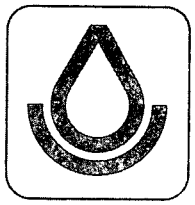
SOIL SURVEY OF

Hughes County, South Dakota



United States Department of Agriculture
Soil Conservation Service

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

Major fieldwork for this soil survey was done in the period 1966–70. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs, and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Hughes County Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Hughes 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.

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

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

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

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

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

Recreation planners and others can find information about the use of soils for recreation in the section "Recreation."

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

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

Newcomers in Hughes 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."

Contents

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SOIL SURVEY OF HUGHES COUNTY, SOUTH DAKOTA

BY MILES W. SMALLEY, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY MILES W. SMALLEY, GARY DELANEY, W. H. DITTEMORE, JAMES DRIESSEN, FRANCIS GLATT DENNIS HEIL, LYLE PASCHKE, AND ROBERT F. SPRINGER[1]

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

HUGHES COUNTY is in the center of South Dakota (fig. 1). It covers an area of 501,760 acres, of

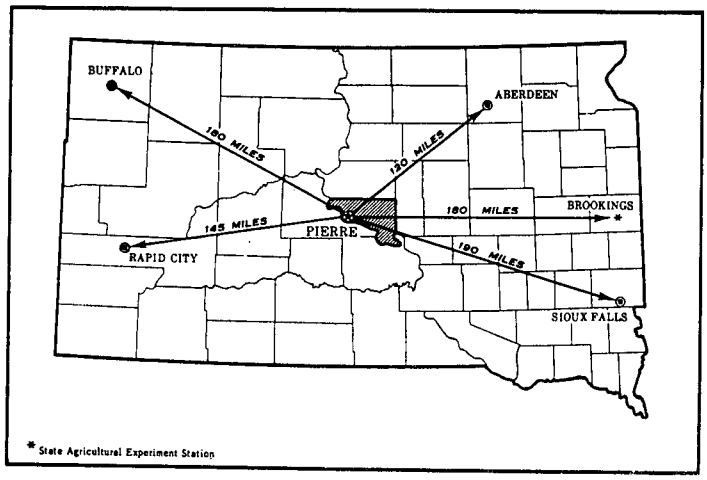

Figure 1.—Location of Hughes County in South Dakota.

which about 23,360 acres is water—Lake Oahe, Lake Sharpe, and the Missouri River. Pierre, which had a population of 9,699 in 1970 (*9*),[2] is the county seat and also is the State capital. Other towns in the county are Blunt and Harrold.

About 72,000 acres is within the Crow Creek Indian Reservation. Of this acreage, about 24,000 acres is allotted and tribal Indian land and Federal land administered by the Bureau of Indian Affairs. Patented land owned by non-Indians is intermingled with Indian land throughout the reservation area.

Hughes County is a part of the Missouri Coteau in the Great Plains physiographic province (*2*, *3*). The relief is mainly nearly level to sloping, but it becomes steeper along the Missouri River and the larger creeks and drainageways. All of the county is drained by the Missouri River.

Raising of livestock is the main farm enterprise. About 44 percent of the county is cropped, much of which is used for growing feed and forage crops for livestock. Growing wheat for cash income also is an important part of the economy. Principal crops are corn, spring wheat, alfalfa, oats, and winter wheat. Other crops are sorghum, barley, rye, and flax. About 53 percent of the county is in native grass used for grazing and hay. The rest is used for miscellaneous purposes, including tame pasture.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Hughes 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 nature of streams, the kinds of native plants or crops, the kinds of rock and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, 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. Agar and Highmore, for example, are the names of two soil series. All the soils in the United States having the same series

[1] Others who contributed to the soil survey are CLIFF PETERS and RONALD F. PETERSON, Bureau of Indian Affairs (Missouri River Basin Investigations).

[2] Italic numbers in parentheses refer to Literature Cited, page 102.

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 is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Lowry silt loam, 0 to 2 percent slopes, is one of several phases within the Lowry 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 other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Hughes County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled 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. Durrstein-Egas complex 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." Raber and Oko stony soils, 3 to 15 percent slopes, is an undifferentiated group in Hughes 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. Rough broken land is a land type in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same 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 medium for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to slow permeability or a high water table. They see that streets, road pavements, and foundations for houses crack on a given kind of soil, and they relate this failure to a high shrink-swell potential. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability for 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 study 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 Hughes 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 guide in managing a watershed, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The ten soil associations in this survey have been grouped into four general kinds of landscapes for broad interpretative purposes. Each of the broad groups and their included soil associations are described in the following paragraphs. The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of the Cavo-Raber-Demky association, the words "loamy" and "silty" refer to the texture of the surface layers.

Silty and Loamy Soils That Formed in Loess and Alluvium on Terraces and Uplands

The major soils in this group of soil associations are deep soils that formed in silty loess and loamy alluvium and loamy soils that are moderately deep over sand and gravel. These soils are mostly nearly level and gently sloping. They are medium in fertility and have high or moderate available water capacity. Risks of erosion and soil blowing are slight or moderate. Most areas are cultivated. Most of the irrigated acreage in the county consists of the major soils in this group. Growing crops for cash income and livestock feed are the main farm enterprises.

1. Lowry-Agar association

Nearly level to gently sloping, well-drained silty soils that formed in loess on uplands and terraces

This soil association is on uplands and terraces adjacent to or within a few miles of Lake Oahe and Lake Sharpe. It is dominantly nearly level and gently sloping. Slopes are long and smooth. Steeper slopes are along some of the larger drainageways. Scattered, small, closed depressions occur throughout some areas, but otherwise the drainage pattern is well defined.

This association makes up about 10 percent of the county. It is about 40 percent Lowry soils, 25 percent Agar soils, and 35 percent other soils and water areas.

Lowry soils are on different levels of the terraces and on uplands. They have a surface layer of dark grayish-brown silt loam. The subsoil is dark grayish-brown and grayish-brown silt loam. The underlying material is calcareous, pale-brown and light brownish-gray silt loam and loam.

Agar soils are on uplands and some of the higher terraces. They have a surface layer of dark-gray silt loam. The subsoil is dark grayish-brown and grayish-brown silty clay loam in the upper part and calcareous, pale-brown silt loam in the lower part.

Less extensive in this association are Dorna and Millboro soils on some of the terraces, Eakin soils on rises in areas of Agar soils, Hoven soils in depressions, Onita soils in swales, and Sully soils on some of the terraces and on uplands.

The Lowry and Agar soils are well suited to all crops commonly grown in the county. They are medium in fertility and have high available water capacity. They are easy to work and are relatively free of stones. The main concerns in management are conserving moisture and controlling the slight to moderate risks of erosion and soil blowing.

Most of this association is used for cultivated crops. Some areas of the less extensive soils are in native grass used for grazing and hay. Much of the irrigated land in the county is in this association. The main farm enterprises are growing wheat for cash income and growing feed crops for beef cattle.

2. Ree-Canning association

Nearly level to gently sloping, well-drained loamy soils that formed in alluvium on terraces and uplands

This soil association is on terraces and uplands east of Chapelle Creek. It is dominantly nearly level and gently sloping. It is steeper on isolated knobs, on terrace fronts, and along entrenched drainageways.

This association makes up slightly more than 1 percent of the county. It is about 60 percent Ree soils, 20 percent Canning soils, and 20 percent other soils.

Ree soils have a surface layer of dark grayish-brown loam and a subsoil of clay loam that is dark grayish brown and grayish brown in the upper and middle parts and pale brown and calcareous in the lower part. The underlying material, to a depth of 50 inches, is calcareous clay loam and loam. Below this is calcareous sand and gravel. Ree soils have moderate permeability and moderate or high available water capacity.

Canning soils have a surface layer and subsoil that are very similar to those of the Ree soils, but they are underlain by sand and gravel at a depth of about 30 inches. Permeability is moderate in the surface layer and subsoil but rapid in the underlying sand and gravel. Canning soils have moderate available water capacity.

Less extensive in this association are Mosher soils in low areas along drainageways and Oahe, Orton, and Schamber soils on isolated knobs and ridges, on terrace fronts, and on the sides of entrenched drainageways.

The Ree soils are well suited to all crops commonly grown in the county. The Canning soils are somewhat droughty and are better suited to sorghum than to corn. They are medium in fertility and are relatively free of stones and easy to work. Conserving moisture and controlling soil blowing and erosion are the main concerns in management.

Most of this association is used for cultivated crops, but a few small areas are in native grass used for grazing or hay. The main farm enterprises are growing crops for cash income and growing feed crops for beef cattle. The soils are well suited to irrigation. Much of the association is underlain by sand and gravel, which ranges from poor to good for construction use, depending on the amount of fine material.

Silty and Loamy Soils That Formed in Glacial Drift, Glacial Till, and Alluvium, Mainly on Uplands

Soils in this group of soil associations are predominantly deep, nearly level to undulating silty and loamy soils that formed in glacial drift and glacial till. Steeper soils are along the Missouri River and the larger creeks and drainageways. Scattered throughout these associations are areas of soils that have a claypan subsoil. All of the soils in these associations are low or medium in fertility and have high or moderate available water capacity. The hazard of erosion is slight to severe, and the hazard of soil blowing is slight. Almost all of the Gettys-Betts association is in native grass. Most of the Highmore-Eakin association and varying amounts of the other four associations are under cultivation. Grazing livestock and growing crops for cash income and livestock feed are the main farm enterprises.

3. Highmore-Eakin association

Nearly level to undulating, well-drained silty soils that formed in glacial drift and glacial till on uplands

This association is a broad upland plain that is thinly mantled with silty glacial drift and is underlain by

glacial till. Much of it is nearly level or gently sloping and in places is broken by slight rises and ill-defined drainageways that terminate in small depressions. Slopes are mostly long and smooth. They are shorter and more undulating on some of the low ridges and along some of the larger drainageways.

This association makes up about 32 percent of the county. It is about 50 percent Highmore soils (fig. 2), 25 percent Eakin soils, and 25 percent other soils.

Highmore soils have a surface layer of dark grayish-brown silt loam and a subsoil of silty clay loam that is dark grayish brown and grayish brown in the upper and middle parts and brown and calcareous in the lower part. The underlying material, to a depth of 40 inches or more, is calcareous, light olive-brown silt loam.

Eakin soils are closely intermingled with Highmore soils. They have a surface layer and subsoil that resemble those of Highmore soils, but they are underlain by glacial till at a depth of less than 40 inches.

Glenham and Onita soils are the most extensive of the other soils in this association. Glenham soils are on some of the ridges, and Onita soils are in swales. Less extensive are Betts and Java soils along some of the well defined drainageways, DeGrey and Walke soils in slightly depressed flats, and Hoven and Macken soils in depressions.

Highmore and Eakin soils are well suited to all crops commonly grown in the county. They are medium in fertility and are moderately permeable as far down as the underlying glacial till. They are easy to work and

