 in 1900, and 14,003 in 1950. By 1970 it had decreased to 12,791. At present the population is largely of Scandinavian, German, and Dutch descent.

Eight incorporated villages are in the county—Edgerton, Hatfield, Holland, Ihlen, Jasper, Ruthton, Trosky, and Woodstock. In 1970 Pipestone, the county seat, had a population of 5,328.

Transportation and Markets

One railway crosses the county from northeast to southwest and serves Ruthton, Holland, Pipestone, Ihlen, and Jasper. Another railway crosses the county from west to southeast and serves Pipestone, Hatfield, and Edgerton.

The major highways are either paved or blacktopped. U.S. Highway No. 75 crosses the county from north to south. Minnesota Highway No. 23 crosses the county from northeast to southwest, and Minnesota Highway No. 30 crosses the county from east to west. Minnesota Highways No. 268 and No. 269 serve parts of the county. Graveled county and township roads serve every farm. About 100 miles of county roads has been blacktopped, and additional miles are completed each year.

Livestock generally are taken by truck to Sioux Falls, Sioux City, or South St. Paul. Most of the milk is marketed as whole milk and picked up daily by truck. Grain elevators are in Pipestone and in most of the villages.

Farming

Farming in Pipestone County is based on cash crops, on beef cattle and hogs, and dairying.

TABLE 10.—*Probabilities of last freezing temperature in spring and first in fall, Pipestone County, Minnesota (2)*

[Data from Pipestone]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 12	April 22	May 4	May 18	May 23
2 years in 10 later than	April 7	April 17	April 29	May 12	May 19
5 years in 10 later than	March 28	April 8	April 20	May 2	May 10
Fall:					
1 year in 10 earlier than	October 25	October 15	September 29	September 21	September 14
2 years in 10 earlier than	October 30	October 20	October 6	September 27	September 19
5 years in 10 earlier than	November 9	October 29	October 18	October 8	September 30

Corn for sale and feed is the principal crop. The acreage of soybeans has increased significantly since 1944. The acreage of oats, the second most important crop, is about one-third less than that in 1949, but the acreage of flax has remained fairly stable. The acreage of alfalfa has increased about one-third since 1949.

In 1969, 83,523 acres was in corn, 39,219 acres in oats, 12,808 acres in flax, 10,613 acres in soybeans, 20,257 acres in alfalfa, and 5,277 acres in other hay crops.

The number of cattle and calves raised for beef has increased greatly since 1950. The number of hogs and pigs has stayed fairly constant. There are presently two-thirds fewer sheep than in 1950 and about one-third fewer milk cows.

According to the 1969 census, 1,307 farms were in the county in 1954 and 934 in 1969. Most of the land, however, was bought or rented by farmers living close by and is still in use. The average size of farms was about 223 acres in 1954 and 295 acres in 1969.

Water Supply

Water for domestic use on farms is drawn from two sources, the deposits of glacial till and alluvium and the quartzite or red rock (7). The quantity of water produced in the glacial deposits varies with the thickness of the drift, the presence of sandy or gravelly strata, and the position of the underlying quartzite. Where the quartzite surface projects above the general ground level, the water in the drift is more plentiful than elsewhere because of greater recharge down the slope of the quartzite. All of the water in the till is highly mineralized and hard. The softest water is obtained in the thin deposits of alluvium that rest directly on the quartzite.

Because it contains numerous fractures, the quartzite yields some water almost everywhere, and in some areas it is the only reliable source of water. The depth necessary to drill to get an adequate supply of water is determined to a large extent by chance; it depends on whether the well passes through compact and unbroken rock or through many crevices. Where the rain enters the rock directly, the water remains soft because the quartzite is largely insoluble. In most places, however, the rock is covered by a layer of loess or till, and in percolating through this soil material the water becomes hard.

Although the water is not suitable for domestic use, many pits and ponds have been dug and built to provide water for livestock. The pits have been dug in bottom lands and in other low places. They intercept runoff and are partly filled by ground water. Farm ponds are built on intermittent streams and drainageways. Some are spring fed.

Irrigation could be used more if dependable and adequate water supplies were available. Many soils are well suited to irrigation. Almost every year some part of the county suffers from drought. Studies are needed to determine the location and extent of underground water.

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Glossary

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

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

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

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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.

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.

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.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are as much as 3 inches in diameter.

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.

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

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

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are these: Terminal, lateral, medial, ground.

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.

Nurse crop. A companion crop grown to protect some other crop sown with it.

Outwash, glacial (geology). Stratified drift deposited by meltwater streams beyond active glacier ice.

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

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

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

Plow planting. The plowing and planting of land in a single operation.

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 degree of acidity or alkalinity are expressed thus:

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

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

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the

silt textural class is 80 percent or more silt and less than 12 percent clay.

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.

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).

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 layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Generally is the A or A1 horizon.

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

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

Till, glacial. Nonsorted, nonstratified sediment deposited by a glacier.