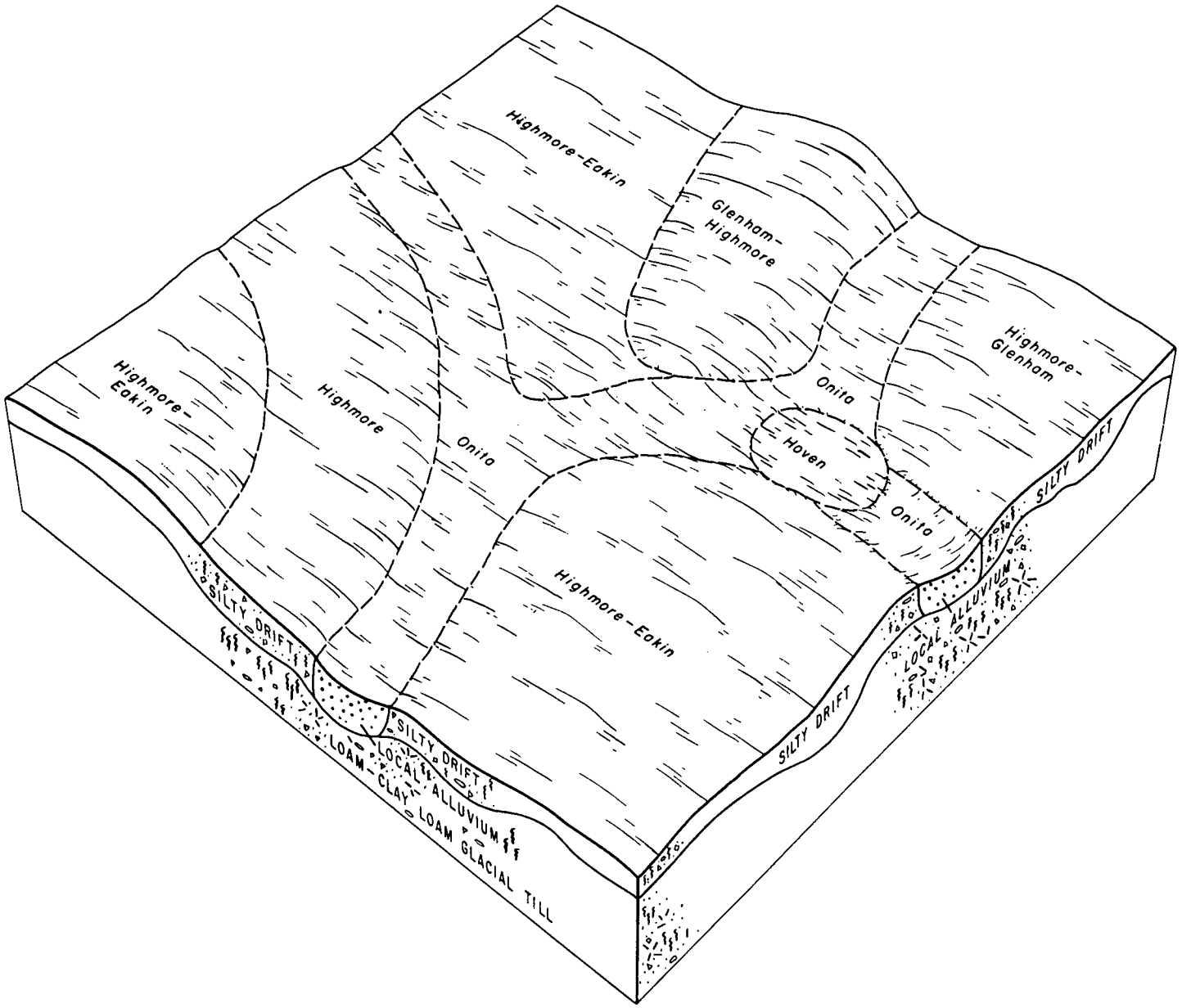

Figure 2.—**Typical pattern of soils and underlying material in Highmore-Eakin association.**

relatively free of stones. Available water capacity is high. Conservation of moisture and the control of erosion and soil blowing are the main concerns in management.

Most of this association is used for cultivated crops, but scattered areas are in native grass and are used for grazing or hay. The main farm enterprises are growing crops for cash income and growing feed crops for beef cattle.

4. Highmore-DeGrey association

Nearly level to gently sloping, well drained silty soils and moderately well drained soils that have a claypan; all formed in glacial drift on uplands

This association is mostly nearly level. Slopes are dominantly long and smooth. Some are broken by slight rises and by ill-defined drainageways that commonly terminate in depressions.

This association makes up about 7 percent of the county. It is about 40 percent Highmore soils, 20 percent DeGrey soils, and 40 percent other soils.

Highmore soils are nearly level to gently sloping, well-drained soils on rises. They have a surface layer of dark grayish-brown silt loam and a subsoil of silty clay loam. The underlying material, to a depth of 40 inches or more, is light olive-brown, calcareous silt loam. Highmore soils are medium in fertility, are high in available water capacity, and have moderate permeability.

DeGrey soils are moderately well drained soils in low spots, or slight depressions, within areas of Highmore soils. They have a surface layer of dark grayish-brown silt loam and a subsurface layer of gray silt loam. Below this is a claypan subsoil of dark grayish-brown silty clay. The underlying material is calcareous, light brownish-gray silty clay loam and clay loam. DeGrey soils are low or medium in fertility. Permeability is slow or very slow, and available water capacity is moderate.

Less extensive in this association are Bon soils on bottom land, Cavo and Walke soils in slight depressions, Eakin and Raber soils on rises, Gettys and Peno soils on the sides of entrenched drainageways, Hoven soils in depressions, and Onita soils in swales.

The Highmore soil is well suited to all crops commonly grown in the county. The DeGrey soil has a claypan subsoil that limits crop growth, and it is better suited to sorghum than to corn. These soils are relatively free of stones. The Highmore soil is easy to work, but the DeGrey soil is difficult to work and has poor tilth. The main concerns in management are conserving moisture and controlling erosion and soil blowing. Improving tilth and water intake is an additional concern in the DeGrey soil.

Some areas of this association are under cultivation, and some are in native grass used for grazing and hay. Growing feed crops for livestock and grazing livestock are the main farm enterprises. Some crops are grown for cash income.

5. Cavo-Raber-Demky association

Nearly level to gently undulating, moderately well drained and well drained loamy and silty soils and soils that have a claypan; all formed in glacial till on uplands

This association is predominantly nearly level, but is interspersed with slight rises and ill-defined drainageways that commonly terminate in small depressions. In some of the gently undulating parts of the association, slopes are short and irregular. The steeper slopes are mainly along the larger drainageways.

This association makes up about 17 percent of the county. It is about 20 percent Cavo soils (fig. 3), 15 percent Raber soils, 10 percent Demky soils, and 55 percent other soils.

Cavo soils are moderately well drained and are in slight depressions. They have a surface layer of silt loam and a subsurface layer of gray silt loam. Below this is a claypan subsoil of clay loam texture. The underlying material is calcareous clay loam. Cavo soils are low or medium in fertility and have slow or very slow permeability. Available water capacity is moderate.

The well-drained Raber soils are on slight rises. They have a surface layer of dark grayish-brown loam and a clay loam subsoil that is brown in the upper part and grayish brown and light brownish gray in the lower part. The underlying material is calcareous clay loam. Raber soils are medium in fertility. Permeability is moderately slow, and available water capacity is moderate or high.

The moderately well drained Demky soils are in slight depressions with Cavo soils. They resemble Cavo soils, but have a less compact clay loam subsoil and do not have a distinct, gray surface layer. Demky soils are medium in fertility. Permeability is slow, and available water capacity is moderate or high.

The less extensive soils in this association are DeGrey, Eakin, and Highmore soils in scattered areas that are thinly mantled with silty material; Gettys, Oko, and Peno soils on some of the ridgetops and on the shoulders of well-defined drainageways; Hoven soils in depressions; and Onita soils in some of the swales and slight depressions.

The claypan subsoil of the Cavo soil limits the use of this association for cultivated crops. Small grain and sorghum are better suited than corn. Improving tilth and the intake of water are the main concerns in management. Conserving moisture and controlling erosion and soil blowing also are important.

About 25 percent of this association is under cultivation. The rest is mostly in native grass used for grazing and hay. Livestock grazing and production of feed and forage crops for livestock are the main farm enterprises.

6. Raber-Peno association

Gently undulating to rolling, well-drained loamy soils that formed in glacial till on uplands

This association is dominantly gently undulating to rolling. Some areas are nearly level. The steeper areas are along some of the drainageways. Slopes are short and convex. In some areas drainageways are well defined, but in other parts they are ill defined and commonly terminate in small, closed depressions and intermittent

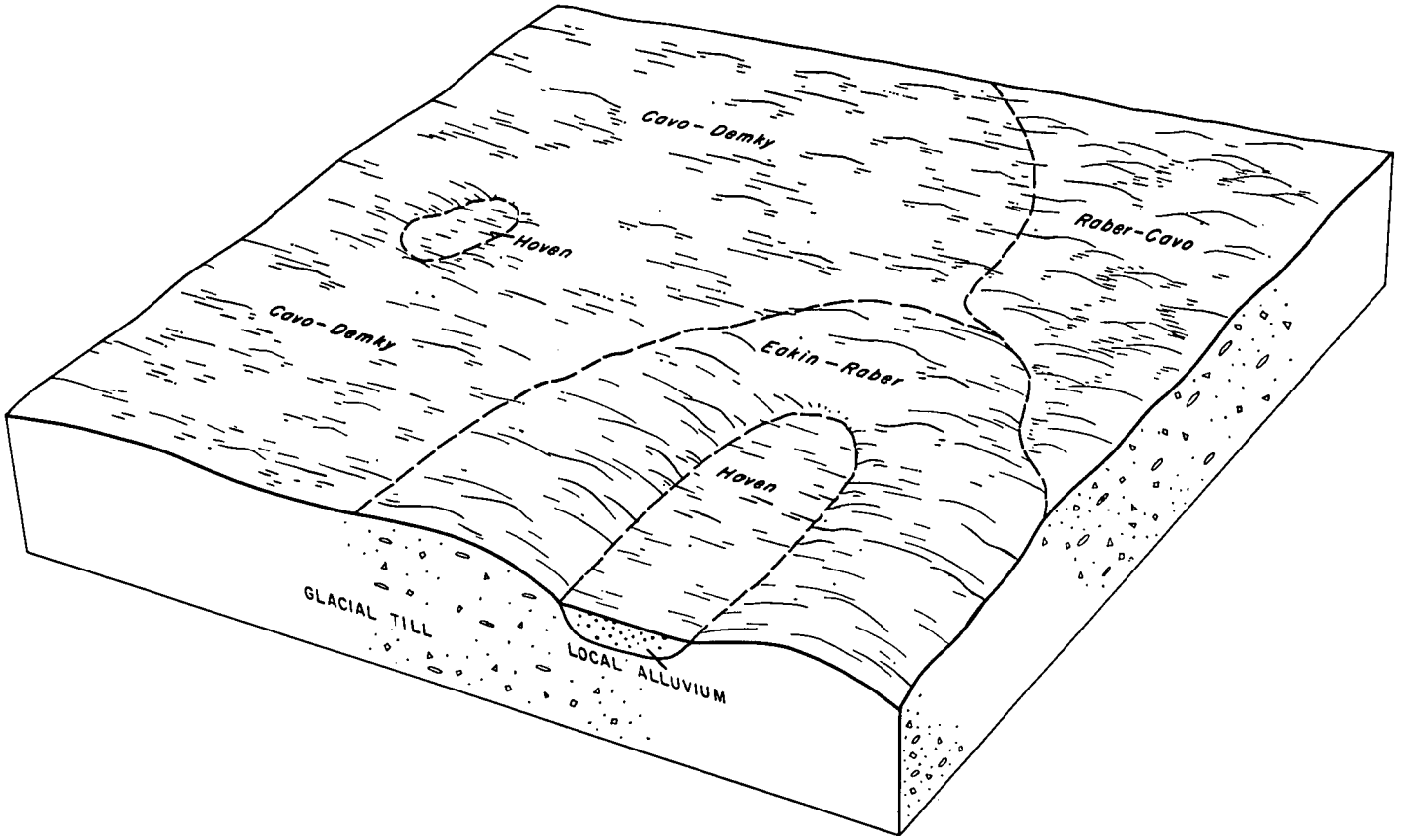

Figure 3.—**Typical pattern of soils and underlying material in Cavo-Raber-Demky association.**

lakes. Scattered glacial boulders are on the surface in parts of the area.

This association makes up about 10 percent of the county. It is about 25 percent Raber soils, 15 percent Peno soils, and 60 percent other soils.

Raber soils are mostly gently undulating to rolling. They have a surface layer of dark grayish-brown loam and a clay loam subsoil that is brown in the upper part and grayish brown and light brownish gray in the lower part. The lower part of the subsoil and the underlying clay loam glacial till are calcareous.

Peno soils are on ridgetops, the higher parts of the landscape, and the sides of entrenched drainageways. They have a thin surface layer of dark-gray clay loam and a clay loam subsoil that is dark grayish brown in the upper part and grayish brown in the lower part. The underlying material is calcareous, grayish-brown and pale-brown clay loam.

The less extensive soils in this association are Cavo and DeGrey soils in swales and slight depressions; Eakin and Highmore soils intermingled in places with Raber soils; Gettys soils on the hilly sides of entrenched drainageways; Hoven and Macken soils in depressions; Oko, Opal, and Promise soils in places that have only a thin mantle of glacial till or no mantle; and Onita soils in swales.

Most crops commonly grown in the county grow well on Raber and Peno soils, both of which are medium in fertility and moderate or high in available water capacity. Because slopes commonly are short and irregular, controlling erosion is difficult.

Most of the association is in native grass used for grazing or hay. Some cultivated areas are used for growing small grain crops for cash income, but most are used for growing feed and forage crops for livestock.

7. *Betts-Java-Durrstein association*

Rolling to steep, well-drained to excessively drained loamy soils that formed in glacial till on uplands, and nearly level, poorly drained soils that have a claypan and formed in alluvium on bottom land

This association is in the valley and on valley sides of Medicine Knoll Creek near the town of Blunt. The valley sides are mostly hilly, and slopes are short and irregular. The steeper soils are on the sides of short, entrenched drainageways. The water table fluctuates between depths of 2 and 10 feet in much of the valley.

This association makes up about 1 percent of the county. It is about 35 percent Betts soils (fig. 4), 20 percent Java soils, 20 percent Durrstein soils, and 25 percent other soils.

Betts soils are rolling to steep and are somewhat excessively drained or excessively drained. They have a thin surface layer of very dark grayish-brown loam and a thin subsoil of calcareous, grayish-brown clay loam. The underlying material is calcareous, light brownish-gray clay loam. Betts soils are low in fertility and high in available water capacity. Surface runoff is rapid.

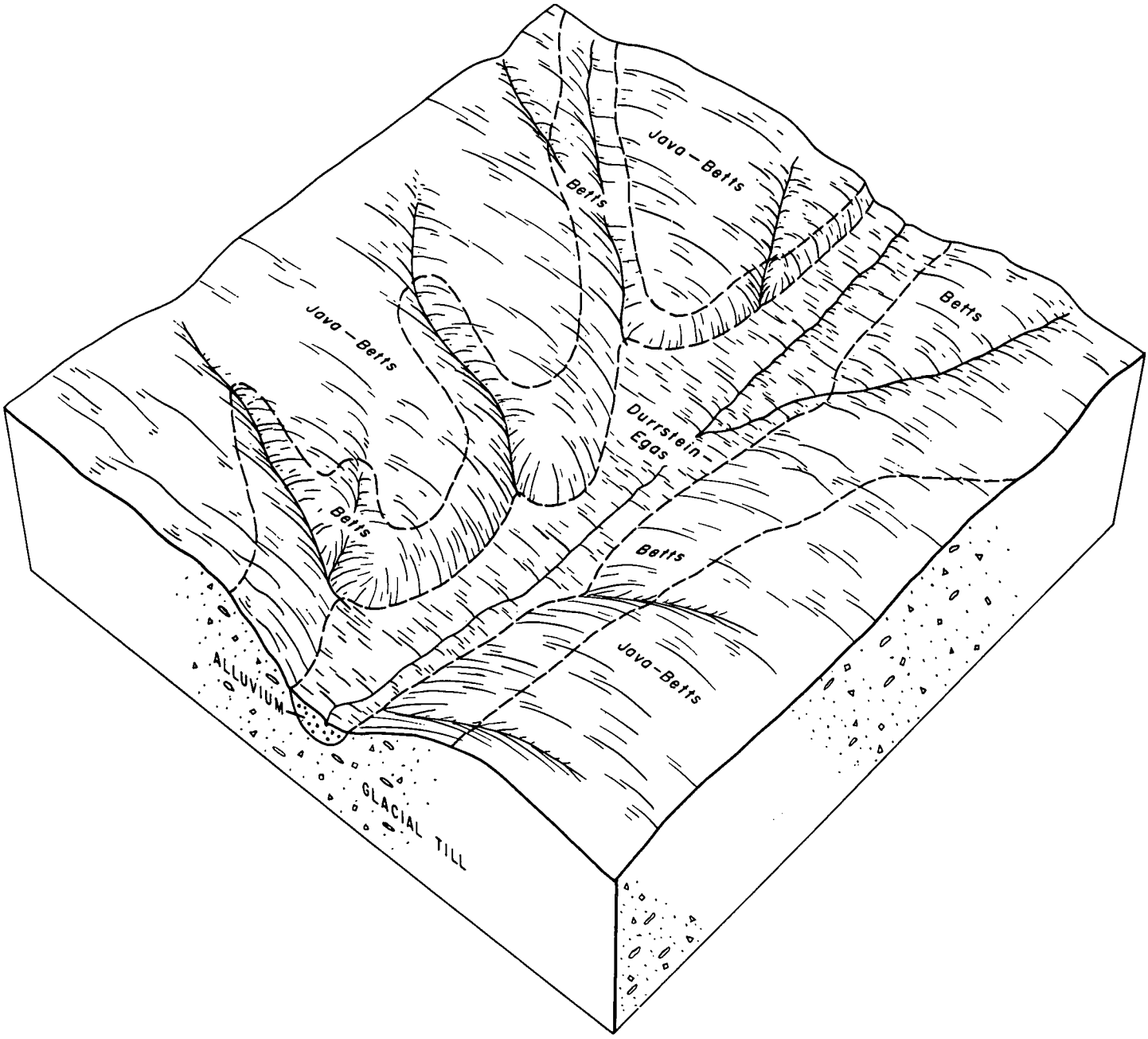

Figure 4.—**Typical pattern of soils and underlying material in Betts-Java-Durrstein association.**

The well-drained Java soils are mostly rolling and are on valley walls and at the heads of drainageways. They have a thin surface layer of dark grayish-brown loam and a subsoil that is dark grayish-brown light clay loam in the upper part and pale-brown calcareous loam in the lower part. The underlying material is light-gray and pale-brown, calcareous clay loam and loam. Java soils are high in available water capacity and medium in fertility.

The poorly drained Durrstein soils are on bottom land. They have a thin surface layer of gray silt loam and a claypan subsoil of dark-gray clay and silty clay. The underlying material is calcareous, gray clay that contains accumulations of salts at a depth of about 14 inches. Durrstein soils have low or moderate available water capacity and slow or very slow permeability.

The less extensive soils in the association include Bon soils along the creek channel; spots of Egas soils on low mounds with Durrstein soils; Glenham soils on valley sides with Betts and Java soils; Mosher and Ree soils on narrow, low terraces slightly above the level of Durrstein soils; and Schamber soils in gravelly areas on valley sides.

Betts and Java soils are too steep and erodible for cultivation, and Durrstein soils are not suitable for cultivation because of wetness and the presence of salts.

Controlling erosion on the Betts and Java soils and improving drainage in the areas of Durrstein soils are the main concerns in management.

Most areas of this association are in native grass used for grazing and hay. Most small areas of Bon and Ree soils are under cultivation, some of which are irrigated from shallow wells. Corn and alfalfa are the main crops grown in these small areas.

8. Gettys-Betts association

Rolling to steep, well-drained to excessively drained loamy soils that formed in glacial till on uplands

This association is mainly the breaks, ridges, and escarpments along the Missouri River and some of the larger creeks and drainageways. The areas are dissected by many drainageways. Slopes are mostly short and steep. Less steep slopes are in the lower parts of the landscape, which consists mainly of narrow strips of bottom land and low terraces. Scattered glacial boulders are on the surface throughout much of the association.

This association makes up about 20 percent of the county. It is about 15 percent Gettys soils, 10 percent Betts soils, and 75 percent soils of minor extent, land types, and much of Lake Oahe and Lake Sharpe.

Gettys soils have a thin surface layer over a thin transitional layer of calcareous, grayish-brown clay loam. The underlying material is firm glacial till of clay loam texture.

Betts soils have a thin surface layer of very dark grayish-brown loam and a thin subsoil of calcareous, grayish-brown clay loam. Their profile resembles that of the Gettys soil, but it formed in loamy glacial till that contains less clay than the glacial till in which the Gettys soil formed.

Less extensive in this association are Bon, Durrstein, and Egas soils and Alluvial land, undifferentiated, on bottom lands; Chantier, Hurley, Opal, Promise, and Swanboy soils in some of the lower and less steep parts of the association; Cut and fill land around the Oahe dam site; Glenham and Java soils intermingled with Betts soils; Lakoma and Sansarc soils and Shale land on the steep sides of drainageways below Gettys and Betts soils; Oko, Peno, and Raber soils intermingled with Gettys soils; Orton and Schamber soils on gravelly escarpments; and Rough broken land.

Betts and Gettys soils are low in fertility and are too steep and erodible for cultivation. Controlling erosion is the main concern in management.

Almost all of this association is in native grass used for grazing. Some of the less steep soils of minor extent are used for hay and a few are used for growing feed and forage crops. Livestock ranching is the main enterprise.

Clayey Soils That Formed in Material Derived From Soft Shale on Uplands

Only the Sansarc association is in this group. The soils are mainly clayey and are shallow over shale. Slopes are mostly steep. The dominant Sansarc soil is low in fertility and has slow permeability and very low available water capacity. The risk of erosion is severe. All areas are in native grass. Livestock ranching is the main enterprise.

9. Sansarc association

Shallow, strongly sloping to steep, well-drained clayey soils over shale on uplands

This association is mainly on river breaks along Lake Sharpe and Chaney Rush Creek. It is dissected by many, deeply entrenched, gullied drainageways. Slopes are mostly steep, and landslides are common. Scattered glacial boulders commonly are on the surface in the higher parts of the landscape.

This association makes up about 2 percent of the county. It is about 40 percent Sansarc soils and 60 percent other soils, land types, and Lake Sharpe.

Sansarc soils have a thin surface layer of dark grayish-brown clay that is underlain by calcareous, grayish-brown clay and shaly clay. At a depth of 16 inches is bedded shale. Sansarc soils have slow permeability and very low available water capacity.

Less extensive in this association are Alluvial land, undifferentiated, on bottom land; Betts, Gettys, and Peno soils on some of the ridges above Sansarc soils; Chantier, Hurley, and Swanboy soils and Slickspots on fans and along drainageways; Lakoma and Opal soils intermingled with Sansarc soils; and Shale land and Shale outcrop in areas where shale is at or very near the surface.

Sansarc soils are low in fertility and are too shallow, steep, and erodible for cultivation. Controlling erosion is the main concern in management. The entire association is range. Livestock ranching is the main enterprise.

Loamy Soils That Formed in Alluvium on Bottom Land

Only the Munjor association is in this group. The soils formed in stratified sandy alluvium. They are deep and loamy and dominantly nearly level. They are mostly low in fertility. Available water capacity is moderate or high. The risk of erosion is slight, and the risk of soil blowing is moderate. Many areas of the Munjor soil are under cultivation. A large part of the association has a potential for recreational, park, and wildlife uses.

10. Munjor association

Nearly level, well-drained loamy soils that formed in sandy alluvium on bottom land

This association is on bottom land and islands. The relief is mostly nearly level, but in places is uneven. The nearly level areas are interspersed with low hummocks of windblown material and cut by old meander scars and secondary flood channels of the Missouri River.

This association makes up less than 1 percent of the county. It is about 20 percent Munjor soils and 80 percent soils of minor extent, miscellaneous land types, and areas of open water.

Munjor soils have a surface layer of calcareous, grayish-brown fine sandy loam. The underlying material is calcareous, light brownish-gray fine sandy loam thinly stratified with loamy fine sand and silty clay loam. Below a depth of 40 inches is calcareous loam. Munjor soils have moderately rapid permeability and moderate or high available water capacity.

Two miscellaneous land types are almost as extensive in this association as Munjor soils. They are Alluvial land, sandy, in some of the hummocky areas and Alluvial land, wet, in some of the lower lying areas that have a high water table. Less extensive in the association are Fill land within the city of Pierre; Dorna and Millboro soils on valley terraces; and Promise and Swanboy soils on fans at the outer edges of the association.

Munjor soils are low in fertility, but they take in water easily and are suited to corn, small grain, and alfalfa. They are well suited to irrigation. Controlling soil blowing is the main concern in management in cultivated areas. Wetness from a high water table limits the use of parts of this association.

Many areas of the Munjor soils are under cultivation. Much of the rest of the association is under urban development or is State or federally owned land used for parks and recreation.

Descriptions of the Soils

This section describes the soil series and mapping units in Hughes County. A 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 the 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 laymen. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile in the series description is representative for mapping units in that series. If the profile of a given mapping unit differs from the one described as representative of the series, these differences are stated in the mapping unit description or are apparent in the name of the mapping unit.

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

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak group in which the mapping unit has been placed. The page for the description of each capability unit, is given in 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 are defined in the "Glossary" at the end of this survey. More detailed information about the terminology and methods of soil mapping are in the Soil Survey Manual (*7*).

Some of the soil series in this county are identified by a different name in the recently published soil survey of Sully County, South Dakota. Such differences in names result from changes in the concepts of soil classification that have occurred since publication.

Agar Series

The Agar series consists of deep, well-drained, nearly level to gently sloping silty soils on uplands. These soils formed in windblown silts.

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

Agar soils are medium in fertility and moderate in organic-matter content. Permeability is moderate, and available water capacity is high. Surface runoff is slow or medium, depending on slope.

Most areas are cultivated. Winter wheat, oats, alfalfa, and corn are the principal crops. Some areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Agar silt loam, 0 to 2 percent slopes, 144 feet east and 2,540 feet north of the southwest corner of sec. 34, T. 109 N., R. 75 W.

A1—0 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B21t—7 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure; hard, very friable; mildly alkaline; gradual, smooth boundary.

B22t—12 to 17 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure; hard, friable; mildly alkaline; clear, wavy boundary.