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

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

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GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. A dash indicates that the mapping unit is not suited to range and was not placed in a range site. Other information is given in tables as follows:

Acreage and extent, table 1, page 9.
Average yields, table 2, page 47.
Performance ratings of shrubs and trees on soils, table 3, page 51.
Potential of soil associations for wildlife, table 4, page 54.
Use of soils for recreation, table 5, page 55.
Engineering uses of soils, tables 6 and 7, pages 58 through 81.

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Name	Page	Number	Page
At	Athelwold silty clay loam	9	IIs-1	41	Overflow	49	1	50
BaB	Barnes loam, 1 to 4 percent slopes	10	IIe-1	39	Silty	49	1	50
BaB2	Barnes loam, 3 to 6 percent slopes, eroded	10	IIe-1	39	Silty	49	1	50
BaC2	Barnes loam, 6 to 12 percent slopes, eroded	10	IIIe-1	42	Silty	49	1	50
BrA	Brookings silty clay loam, 0 to 3 percent slopes	11	I-1	39	Overflow	49	1	50
BuE	Buse loam, 18 to 25 percent slopes	12	VIe-1	43	Thin Upland	49	6	52
BuF	Buse loam, 25 to 40 percent slopes	12	VIIe-1	45	Thin Upland	49	6	52
BwC2	Buse-Barnes loams, 6 to 12 percent slopes, eroded	12	IIIe-1	42	Silty	49	--	--
	Buse soil	--	------	--	----------	--	5	52
	Barnes soil	--	------	--	----------	--	1	50
BwD	Buse-Barnes loams, 12 to 18 percent slopes	13	IVe-1	43	Thin Upland	49	6	52
BxD	Buse-Sioux complex, 12 to 18 percent slopes	13	VIe-2	44	----------	--	--	--
	Buse soil	--	------	--	Thin Upland	49	6	52
	Sioux soil	--	------	--	Very Shallow	50	8	52
BxE	Buse-Sioux complex, 18 to 40 percent slopes	13	VIIe-1	45	----------	--	--	--
	Buse soil	--	------	--	Thin Upland	49	6	52
	Sioux soil	--	------	--	Very Shallow	50	8	52
ByC	Buse-Vienna loams, 6 to 12 percent slopes	13	IIIe-1	42	Silty	49	--	--
	Buse soil	--	------	--	----------	--	5	52
	Vienna soil	--	------	--	----------	--	1	50
ByC2	Buse-Vienna loams, 6 to 12 percent slopes, eroded	13	IIIe-1	42	Silty	49	--	--
	Buse soil	--	------	--	----------	--	5	52
	Vienna soil	--	------	--	----------	--	1	50
ByD	Buse-Vienna loams, 12 to 18 percent slopes	13	IVe-1	43	Thin Upland	49	6	52
ByD2	Buse-Vienna loams, 12 to 18 percent slopes, eroded	14	IVe-1	43	Thin Upland	49	6	52
DaB	Darnen loam, 2 to 6 percent slopes	14	IIe-1	39	Overflow	49	1	50
EsA	Estelline silty clay loam, 0 to 2 percent slopes	16	IIs-1	41	Silty	49	7	52
EsB	Estelline silty clay loam, 2 to 6 percent slopes	16	IIe-2	40	Silty	49	7	52
EsB2	Estelline silty clay loam, 2 to 6 percent slopes, eroded	16	IIe-2	40	Silty	49	7	52
EtA	Estelline silty clay loam, deep, 0 to 2 percent slopes	17	I-1	39	Silty	49	1	50
FaA	Flandreau silt loam, 0 to 2 percent slopes	17	IIs-1	41	Silty	49	7	52
FaB	Flandreau silt loam, 2 to 6 percent slopes	18	IIe-2	40	Silty	49	7	52
FaB2	Flandreau silt loam, 2 to 6 percent slopes, eroded	18	IIe-2	40	Silty	49	7	52