B3—17 to 27 inches, pale-brown (10YR 6/3) heavy silt loam, yellowish brown (10YR 5/4) moist; weak, medium, subangular blocky structure; hard, friable; few fine segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—27 to 33 inches, pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; massive; hard, friable; common medium and fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—33 to 44 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable; common fine iron stains; common fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—44 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable; common fine iron stains; few very fine segregations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 14 to 24 inches. The A horizon is dark gray or dark grayish brown in hue of 10YR and ranges from 5 to 8 inches in thickness. The B2t horizon ranges from 8 to 20 inches in thickness and from 18 to 35 percent in clay content; typically it is about 28 percent clay that is less than 3 percent material coarser

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Agar silt loam, 0 to 2 percent slopes	9, 859	2. 1	Lowry-Urban land complex, 2 to 5 percent slopes	318	0. 1
Agar silt loam, 2 to 5 percent slopes	1, 355	. 3	Lowry-Urban land complex, 5 to 9 percent slopes	193	(1)
Agar-Eakin silt loams, 2 to 5 percent slopes	675	. 1	Macken silty clay	1, 910	. 4
Alluvial land, sandy	693	. 1	Millboro silty clay loam, 0 to 2 percent slopes	1, 392	. 3
Alluvial land, undifferentiated	3, 356	. 7	Mosher silt loam, 0 to 2 percent slopes	1, 651	. 3
Alluvial land, wet	712	. 2	Munjor fine sandy loam	755	. 2
Betts loam, 15 to 40 percent slopes	11, 258	2. 4	Oahe-Orton loams, 2 to 9 percent slopes	1, 557	. 3
Bon loam	3, 327	. 7	Oko clay loam, 2 to 5 percent solpes	786	. 2
Canning loam, 0 to 2 percent slopes	2, 602	. 5	Oko clay loam, 5 to 9 percent slopes	1, 263	. 3
Canning loam, 2 to 5 percent slopes	1, 339	. 3	Oko-Jerauld complex, 2 to 9 percent slopes	2, 380	. 5
Cavo-Demky silt loams, 0 to 2 percent slopes	21, 389	4. 5	Onita silt loam, 0 to 2 percent slopes	22, 821	4. 8
Chantier clay, 2 to 9 percent slopes	833	. 2	Onita-Hoven silt loams, 0 to 1 percent slopes	5, 281	1. 1
Cut and fill land	1, 256	. 3	Opal clay, 2 to 5 percent slopes	548	. 1
DeGrey-Walke silt loams, 0 to 2 percent slopes	9, 497	2. 0	Opal clay, 5 to 9 percent slopes	1, 402	. 3
Demky-Cavo silt loams, 0 to 2 percent slopes	4, 079	. 9	Opal-Lakoma clays, 9 to 15 percent slopes	6, 328	1. 3
Dorna silt loam	1, 234	. 2	Peno-Gettys clay loams, 9 to 15 percent slopes	10, 321	2. 2
Dorna silt loam, thin solum	1, 453	. 3	Peno-Swanboy complex, 3 to 15 percent slopes	893	. 2
Durrstein-Egas complex	2, 269	. 5	Promise clay, 0 to 2 percent slopes	2, 121	. 4
Eakin-Raber silt loams, 0 to 2 percent slopes	2, 545	. 5	Promise clay, 2 to 5 percent slopes	2, 103	. 4
Eakin-Raber silt loams, 2 to 5 percent slopes	11, 709	2. 5	Promise-Mosher complex, 0 to 2 percent slopes	2, 447	. 5
Eakin-Raber silt loams, 5 to 9 percent slopes	5, 227	1. 1	Raber-Cavo loams, 0 to 2 percent slopes	1, 941	. 4
Fill land	235	(1)	Raber-Cavo loams, 2 to 5 percent slopes	12, 612	2. 6
Gettys clay loam, 15 to 40 percent slopes	12, 346	2. 6	Raber-Peno clay loams, 2 to 9 percent slopes	2, 798	. 6
Glenham-Highmore silt loams, 5 to 9 percent slopes	6, 806	1. 4	Raber and Oko stony soils, 3 to 15 percent slopes	925	. 2
Highmore silt loam, 0 to 2 percent slopes	6, 466	1. 4	Ree loam, 0 to 2 percent slopes	6, 110	1. 2
Highmore-DeGrey silt loams, 0 to 2 percent slopes	26, 577	5. 6	Ree loam, 2 to 5 percent slopes	2, 730	. 6
Highmore-DeGrey silt loams, 2 to 5 percent slopes	5, 956	1. 2	Ree-Mosher complex, 0 to 2 percent slopes	1, 649	. 3
Highmore-Eakin silt loams, 0 to 2 percent slopes	72, 039	15. 0	Rough broken land	3, 944	. 8
Highmore-Eakin silt loams, 2 to 5 percent slopes	45, 627	9. 6	Sansarc-Gettys complex, 9 to 34 percent slopes	2, 569	. 5
Highmore-Glenham silt loams, 2 to 5 percent slopes	10, 454	2. 2	Sansarc-Lakoma clays, 9 to 40 percent slopes	10, 967	2. 3
Highmore-Walke silt loams, 0 to 2 percent slopes	2, 166	. 5	Sansarc-Shale outcrop complex	7, 090	1. 5
Hoven silt loam	10, 082	2. 1	Schamber-Orton complex	6, 961	1. 5
Hoven-Onita silt loams	2, 772	. 6	Shale land	1, 424	. 3
Hurley silt loam, 0 to 6 percent slopes	1, 661	. 3	Sully silt loam, 0 to 2 percent slopes	460	. 1
Java-Betts loams, 9 to 15 percent slopes	5, 750	1. 2	Sully silt loam, 2 to 9 percent slopes	678	. 1
Java-Glenham loams, 2 to 9 percent slopes	6, 608	1. 4	Sully silt loam, 9 to 15 percent slopes	695	. 1
Jerauld silt loam, 0 to 2 percent slopes	8, 519	1. 8	Sully silt loam, 15 to 35 percent slopes	555	. 1
Lowry silt loam, 0 to 2 percent slopes	12, 574	2. 6	Swanboy clay, 0 to 6 percent slopes	1, 540	. 3
Lowry silt loam, 2 to 5 percent slopes	6, 271	1. 3	Swanboy-Slickspots complex	1, 947	. 4
Lowry silt loam, 5 to 9 percent slopes	1, 665	. 3	Marsh (indicated by symbol on soil map)	274	. 1
			Open water (less than 40 acres in size)	2, 820	. 6
			Total land area	478, 400	100. 0
			Open water (more than 40 acres in size)	23, 360	
			Total area	501, 760	

[1] Less than 0.05 percent.

than very fine sand. It has weak or moderate, medium, prismatic structure that parts to weak or moderate, medium or fine, subangular blocky structure. The B3 horizon and upper part of the C horizon have few to many, fine or medium segregations of lime. Glacial till of loam or clay loam texture is at a depth of 40 to 60 inches in some places.

Agar soils are mapped with or are near Eakin, Lowry, and Onita soils. They contain more clay in the B horizon than Lowry soils and have a thinner A horizon and less clay in the B horizon than Onita soils. They formed in silty material that is thicker over glacial till than the silty material in which Eakin soils formed.

Agar silt loam, 0 to 2 percent slopes (AgA).—This soil is mostly nearly level, but in some small areas slopes are more than 2 percent. Slopes are long and smooth. The soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Eakin and Onita soils. Eakin soils are on some of the slight rises. Onita soils are in swales.

This Agar soil is free of stones and is easy to work. Available water capacity is high. Surface runoff is slow, and the hazard of erosion is slight. Soil blowing can be a hazard during dry periods. The main concern in management is conserving moisture.

Most areas are under cultivation. The soil is well suited to all crops commonly grown in the area. It is well suited to irrigation. Capability unit IIc–2; Silty range site; windbreak group 3.

Agar silt loam, 2 to 5 percent slopes (AgB).—This soil is mostly gently sloping and has long, smooth slopes. It has a similar profile to the one described as representative of the series, except that the surface layer is thinner and the soil is calcareous at a depth of about 15 inches. In places glacial till is at a depth of 40 to 60 inches.

Included with this soil in mapping are areas of Eakin and Onita soils. Eakin soils are on ridgetops. Onita soils are in swales and along drainageways.

This Agar soil is easy to work and is free of stones. It takes in water readily, and available water capacity is high. Surface runoff is medium. Controlling erosion is the main concern in management.

Most areas are cultivated. The soil is well suited to all crops commonly grown in the county. Capability unit IIe-1; Silty range site; windbreak group 3.

Agar-Eakin silt loams, 2 to 5 percent slopes (AkB).—This complex is about 65 percent Agar soil and 35 percent Eakin soil. The two soils are intermingled in an erratic pattern in which the Eakin soil is in areas where glacial till is at a depth of less than 40 inches. In places the surface layer of both soils is thinner than is typical. Slopes are long and smooth. In some cultivated areas these soils are moderately eroded.

Included with these soils in mapping are small areas of Glenham and Onita soils. Glenham soils are on ridgetops that lack the thin mantle of silty materials over glacial till. Onita soils are in swales.

Agar and Eakin soils are easy to work and are relatively free of stones. They take in water readily and have a high available water capacity. Surface runoff is medium. Controlling erosion is the main concern in management.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. A few areas are in native grass and are used for grazing or hay. Capability unit IIe-1; Silty range site; windbreak group 3.

Alluvial Land

Alluvial land consists of stratified alluvial soils that range from fine sand to clay in texture and are subject to varying degrees of wetness and flooding. Areas are on bottom lands of the Missouri River and along channels of creeks and the larger upland drainageways.

Alluvial land, sandy (0 to 2 percent slopes) (As).—This mapping unit is on bottom land along the Missouri River and also on Farm Island and Laframboise Island. It is nearly level except for small hummocks 2 to 4 feet high. The surface layer commonly is fine sand, but in places it is loamy fine sand or coarse sandy loam. The underlying material is mostly sandy, but in places it is stratified with silty and clayey alluvium 3 to 12 inches thick.

Included with this land in mapping are areas of loamy alluvial soils that make up as much as 25 percent of some areas on the more nearly level terrain. Also included on Farm Island and Laframboise Island are alluvial soils that have a high water table, related to the permanent water level of Lake Sharpe.

Surface runoff is very slow. This sandy material blows easily when the vegetation is removed. Controlling soil blowing is the main concern in management.

All areas are in native vegetation that consists of sparse to thick stands of native trees and shrubs. Tall grasses are dominant where the trees are sparse or absent. These areas provide wildlife habitat, and they also have excellent potential as recreation areas. Capability unit VIe-8; Sands range site; windbreak group 10.

Alluvial land, undifferentiated (0 to 2 percent slopes) (Au).—This land is along the channels of creeks and along some of the larger drainageways. Most areas are less than 500 feet wide and as much as a mile or more long. Most are cut into small parcels by deep, meandering channels or gullies. This alluvial material is stratified. The texture of the material at the surface ranges from sandy loam to clay.

Alluvial land, undifferentiated, is flooded almost annually during snowmelt and following heavy rains. Flood damage consists of streambank erosion and the deposition of additional sediment and debris. The water table fluctuates between depths of 2 and 10 feet in some areas.

All areas are in native vegetation and are used for grazing. Native vegetation consists of tall and mid grasses and scattered stringers and clumps of trees and shrubs. The trees and shrubs provide habitat for wildlife, as well as limited protection in winter for livestock. Capability unit VIw-3; Overflow range site; windbreak group 10.

Alluvial land, wet (0 to 2 percent slopes) (Aw).—This mapping unit is in low-lying areas on Farm Island and on bottom lands along Lake Sharpe near the city of Pierre. The soil material ranges from loamy sand to loam and commonly is stratified with finer and coarser textures. Included in mapping are small marshy areas where water is on the surface most of the time.

Surface runoff is very slow. The water level maintained for Lake Sharpe has created a water table at a depth of 6 inches to 3 feet. Wetness is the main limitation.

All areas are in native vegetation that consists of sparse to thick stands of native trees and shrubs. Tall grasses are dominant in areas where trees are sparse or absent. Some trees, such as eastern redcedar and cottonwood, are not expected to survive because of the high water table. This land provides excellent habitat for deer and other wildlife, but its potential for many recreational uses is severely limited by the high water table. Capability unit Vw-1; Subirrigated range site; windbreak group 10.

Betts Series

The Betts series consists of deep, somewhat excessively drained or excessively drained, rolling to steep loamy soils on uplands. These soils formed in glacial till of loam or clay loam texture.

In a representative profile the surface layer is very dark grayish-brown loam about 3 inches thick. The subsoil, about 6 inches thick, is grayish-brown, calcareous light clay loam. It is hard when dry and friable when moist. The underlying material is light brownish-gray, calcareous clay loam that has spots and streaks of soft lime in the upper part.

Betts soils are low in fertility and moderately low in organic-matter content. Permeability is moderate in the surface layer and subsoil, but is moderate or moderately slow in the underlying material. Available water capacity is high. Surface runoff is rapid.

Nearly all areas are in native grass and are used for grazing. The native vegetation is a mixture of tall, mid, and short grasses.

Representative profile of Betts loam, 15 to 40 percent slopes, in native grass, 90 feet south and 51 feet east of

fence from the northwest corner of sec. 3, T. 112 N., R. 76 W.

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

B2—3 to 9 inches, grayish-brown (2.5Y 5/2) light clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure; hard, friable; strong effervescence; mildly alkaline; clear, wavy boundary.

C1ca—9 to 22 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; hard, friable; many medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2ca—22 to 41 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/3) moist; massive; hard, firm; few fine segregations of lime; few fine shale chips; strong effervescence; moderately alkaline; clear, wavy boundary.

C3—41 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm; common fine nests of gypsum; common iron stains; mildly alkaline.

Free carbonates are at the surface or within a depth of 6 inches. The A horizon ranges from very dark grayish brown to grayish brown in hue of 10YR. It commonly is loam, but ranges from fine sandy loam to clay loam in texture and from 2 to 4 inches in thickness. The B2 horizon ranges from grayish brown to pale brown in hue of 2.5Y or 10YR and from 3 to 6 inches in thickness. It is loam or light clay loam and has weak, medium or coarse, prismatic or subangular blocky structure. The C horizon is loam or clay loam but contains thin silty layers in some places. Nests or striations of gypsum are few or common in the lower part of the C horizon. Relict mottles are in this horizon in some places.

Betts soils resemble Gettys soils and are near or are mapped with Glenham and Java soils. They contain less clay than Gettys soils. They differ from Glenham and Java soils in having thinner horizons that are very dark grayish brown or darker when moist, and they are calcareous nearer the surface.

Betts loam, 15 to 40 percent slopes (BeE).—This soil has the profile described as representative of the series. It is dominantly hilly to steep, but slopes in some small areas are less than 15 percent. Many small drainageways are in the areas. Few to many, scattered glacial boulders, from 1 to 6 feet in diameter, are on the surface or are partly embedded in the soil.

Included with this soil in mapping are areas of Gettys, Glenham, Java, and Schamber soils. Gettys soils are intermingled with Betts soils. Glenham and Java soils are on the middle and lower parts of the landscapes where slopes are less steep. Schamber soils are on gravelly knobs and ridges. Also included is Alluvial land, undifferentiated, in some of the larger areas along drainageways; and in a few areas along Chapelle Creek and Joe Creek a soil that is more silty than Betts soils.

This Betts soil has a high available water capacity, but has rapid runoff and is too steep and erodible for cultivation. Control of erosion is the main concern in management.

All areas are in native grass and are used for grazing. Capability unit VIIe-3; Thin Upland range site; windbreak group 10.

Bon Series

The Bon series consists of deep, well drained or moderately well drained, nearly level loamy soils on bottom lands. These soils formed in stratified alluvium.

In a representative profile the surface layer is about 27 inches thick. The upper part is very dark grayish-brown loam. The lower part is dark grayish-brown loam, sandy loam, and clay loam. It is friable when moist and calcareous. The underlying material is light brownish-gray, calcareous silty clay loam.

Bon soils are high in fertility and organic-matter content. Permeability is moderate, and available water capacity is high. Surface runoff is slow. The soils are subject to occasional overflow and have a water table that fluctuates between depths of 4 and 10 feet.

Many areas are cultivated. Alfalfa and corn are the principal crops. Some areas are used for grazing and hay. The native vegetation is a mixture of tall, mid, and short grasses.

Representative profile of Bon loam 1,650 feet west and 135 feet north of road ditch from the southeast corner of sec. 8, T. 112 N., R. 76 W.

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

A12—6 to 14 inches, very dark grayish-brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

A13—14 to 19 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure; slightly hard, friable; slight effervescence; mildly alkaline; abrupt, wavy boundary.

A14—19 to 23 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; massive; slightly hard, very friable; slight effervescence; moderately alkaline; clear, smooth boundary.

A15—23 to 27 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; massive; hard, friable; slight effervescence; moderately alkaline; clear, smooth boundary.

C1—27 to 38 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) moist; massive; hard, firm; slight effervescence; moderately alkaline; clear, smooth boundary.

C2—38 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, brown (10YR 5/3) moist; massive; hard, firm; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 6 to 16 inches. The weighted average clay content between depths of 10 and 40 inches ranges from 20 to 30 percent. The A horizon ranges from very dark gray to dark grayish brown in hue of 10YR and from 20 to 30 inches in thickness. It commonly is loam, but ranges from sandy loam to light clay loam or silty clay loam. The C horizon ranges from dark grayish brown to pale brown in hues of 10YR or 2.5Y. It commonly is stratified with coarser textured material. Few or common faint mottles, accumulations of gypsum and other salts, and buried dark-colored layers are in the lower part of the C horizon in some places.

In contrast with Ree soils, which are on nearby terraces, Bon soils have a thicker A horizon and lack a B horizon. They have a thicker and darker colored A horizon and are less sandy than Munjor soils, which also are on bottom lands.

Bon loam (0 to 2 percent slopes) (Bo).—This soil is on bottom lands or low terraces along streams (fig. 5). In some areas the surface layer is silt loam or silty clay loam and is slightly thinner than typical.

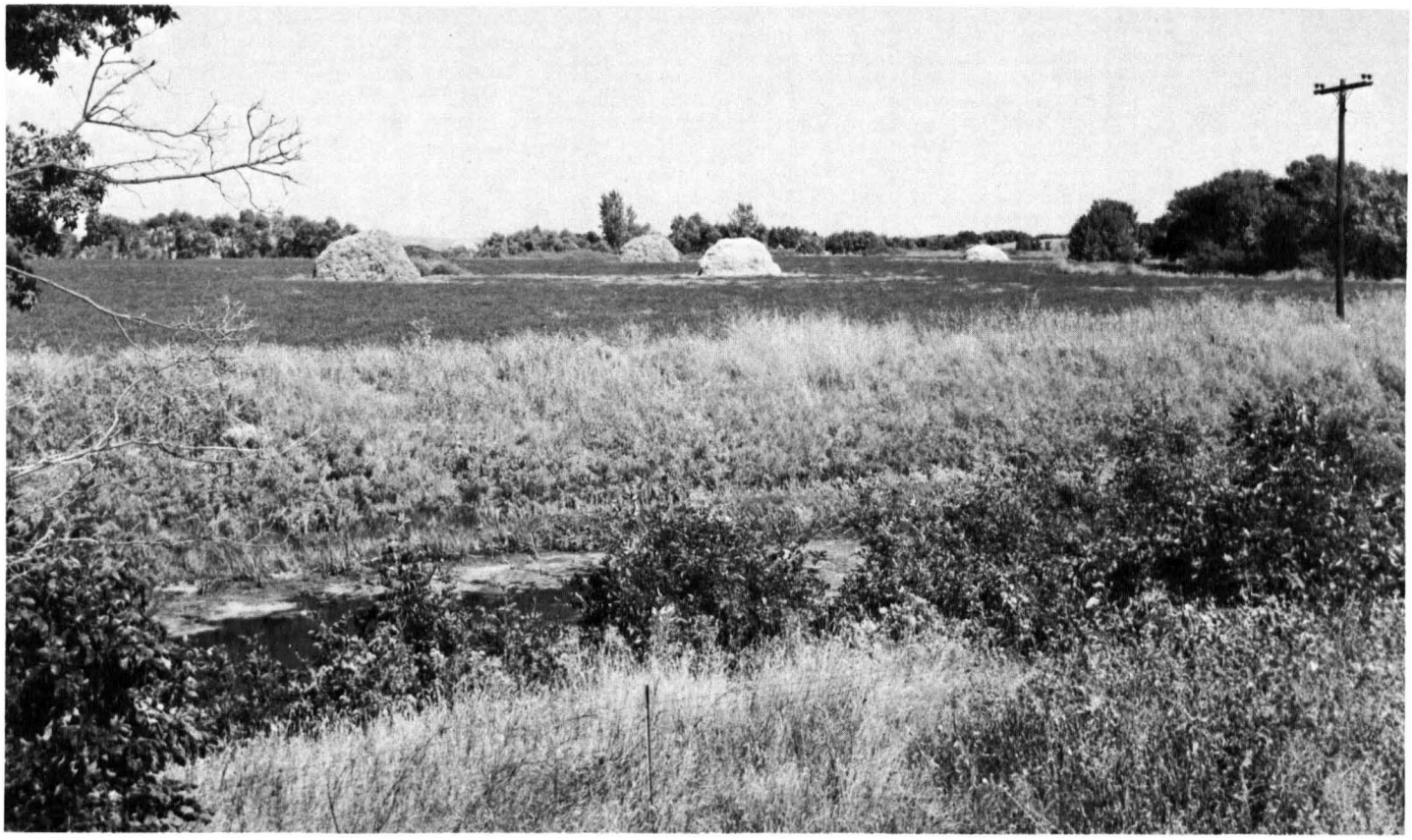

Figure 5.—**Area of Bon loam along South Medicine Knoll Creek.**

Included with this soil in mapping are areas of soils along South Medicine Knoll Creek that are silty to a greater depth than Bon soils, narrow strips of Alluvial land, undifferentiated, along creek channels, and spots where salts have accumulated at or near the surface.

This Bon soil is easily worked and is high in fertility. Available water capacity is high. The water table fluctuates between depths of 4 and 10 feet in most areas. Surface runoff is slow. Most areas receive additional moisture as runoff from adjacent soils or from stream flooding. Conserving moisture is the main concern in management.

Many areas are cultivated. Corn and alfalfa are the main crops, but all crops commonly grown in the county are well suited. Some areas are in native grass and are used for grazing or hay. Capability unit IIc-3; Overflow range site; windbreak group 1.

Canning Series

The Canning series consists of well-drained, nearly level to gently sloping loamy soils that are moderately deep over sand and gravel. These soils formed in alluvium and are on terraces.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The subsoil, about 13 inches thick, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. It is hard when dry and friable when moist. The underlying material is pale-brown, calcareous clay loam to a depth of 30 inches. Loose sand and gravel are below a depth of 30 inches.

Canning soils are medium in fertility and moderate in organic-matter content. Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel. Available water capacity is moderate. Surface runoff is slow or medium, depending on the slope.

Most areas are cultivated. Small grain and sorghum are the principal crops. Some areas are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Canning loam, 0 to 2 percent slopes, in native grass, 2,520 feet north and 66 feet east of fence from the southwest corner of sec. 28, T. 110 N., R. 75 W.

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, platy and moderate, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B21t—5 to 12 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable; thin, continuous clay films; neutral; gradual, smooth boundary.

B22t—12 to 18 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; thin, patchy clay films; mildly alkaline; abrupt, wavy boundary.

C1ca—18 to 30 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak, coarse, subangular blocky structure; hard, friable; many, fine and medium segregations of lime; strong effervescence; moderately alkaline; abrupt, wavy boundary.

IIC2—30 to 60 inches, varicolored sand and gravel that contains numerous fine shale chips; single grained; loose; strong effervescence; mildly alkaline.

Depth to free carbonates ranges from 12 to 20 inches, and depth to sand and gravel from 20 to 40 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR and ranges from 4 to 7 inches in thickness. It commonly is loam, but is silt loam in places. The B2t horizon ranges from 10 to 18 inches in thickness and is clay loam or loam that has a clay content of 26 to 35 percent, typically about 28 percent. A B3 or B3ca horizon occurs in some profiles of this series, and it ranges from grayish brown to pale brown in hues of 10YR or 2.5Y. The C horizon above the sand and gravel commonly is clay loam, but is loam or sandy loam in some places.

Canning soils are near Orton and Ree soils. They contain more clay in the B horizon than Orton soils. They are shallower over sand and gravel than Ree soils.

Canning loam, 0 to 2 percent slopes (CaA).—This soil is on terraces mainly along Chapelle Creek. It is dominantly nearly level, but in small areas slopes are 2 percent or more. It has the profile described as representative of the series, but in a few places the surface layer is silt loam.

Included with this soil in mapping are areas of Onita and Ree soils. Onita soils are in swales or slight depressions. Ree soils are in areas where gravel is at a depth of 40 inches or more.