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Name	Page	Number	Page
Fm	Flom and Roliss clay loams	18	IIw-1	40	Subirrigated	49	--	--
	Flom soil	--	------	--	----------	--	2	51
	Roliss soil	--	------	--	----------	--	3	51
FoA	Fordville loam, 0 to 2 percent slopes	19	IIs-1	41	Silty	49	7	52
FoB2	Fordville loam, 2 to 6 percent slopes, eroded	19	IIe-2	40	Silty	49	7	52
Gp	Gravel pit	20	------	--	----------	--	8	52
Hd	Hidewood silty clay loam	20	IIw-1	40	Subirrigated	49	2	51
IhA	Ihlen silty clay loam, 0 to 2 percent slopes	21	IIs-1	41	Silty	49	7	52
IhB	Ihlen silty clay loam, 2 to 6 percent slopes	21	IIs-1	41	Silty	49	7	52
IrB	Ihlen-Rock outcrop complex, 0 to 6 percent slopes	21	VIs-1	45	----------	--	8	52
	Ihlen soil	--	------	--	Silty	49	--	--
	Rock outcrop	--	------	--	Very Shallow	50	--	--
KrA	Kranzburg silty clay loam, 0 to 2 percent slopes	23	I-1	39	Silty	49	1	50
KrB	Kranzburg silty clay loam, 2 to 4 percent slopes	23	IIe-1	39	Silty	49	1	50
KrB2	Kranzburg silty clay loam, 3 to 6 percent slopes, eroded	23	IIe-1	39	Silty	49	1	50
La	Lamoure silty clay loam	24	IIw-3	41	Subirrigated	49	3	51
Lb	Lamoure silty clay loam, frequently flooded	24	VIw-1	44	Subirrigated	49	8	52
Lc	Lamoure and La Prairie soils, frequently flooded	24	VIw-1	44	----------	--	8	52
	Lamoure soil	--	------	--	Subirrigated	49	--	--
	La Prairie soil	--	------	--	Overflow	49	--	--
Lp	La Prairie loam	24	IIw-4	41	Overflow	49	1	50
LsA	Lismore silty clay loam, 0 to 3 percent slopes	25	I-1	39	Overflow	49	1	50
Ma	Marsh	25	VIIIw-1	46	----------	--	8	52
MoA	Moody silty clay loam, 0 to 2 percent slopes	26	I-1	39	Silty	49	1	50
MoB	Moody silty clay loam, 2 to 4 percent slopes	26	IIe-1	39	Silty	49	1	50
MoB2	Moody silty clay loam, 3 to 6 percent slopes, eroded	26	IIe-1	39	Silty	49	1	50
Qu	Quam silty clay loam	27	IIIw-1	42	Wetland	49	2	51
Ra	Rauville silty clay loam	28	VIw-2	45	Wetland	49	8	52
ReA	Renshaw loam, 0 to 2 percent slopes	28	IIIs-1	43	Shallow	50	4	52
ReB	Renshaw loam, 2 to 6 percent slopes	28	IIIe-2	42	Shallow	50	4	52
ReC	Renshaw loam, 6 to 12 percent slopes	29	IVe-2	43	Very Shallow	50	4	52
ReD	Renshaw loam, 12 to 18 percent slopes	29	VIe-2	44	Very Shallow	50	8	52
RnB2	Renshaw-Vienna-Buse loams, 2 to 6 percent slopes, eroded	29	IIIe-2	42	----------	--	--	--
	Renshaw soil	--	------	--	Shallow	50	4	52
	Vienna soil	--	------	--	Silty	49	1	50
	Buse soil	--	------	--	Silty	49	5	52
RnC2	Renshaw-Vienna-Buse loams, 6 to 12 percent slopes, eroded	29	IVe-2	43	----------	--	--	--
	Renshaw soil	--	------	--	Very Shallow	50	4	52
	Vienna soil	--	------	--	Silty	49	1	50
	Buse soil	--	------	--	Silty	49	5	52

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Name	Page	Number	Page
RoC	Rock outcrop-Ihlen complex, 6 to 12 percent slopes	30	VIIs-1	46	----------	--	8	52
	Rock outcrop	--	------	--	Very Shallow	50	--	--
	Ihlen soil	--	------	--	Silty	49	--	--
SoE	Sioux gravelly loamy coarse sand, 2 to 40 percent slopes	31	VIIs-1	46	Very Shallow	50	8	52
SvA	Svea clay loam, 0 to 3 percent slopes	32	I-1	39	Overflow	49	1	50
SwA	Sverdrup fine sandy loam, 0 to 2 percent slopes	32	IIIs-1	43	Shallow	50	4	52
SwB	Sverdrup fine sandy loam, 2 to 6 percent slopes	33	IIIe-2	42	Shallow	50	4	52
SyA	Swenoda loam, 0 to 2 percent slopes	33	IIs-1	41	Silty	49	1	50
SyB	Swenoda loam, 2 to 6 percent slopes	34	IIe-2	40	Silty	49	1	50
To	Tonka silt loam	34	IIIw-1	42	Wetland	49	2	51
TrA	Trent silty clay loam, 0 to 3 percent slopes	35	I-1	39	Overflow	49	1	50
Ts	Trosky silty clay loam	36	IIw-2	41	Subirrigated	49	3	51
VaC	Vienna loam, 6 to 12 percent slopes	36	IIIe-1	42	Silty	49	1	50
VaC2	Vienna loam, 6 to 12 percent slopes, eroded	36	IIIe-1	42	Silty	49	1	50
VbA	Vienna silty clay loam, 0 to 2 percent slopes	37	I-1	39	Silty	49	1	50
VbB	Vienna silty clay loam, 2 to 4 percent slopes	37	IIe-1	39	Silty	49	1	50
VbB2	Vienna silty clay loam, 3 to 6 percent slopes, eroded	37	IIe-1	39	Silty	49	1	50
Wh	Whitewood silty clay loam	38	IIw-1	40	Subirrigated	49	2	51

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