This Canning soil is easy to work and medium in fertility, but it is somewhat droughty because of the underlying sand and gravel. Surface runoff is slow. Conserving moisture is the main concern in management.

Most areas are under cultivation. Under dryland farming this soil is better suited to small grain, sorghum, and tame grasses than to corn and alfalfa. It is well suited to irrigation. Some areas are in native grass and are used for grazing. Capability unit IIIs-2; Silty range site; windbreak group 6.

Canning loam, 2 to 5 percent slopes (CaB).—This soil is at the outer edges of upland terraces. It is dominantly gently sloping, but in some small areas it is nearly level, and on isolated knolls it has slopes of more than 5 percent. It has a slightly thinner surface layer than that of the representative profile.

Included with this soil in mapping is a soil, on low ridgetops and the crests of rounded knolls, that has sand and gravel at a depth of 10 to 20 inches.

This Canning soil is somewhat droughty for deep-rooted crops, such as corn and alfalfa. Surface runoff is medium, and cultivated areas are susceptible to erosion and soil blowing. The main concerns in management are controlling erosion and soil blowing and conserving moisture.

Most areas are in native grass and are used for grazing. If cultivated, this soil is better suited to spring-sown small grain and tame grasses than to corn and alfalfa. Capability unit IIIe-6; Silty range site; windbreak group 6.

Cavo Series

The Cavo series consists of deep, moderately well drained, nearly level to gently undulating silty soils that have a claypan subsoil. These soils formed in glacial till of clay loam texture on uplands.

In a representative profile the surface layer is dark grayish-brown silt loam about 4 inches thick. The subsurface layer is gray silt loam about 3 inches thick. The subsoil, about 13 inches thick, is dark grayish-brown heavy clay loam in the upper part and grayish-brown clay loam in the lower part. The upper part is extremely hard when dry and very firm when moist. The lower part is calcareous. The underlying material is light brownish-gray, calcareous clay loam to a depth of 31 inches and has many spots and streaks of soft lime. Below this is light yellowish-brown, calcareous clay loam.

Cavo soils are low or medium in fertility and are moderately low in organic-matter content. Permeability is slow or very slow, and surface runoff is slow or medium. Available water capacity is moderate.

Many areas are cultivated. Winter wheat and oats are the main crops. Spring wheat, corn, tame grasses, and alfalfa also are grown. Other areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Cavo silt loam from an area of Cavo-Demky silt loams, 0 to 2 percent slopes, in native grass, 1,520 feet south and 60 feet east of the center of sec. 11, T. 111 N., R. 75 W.

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

A2—4 to 7 inches, gray (10YR 5/1) silt loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, platy structure parting to weak, fine, granular; slightly hard, very friable; neutral; abrupt, smooth boundary.

B21t—7 to 9 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; thin gray (10YR 5/1) coatings on column tops; moderate, medium, columnar structure parting to strong, fine, blocky; extremely hard, very firm; thin patchy clay films; mildly alkaline; clear, smooth boundary.

B22t—9 to 14 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; strong, fine, blocky structure; very hard, very firm; thin patchy clay films; mildly alkaline; clear, wavy boundary.

B3ca—14 to 20 inches, grayish-brown (10YR 5/2) clay loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; very hard, firm; few, very fine segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—20 to 31 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; medium, subangular blocky structure; very hard, firm; many medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—31 to 60 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 4/3) moist; massive; hard, firm; common iron stains; common fine shale chips; few fine segregations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 10 to 18 inches. The A1 horizon ranges from very dark gray to grayish brown in hue of 10YR, is silt loam or loam, and ranges from 3 to 5 inches in thickness. The A2 horizon is gray or light gray in hue of 10YR and from 1 to 3 inches in thickness. It has a fine to coarse platy structure. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR or 2.5Y. It is heavy clay loam or light clay that has a clay content ranging from 35 to 50 percent. The columnar structure in the

B21t horizon is moderate or strong and medium or fine. The B22t horizon commonly has moderate, medium, prismatic structure that parts to moderate or strong, medium or fine, blocky. The B3ca and C horizons have few to many, very fine to medium spots and striations of segregated lime and other salts. Exchangeable sodium exceeds 15 percent in some part of the B or C horizon.

Cavo soils are similar to DeGrey soils, are mapped with Demky and Raber soils, and are near Glenham and Jerauld soils. They contain less silt in the B horizon than DeGrey soils. They have a thinner A1 horizon and a more distinct A2 horizon than Demky soils. They contain more clay in the B horizon than Glenham soils. They have a thicker A horizon and contain less salts than Jerauld soils. They differ from Raber soils in having an A2 horizon and more sodium in the B horizon.

Cavo-Demky silt loams, 0 to 2 percent slopes (CdA).—This complex is about 40 percent Cavo soil, 30 percent Demky soil, and 30 percent other soils. The Cavo soil is in slight depressions. The Demky soil is closely intermingled with the Cavo soil, or it is at the outer edges of mapped areas. Both soils have the profiles described as representative of their respective series. Few or common glacial boulders are on the surface in most areas.

Included with these soils in mapping are areas of Eakin, Jerauld, and Raber soils. Of these, Raber soils are the most common and make up about 20 percent of the mapped areas. Raber and Eakin soils are on slight rises. Jerauld soils are in some of the low spots with Cavo soils.

Cavo and Demky soils have poor tilth and take in water slowly or very slowly. Their claypan subsoil releases moisture slowly to plants and restricts the development of root systems. Improving tilth and the intake of water are concerns in management.

Most areas are in native grass and are used for grazing or hay. If cultivated, these soils are better suited to small grain, alfalfa, and tame grasses than to corn. Capability unit IVs-2; Cavo soil in Claypan range site, windbreak group 9; Demky soil in Clayey range site, windbreak group 4.

Chantier Series

The Chantier series consists of shallow, well-drained, gently sloping to sloping clayey soils on uplands. These soils formed in clayey materials weathered from the underlying shale.

In a representative profile the surface layer is light brownish-gray, calcareous clay about 2 inches thick. The subsoil, about 11 inches thick, is light brownish-gray, calcareous clay. It is extremely hard when dry, extremely firm when moist, and very sticky and very plastic when wet. Many streaks and spots of gypsum and other salts are in the lower part. Below the subsoil is about 5 inches of light olive-gray shaly clay. Bedded shale is at a depth of 18 inches.

Chantier soils are low in fertility and in organic-matter content. Permeability is very slow, and surface runoff is medium or rapid. Available water capacity is very low.

All areas are in native vegetation, which consists of a sparse stand of mid grasses and very little or no understory of short grasses.

Representative profile of Chantier clay, 2 to 9 percent slopes, in native grass, 1,450 feet north and 530 feet east of the southwest corner of sec. 21, T. 111 N., R. 79 W.

A1—0 to 2 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; moderate, fine, granular and weak, fine, blocky structure; very hard, firm, sticky, plastic; slight effervescence; moderately alkaline; clear, smooth boundary.

B2—2 to 6 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak, medium and coarse, blocky structure; extremely hard, extremely firm, very sticky and very plastic; slight effervescence; moderately alkaline; clear, wavy boundary.

B3cssa—6 to 13 inches, light brownish-gray (2.5Y 6/2) clay, olive gray (5Y 4/2) moist; weak, coarse, blocky structure; extremely hard, extremely firm, very sticky and very plastic; many fine segregations of gypsum and salt; slight effervescence; moderately alkaline; clear, wavy boundary.

C1—13 to 18 inches, light olive-gray (5Y 6/2) shaly clay, olive gray (5Y 5/2) moist; massive; hard, firm, sticky and plastic; about 60 to 70 percent of mass is fragments of partly weathered shale; few fine segregations of gypsum; slight effervescence; moderately alkaline; gradual, wavy boundary.

C2—18 to 60 inches, light olive-gray (5Y 6/2) bedded shale, olive gray (5Y 5/2) moist; hard and brittle, firm; interbedded below a depth of 36 inches with thin layers of pale-olive (5Y 6/3) bentonite; moderately alkaline.

Depth to bedded shale ranges from 12 to 20 inches. When the soil is dry, cracks 1 to 2 inches wide and several feet long extend downward through the B horizon. Soil colors range from grayish brown to light olive gray in hues of 2.5Y and 5Y. The A horizon commonly has a weak crust that parts readily to granular structure. It ranges from 1 to 3 inches in thickness. The B2 horizon has a clay content ranging from 65 to 75 percent, and it ranges from 4 to 8 inches in thickness. The B3cssa horizon is moderately alkaline or strongly alkaline, and conductivity ranges from 4 to 12 millimhos per centimeter.

Chantier soils are near Lakoma, Sansarc, and Swanboy soils. They contain more salts and are of harder consistence than Lakoma and Sansarc soils. They are shallower over bedded shale than Swanboy soils.

Chantier clay, 2 to 9 percent slopes (ChC).—This soil is on uplands. Scattered glacial boulders ranging from 1 to 6 feet in diameter are on the surface in some areas.

Included with this soil in mapping are areas of Swanboy soils and Slickspots along drainageways. Also included in some areas is a soil similar to Chantier soils, but more than 20 inches deep over shale.

This Chantier soil is low in fertility and has very low available water capacity. Permeability is very slow. Surface runoff is medium or rapid, and the soil erodes easily.

All areas are in native grass and are used for grazing. Capability unit VIs-5; Dense Clay range site; windbreak group 10.

Cut and Fill Land

Cut and fill land (2 to 40 percent slopes) (Cu) consists of compacted land fills and deeply cut areas. The original soils are so altered that they cannot be identified. Some areas have been covered with thin layers of topsoil and revegetated with tame and native grasses. The largest area surrounds Oahe Dam and its powerhouse. Smaller areas, within the city of Pierre, consist of cut areas along drainageways and escarpments and of former drainageways and low areas filled with shale, clay, sand, gravel, debris, and various other kinds of fill material.

Natural fertility is low in most areas. Properties related to soil moisture differ from one area to another. The shrink-swell potential is high in cut areas where

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clayey shale is near the surface and in areas filled with clay and shale. Controlling erosion is a serious concern unless vegetation is established.

Most areas have been revegetated with tame and native grasses. Drains and diversions have been installed in some areas to help control runoff and erosion. Onsite investigation to determine the nature of the underlying material is advisable before construction of buildings. Additional topsoil is needed in most areas for establishment of lawns. Not assigned to interpretive groups.

DeGrey Series

The DeGrey series consists of deep, moderately well drained, nearly level to gently sloping silty soils that have a claypan subsoil. These soils formed in silty material on uplands.

In a representative profile the surface layer is dark grayish-brown silt loam about 4 inches thick. The subsurface layer is about 3 inches of gray silt loam. The subsoil, about 10 inches thick, is dark grayish-brown silty clay. It is very hard when dry and very firm when moist. The underlying material is light brownish-gray, calcareous silty clay loam to a depth of 30 inches. Below this is light brownish-gray, calcareous clay loam.

DeGrey soils are low or medium in fertility and are moderate in organic-matter content. Permeability is slow or very slow, and surface runoff is slow or medium. Available water capacity is moderate.

Some areas are cultivated. Winter wheat and oats are the main crops. Spring wheat, corn, tame grasses, and alfalfa also are grown. Other areas are in native grass and are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of DeGrey silt loam from an area of DeGrey-Walke silt loams, 0 to 2 percent slopes, in native grass, 2,410 feet north and 150 west of fence from the southeast corner of sec. 23, T. 112 N., R. 75 W.

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

A2—4 to 7 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, medium and coarse, platy structure; slightly hard, very friable; mildly alkaline; abrupt, smooth boundary.

B21t—7 to 10 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2 moist; gray (10YR 5/1) coatings on column tops and some vertical faces of peds; moderate, medium, columnar structure parting to strong, fine, blocky; very hard, very firm; thin patchy clay films; mildly alkaline; clear, wavy boundary.

B22t—10 to 17 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, blocky structure; very hard, very firm; thin patchy clay films; mildly alkaline; clear, wavy boundary.

C1cacs—17 to 30 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; hard, firm; few fine nests of salts; common fine segregations and striations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC2ca—30 to 48 inches, light brownish-gray (2.5Y 6/2) clay loam, olive brown (2.5Y 4/3) moist; weak, medium, subangular blocky structure; hard, firm; few fine and medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC3—48 to 60 inches, light brownish-gray, (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; common, fine mottles of yellowish red (5YR 4/6); massive; hard, friable; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 12 to 20 inches. The silty mantle in which the soil formed ranges from 20 to 40 inches in thickness over the underlying glacial till and is less than 10 percent sand coarser than very fine sand. The A1 horizon ranges from dark gray to grayish brown in hue of 10YR and is 3 to 6 inches thick. The A2 horizon ranges from gray to light brownish gray in hue of 10YR and is 1 to 3 inches thick. In cultivated areas the A1 and A2 horizons commonly are mixed by plowing, and the fields have a spotted, gray appearance. The B2t horizon is dark grayish brown or grayish brown in hues of 10YR or 2.5Y and ranges from 40 to 50 percent in clay content. The columnar structure in the B21t horizon is moderate or strong and medium or fine. The B22t horizon commonly has moderate, medium, prismatic structure that parts to moderate or strong, medium or fine, blocky structure. In places the soil has a B3ca horizon. Segregations of lime, gypsum, and other salts range from few to many in the C1 and IIC horizons.

DeGrey soils are similar to Cavo soils, and are near or are mapped with Eakin, Highmore, and Walke soils. They contain more silt and less sand in the Bt horizon than Cavo soils. They contain more clay and sodium in the B horizon than Eakin and Highmore soils. They differ from Walke soils in having a more distinct A2 horizon and columnar structure in the Bt horizon.

DeGrey-Walke silt loams, 0 to 2 percent slopes (DeA).—This complex is about 50 percent DeGrey soil, 30 percent Walke soil, and 20 percent other soils. These DeGrey and Walke soils are closely intermingled with the DeGrey soils in small slight depressions and the Walke soils on very slight rises between the low spots. The profiles of these soils are the ones described as representative of their respective series, but in a few places the silty material in which the soil formed extends below a depth of 40 inches.

Included with these soils in mapping are areas of Cavo, Eakin, Highmore, and Hoven soils. Of these, Eakin and Highmore soils are the most extensive. They are on slight rises. Spots of Cavo soils are in slight depressions in some areas of this mapping unit in T. 112 N., R. 74 W. Hoven soils are in small closed depressions and are identified by a wet spot symbol on the soil map.

These DeGrey and Walke soils take in water slowly or very slowly. The DeGrey soil has poor tilth and is difficult to work. Its claypan subsoil releases moisture slowly to plants and restricts roots. Improving tilth and water intake are the main concerns in management.

Many areas are under cultivation. Small grain, corn, and alfalfa are the main crops. Corn is less well suited than the other crops. Other areas are in native grass used for grazing and hay. Capability unit IVs-2; DeGrey soil in Claypan range site, windbreak group 9; Walke soil in Clayey range site, windbreak group 4.

Demky Series

The Demky series consists of deep, moderately well drained, nearly level silty soils on uplands. These soils formed in firm clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsurface layer, about 3 inches thick, is grayish-brown

light clay loam that contains gray coatings of bleached sand grains. The subsoil, about 14 inches thick, is clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and light brownish gray in the lower part. The upper and middle parts are very hard when dry, firm when moist, and sticky and plastic when wet. The lower part is calcareous and has spots and streaks of soft lime that extend to the underlying material. The underlying material is light brownish-gray and grayish-brown, calcareous clay loam.

Demky soils are medium in fertility and moderate in organic-matter content. Permeability is slow, and surface runoff is slow. Available water capacity is moderate or high.

Many areas are cultivated. Small grain, corn, alfalfa, and tame grasses are the main crops. The native vegetation is a mixture of mid and short grasses.

Representative profile of Demky silt loam from an area of Cavo-Demky silt loams, 0 to 2 percent slopes, in native grass, 2,505 feet south and 36 feet east of fence from the northwest corner of sec. 15, T. 112 N., R. 75 W.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A12—4 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; slightly hard, friable; neutral; clear, smooth boundary.

B&A—8 to 11 inches, grayish-brown (10YR 5/2) light clay loam (B part), very dark grayish brown (10YR 3/2) moist; many gray (10YR 6/1 and 10YR 5/1) patches of bleached sand grains (in A part), dark gray (10YR 4/1) moist; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, wavy boundary.

B21t—11 to 15 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, fine, blocky; very hard, firm, sticky, plastic; thin patchy clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—15 to 18 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, fine, blocky structure; very hard, firm, sticky, plastic; thin patchy clay films on faces of peds; slight effervescence; moderately alkaline; clear, wavy boundary.

B3ca—18 to 25 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—25 to 36 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—36 to 60 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine nests of gypsum crystals; few fine segregations of lime; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 12 to 20 inches. The A1 horizon is dark grayish brown or grayish brown in hue of 10YR, is silt loam or loam, and is 5 to 8 inches thick. The B&A horizon is 2 or 3 inches thick. The B2t horizon has a clay content ranging from 35 to 45 percent. Segregations of lime in the B3ca and Cca horizons are few to many and are fine or medium in size. The C horizon ranges from grayish brown to pale brown in hue of 10YR or 2.5Y and from loam to light clay in texture. In places it contains a few segregations of gypsum and other salts.

Demky soils are mapped with or are near Cavo and Raber soils and are similar to Walke soils. They do not have the distinct A2 horizon that is typical of Cavo soils nor the columnar structure in the Bt horizon. They have more sodium in the B horizon than Raber soils. They contain less silt and more sand in the Bt horizon than Walke soils.

Demky-Cavo silt loams, 0 to 2 percent slopes (DkA).—This complex is about 50 percent Demky soil, 30 percent Cavo soil, and 20 percent other soils. Slopes appear long and smooth, but the surface is uneven and is spotted with many slight depressions. The Demky soil is on the very slight rises and the Cavo soil is in the depressions.

Included with these soils in mapping are areas of Eakin, Glenham, Jerauld, and Raber soils. Of these, Raber soils are the most extensive and make up as much as 20 percent of some mapped areas. Eakin, Glenham, and Raber soils are on slight rises. Jerauld soils are in some of the low spots with Cavo soils.

These Demky and Cavo soils take in water slowly or very slowly. The Cavo soil has poor tilth and is difficult to work. Its claypan subsoil restricts roots.

The Demky soil is suited to most crops grown in the county, but because areas are partly Cavo soils, sorghum is a better suited row crop than corn. Some areas are in native grass and are used for grazing and hay. Capability unit IIIs-1; Demky soil in Clayey range site, windbreak group 4; Cavo soil in Claypan range site, windbreak group 9.

Dorna Series

The Dorna series consists of deep, well-drained, nearly level silty soils on terraces. These soils formed in wind-deposited silts that are underlain by clayey material.

In a representative profile the surface layer is about 15 inches thick. It is dark grayish-brown silt loam in the upper part and very dark grayish-brown, calcareous silt loam in the lower part. The next layer is grayish-brown, calcareous silt loam about 9 inches thick. Below a depth of 24 inches is light brownish-gray and grayish-brown, calcareous silty clay. Many spots and streaks of soft lime are in the upper few inches. Spots and streaks of salts are below a depth of 39 inches.

Dorna soils are medium in fertility and moderate in organic-matter content. Permeability is moderate to a depth of 24 inches and slow below that depth. Surface runoff is slow, and available water capacity is moderate or high.

Most areas are cultivated. Corn, alfalfa, and small grain are the principal crops. A few, small areas are irrigated. Some areas are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Dorna silt loam, in a cultivated field, 1,176 feet west of the center of sec. 3, T. 109 N., R. 76 W.

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

A12—7 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) moist; weak, coarse, prismatic structure; slightly hard, very

friable; common very fine striations of soft lime; slight effervescence; mildly alkaline; clear, smooth boundary.

C1—15 to 24 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure; slightly hard, very friable; few very fine segregations of lime; strong effervescence; mildly alkaline; abrupt, smooth boundary.

IIC2ca—24 to 27 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; moderate, medium and fine, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC3—27 to 39 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; weak, medium and coarse, subangular blocky structure; very hard, firm, sticky and plastic; few fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC4—39 to 46 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky and plastic; common very fine segregations of lime and salts; slight effervescence; moderately alkaline; gradual, wavy boundary.

IIC5—46 to 60 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky and plastic; few fine and very fine segregations of salts; slight effervescence; moderately alkaline.

Depth to free carbonates commonly ranges from 4 to 10 inches, but in some places the soil is calcareous at the surface. The silty material in which the soil formed ranges from 20 to 40 inches in thickness. It is silt loam or very fine sandy loam and is less than 18 percent clay and less than 15 percent fine sand or coarser. In places the soil has a buried A horizon. The A horizon ranges from very dark grayish brown to grayish brown in hue of 10YR and from 8 to 18 inches in thickness. The C1 horizon ranges from grayish brown to pale brown in hue of 10YR. The IICca horizon ranges from grayish brown to pale brown in hue of 10YR or 2.5Y and is heavy silty clay loam or silty clay. Segregations of lime are common or many and are medium or coarse in size. The IIC horizon, below the IICca horizon, ranges from grayish brown to pale olive in hue of 2.5Y or 5Y. This horizon contains few to many, very fine to medium segregations of salts.

Dorna soils are near Lowry and Sully soils. They differ from those soils in having clayey underlying material at a depth of less than 40 inches. They also have a thicker A horizon than Sully soils.

Dorna silt loam (0 to 2 percent slopes) (Do).—This soil is on terraces or benches along Lake Oahe and Lake Sharpe. The terraces or benches are at levels ranging from 15 to 150 feet above the high water level of these reservoirs. The terrain is dominantly nearly level, but in some mapped areas slopes are as much as 4 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of Lowry soils, in places where the silty material extends below a depth of 40 inches. Also included is a soil that is similar to this Dorna soil, but has clayey material at a depth of 10 to 18 inches; and a few areas, in slight depressions and swales, of a soil that has a thicker surface layer than that of the Dorna soil.

This Dorna soil is free of stones and is easy to work. Available water capacity is moderate or high, but moisture penetrates the underlying clayey material slowly. Controlling soil blowing and conserving moisture are the main concerns in management.

Most areas are cultivated, and the soil is suited to all crops commonly grown in the area. A few small areas are irrigated. Corn, alfalfa, and small grain are the main crops. A few areas are in tame pasture, and some are in native grass. Capability unit IIe-1; Silty range site; windbreak group 3.

Dorna silt loam, thin solum (0 to 2 percent slopes) (Dr).—This soil is on benches or terraces adjacent to Lake Sharpe. The terrain is smooth except in small areas where slopes are as much as 4 percent. The profile of this soil differs from the one described as representative of the Dorna series in having clayey material at a depth of 10 to 20 inches. Also, the surface layer is thinner and in places is very fine sandy loam.

Included with this soil in mapping are areas of Millboro soils, where the silty material is less than 10 inches thick. Also included are small areas where the profile of this soil differs only slightly from the one described as representative of the Dorna series.

This Dorna soil is free of stones and is easy to work. The upper part takes in water readily, but the clayey underlying material takes in water slowly and releases moisture slowly to plants. Root systems of deep-rooted crops are restricted by the underlying clayey material. Improving water intake, controlling soil blowing, and conserving moisture are the main concerns in management.

Many areas are cultivated. Corn, alfalfa, and small grain are the main crops. Sorghum is a better suited row crop than corn. Capability unit IIIs-3; Silty range site; windbreak group 4.

Durrstein Series

The Durrstein series consists of deep, poorly drained, nearly level silty soils that have a claypan subsoil. These soils formed in alluvium and are on bottom lands.

In a representative profile the surface layer is gray silt loam about 2 inches thick. The subsoil, about 12 inches thick, is dark-gray clay and silty clay. The upper part is extremely hard when dry, very firm when moist, and sticky and plastic when wet. The underlying material is gray, calcareous silty clay. It is strongly alkaline in reaction and contains spots of gypsum and other salts.

Durrstein soils are low or medium in fertility and moderate in organic-matter content. Permeability is slow or very slow. Surface runoff is slow. A water table fluctuates between depths of 3 and 10 feet. Available water capacity is low or moderate.

Most areas are in native grass and are used for grazing or hay. Alfalfa is the main crop in the few areas that are cultivated. The native vegetation is a mixture of tall, mid, and short grasses.

Representative profile of Durrstein silt loam from an area of Durrstein-Egas complex, 1,584 feet east and 156 feet south of fence from the northwest corner of sec. 2, T. 112 N., R. 76 W.

A2—0 to 2 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; few, distinct mottles of yellowish brown (10YR 5/8); weak, fine, platy structure; soft, very friable; slightly acid; abrupt, smooth boundary.

B21t—2 to 5 inches, dark-gray (10YR 4/1), clay, very dark gray (10YR 3/1) moist, gray (10YR 6/1 and 5/1) coats on column tops; moderate, medium, columnar

structure parting to strong, fine, blocky; extremely hard, very firm, sticky and plastic; mildly alkaline; clear, wavy boundary.

B22t—5 to 14 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, blocky; very hard, firm, sticky and plastic; mildly alkaline, clear, wavy boundary.

C1gsa—14 to 23 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; weak, fine, subangular blocky structure; very hard, firm, sticky and plastic; many, fine segregations and striations of gypsum and other salts; slight effervescence; strongly alkaline; gradual, wavy boundary.

C2gsa—23 to 60 inches, gray (5Y 5/1) silty clay, olive gray (5Y 4/2) moist; massive; very hard, firm, sticky and plastic; many, fine segregations and striations of gypsum and other salts; strong effervescence; strongly alkaline.

Depth to free carbonates and salt accumulations ranges from 12 to 20 inches. Exchangeable sodium exceeds 15 percent in part of the B or C horizon. The A2 horizon ranges from gray to light brownsh gray in hue of 10YR and is 1 to 4 inches thick. The B2t horizon is dark gray or gray in hue of 10YR and is clay or silty clay that has a clay content ranging from 40 to 55 percent. It has weak or moderate, medium or fine, columnar structure in the upper part and is 8 to 12 inches thick. In places the soil has a B3ca horizon. The C horizon ranges from dark gray to light olive gray in hue of 2.5Y or 5Y and is silty clay or clay. Few to many, faint or distinct mottles commonly are in the B3 or C horizons. Thin layers of coarser textured material are below a depth of 40 inches in some places. The C horizon is moderately alkaline or strongly alkaline.

Durrstein soils are mapped with Egas soils and are near Mosher soils. They differ from Egas soils in having a columnar-structured B horizon and segregations of salts deeper in the profile. Durrstein soils are more poorly drained than Mosher soils and have segregations of salts nearer the surface.

Durrstein-Egas complex (0 to 2 percent slopes) (Du).—This complex is typically about 70 percent Durrstein soil and 30 percent Egas soil, but in one small area along North Medicine Knoll Creek near the Sully County line, the Egas soil is dominant. These soils are on bottom lands mainly along Chapelle, North Medicine Knoll, and South Medicine Knoll Creeks. They are nearly level, but the surface is uneven because many, small depressions are interspersed between low mounds. Durrstein soils are in the depressions and Egas soils are on the low mounds. The profile of each soil is the one described as representative of the respective series, but the texture of the surface layer differs from one place to another. The texture is loam, silt loam, silty clay loam, or silty clay.

A fluctuating water table and accumulations of salts limit the use of these soils. The Egas soil has accumulations of salts at or within 10 inches of the surface.

Most areas are in native grass and are used for grazing. Alfalfa is the main crop in the few cultivated areas. Capability unit VIw-4; Saline Lowland range site; windbreak group 10.

Eakin Series

The Eakin series consists of deep, well-drained, nearly level to sloping or undulating silty soils on uplands. These soils formed in silty materials and the underlying loam or clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil, about 15 inches thick, is silty clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and light brownish gray in the lower part. The upper part is slightly hard when dry and friable when moist. The middle and lower parts are calcareous. In addition, the lower part contains spots and streaks of soft lime that extend into the underlying material. The underlying material is light brownish-gray, calcareous silty clay loam to a depth of 33 inches. Below this is grayish-brown and light olive-gray, calcareous glacial till of heavy clay loam texture.

Eakin soils are medium in fertility and moderate in organic-matter content. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying glacial till. Surface runoff is slow or medium, depending on the slope. Available water capacity is high.

Most areas are cultivated. Principal crops are small grain, corn, alfalfa, and sorghums. Some areas are in native grass and are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Eakin silt loam from an area of Eakin-Raber silt loams, 2 to 5 percent slopes, in native grass, 1,000 feet west and 88 feet south of the northeast corner of sec. 2, T. 109 N., R. 74 W.

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky and moderate, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

B2t—7 to 13 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B31—13 to 18 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky; slightly hard, friable; slight effervescence; mildly alkaline; clear, wavy boundary.

B32ca—18 to 22 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; hard, friable; many medium segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

C1ca—22 to 33 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure; very hard, firm; many medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

IIC2—33 to 50 inches, grayish-brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; hard, firm; few, fine, yellowish-brown (10YR 5/6) iron stains; few fine segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

IIC3—50 to 60 inches, light olive-gray (5Y 6/2) heavy clay loam, olive gray (5Y 4/2) moist; massive; hard, firm; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 10 to 18 inches. Depth to underlying glacial till ranges from 20 to 40 inches. The A horizon ranges from dark gray to grayish brown in hue of 10YR and is 5 to 8 inches thick. The B2t horizon is dark grayish brown or grayish brown in hues of 10YR or 2.5Y. Estimated clay content ranges from 25 to 35 percent, but is typically about 28 percent. The IIC horizon ranges from grayish brown to light olive gray in hues of 10YR through 5Y. It is commonly clay loam, but has a thin stratum of loam or silt loam in some places.

Eakin soils are mapped with or are near Glenham, Highmore, Onita, and Raber soils. They contain more silt and less sand in the B horizon than Glenham soils. They are shallower over glacial till than Highmore soils. They contain less clay in the B horizon than Onita and Raber soils.

Eakin-Raber silt loams, 0 to 2 percent slopes (ErA).—This complex is about 50 percent Eakin soil, 30 percent Raber soil, and 20 percent other soils. The soils are intermingled in an erratic pattern. The surface layer of the Raber soil is silt loam and is slightly thicker than is typical. A few low ridges and slight depressions or swales interrupt the otherwise smooth, nearly level terrain. A few glacial boulders are on the surface in some areas.

Included with these soils in mapping are areas of Cavo, Highmore, and Onita soils. The Highmore soil is the most extensive of these and makes up as much as 20 percent of mapped areas. It is closely intermingled with Eakin soils. Cavo and Onita soils are in some of the slight depressions and swales.

These Eakin and Raber soils are medium in fertility and are easy to work. Surface runoff is slow, and available water capacity is high. Conserving moisture is the main concern in management.

Most areas are cultivated. Small grain, corn, alfalfa, and sorghums are the main crops. Capability unit IIc-2; windbreak group 3; Eakin soil in Silty range site, Raber soil in Clayey range site.

Eakin-Raber silt loams, 2 to 5 percent slopes (ErB).—The Eakin soil makes up about 55 percent of this complex, the Raber soil 35 percent, and other soils 10 percent. The soils are intermingled in an erratic pattern. They are mostly gently undulating, but in small areas they are nearly level and undulating. The profile of the Eakin soil is the one described as representative of the series. The surface layer of the Raber soil is silt loam and is slightly thicker than is typical.

Included with these soils in mapping are areas of Cavo, Highmore, and Onita soils. Cavo and Onita soils are in the lower parts of the landscape along drainageways and in swales. Highmore soils are intermingled with the Eakin soils.

These Eakin and Raber soils are medium in fertility and are easy to work. Available water capacity is high, and surface runoff is medium. Controlling erosion is the main management concern.

Most areas are cultivated. Small grain, corn, alfalfa, and sorghums are the main crops. A few areas are in native grass used for grazing and hay. Capability unit IIe-2; windbreak group 3; Eakin soil in Silty range site, Raber soil in Clayey range site.

Eakin-Raber silt loams, 5 to 9 percent slopes (ErC).—This undulating complex is about 50 percent Eakin soil, 40 percent Raber soil, and 10 percent other soils. The soils are in an erratic pattern. The Eakin soil has a slightly thinner surface layer and subsoil than is typical for its series. The Raber soil has the profile described as representative of its series, but in many places the surface layer is silt loam. The soils in some cultivated areas are moderately eroded, and the surface layer has been mixed with the subsoil by plowing. Slopes are short and irregular in shape. A few scattered glacial boulders commonly are on the ridgetops.

Included with these soils in mapping are areas of Cavo, Highmore, Hoven, Jerauld, and Peno soils. Cavo and Jerauld soils are in the lower parts of the landscape or along drainageways. Highmore soils are intermingled with the Eakin soils. Hoven soils are in small depressions less than 2 acres in size and are identified by a wet spot symbol on the soil map. Peno soils are on ridgetops. Also included are small stony areas, less than 3 acres in size, that are designated by a stony symbol on the soil map.

Surface runoff is medium, and erosion is a severe hazard in cultivated areas. Controlling erosion is the main concern in management.

Many areas are in native grass and are used for grazing. In cultivated areas small grain, alfalfa, and tame grasses are better suited to these soils than row crops because the hazard of erosion is severe. Capability unit IIIe–2; windbreak group 3; Eakin soil in Silty range site, Raber soil in Clayey range site.

Egas Series

The Egas series consists of deep, poorly drained, nearly level silty soils that are high in salts. These soils formed in alluvium and are on bottom lands.

In a representative profile the surface layer is gray silt loam in the upper part and dark-gray silty clay loam in the lower part. It is about 5 inches thick. Below the surface layers are layers of very dark gray and dark-gray silty clay loam that contain many spots and streaks of salts. Below a depth of 15 inches is olive-gray and gray, calcareous silty clay. In it are spots and streaks of soft lime and other salts.

Egas soils are low in fertility and moderate in organic-matter content. Permeability is slow, and surface runoff is slow. The water table fluctuates between depths of 2 and 5 feet. Available water capacity is low or moderate.

Nearly all areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of tall, mid, and short grasses.

The Egas soils in Hughes County are mapped only with Durrstein soils.

Representative profile of Egas silt loam from an area of Durrstein-Egas complex, in native grass, 2,280 feet west and 162 feet north of fence from the southeast corner of sec. 16, T. 112 N., R. 76 W.

A11—0 to 2 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, coarse, platy and moderate, fine, granular structure; hard, firm; mildly alkaline; clear, smooth boundary.

A12—2 to 5 inches, dark-gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak, medium and fine, subangular blocky structure; hard, firm; mildly alkaline; clear, wavy boundary.

C1sa—5 to 9 inches, very dark gray (10YR 3/1) silty clay loam, very dark brown (10YR 2/2) moist; weak, medium, subangular blocky structure; hard, firm, slightly sticky and slightly plastic; many fine segregations and striations of salts; mildly alkaline; clear, wavy boundary.

C2sa—9 to 15 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; massive; very hard, firm, slightly sticky and slightly plastic; many fine segregations and striations of salts; slight effervescence; moderately alkaline; clear, wavy boundary.

C3gsa—15 to 36 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) moist; massive; very hard, very firm, sticky and plastic; common fine segregations and striations of salts; strong effervescence; moderately alkaline; gradual, wavy boundary.

C4gsa—36 to 60 inches, gray (5Y 5/1) silty clay, dark gray (5Y 4/1) moist; massive; very hard, very firm, sticky and plastic; common fine segregations of lime and salts; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 4 to 10 inches except in some disturbed areas where the soil is calcareous at the surface. White crusts of salts are on the surface in places. The A11 horizon commonly is silt loam, but it is loam or silty clay loam in some places. The A12 horizon is dark gray or gray in hue of 10YR and is silty clay loam or silty clay. The C horizon ranges from very dark gray in the upper part to pale olive in hues of 10YR through 5Y. It is heavy silty clay loam, silty clay, or clay, but thin strata of coarser textures are below a depth of 40 inches in some places. The C horizon has mottled colors in places.

Egas soils lack a Bt horizon and are shallower over accumulations of salts than Durrstein soils with which they are mapped.

Fill Land

Fill land (0 to 2 percent slopes) (Fd) is in the lower part of the city of Pierre in much of the downtown business district. Much of it is covered with buildings and streets. The fill material consists of silt and clay mixed with various kinds of debris, including old trees and fragments of concrete and brick. In most places it is 1 foot to 6 feet thick over silty and sandy alluvium. Topsoil has been spread over the fill material to topdress gardens and lawns in residential areas.

Included with Fill land in mapping are small areas of undisturbed Munjor soils and a small area of clayey soils near the mouth of Hilgers Gulch Creek.

Fill land is subject to flooding. Runoff after heavy rains floods Main Street and occasionally runs into stores and fills basements.

Onsite investigation to determine the nature of the underlying material is advisable before construction of buildings. Not assigned to interpretive groups.

Gettys Series

The Gettys series consists of deep, well-drained through excessively drained, rolling to steep loamy soils on uplands. These soils formed in firm glacial till of clay loam texture.

In a representative profile the surface layer is grayish-brown clay loam about 3 inches thick. The next layer, about 6 inches thick, is grayish-brown, calcareous clay loam. It is hard when dry, friable when moist, and slightly sticky and slightly plastic when wet. The underlying material is light brownish-gray, calcareous clay loam. It contains spots and streaks of soft lime in the upper part and nests of gypsum crystals in the lower part.

Gettys soils are low in fertility and moderately low in organic-matter content. Permeability is moderately slow, and surface runoff is rapid. Available water capacity is moderate or high.

All areas are in native grass and are used for grazing. The native vegetation is a mixture of mid and short grasses.

Representative profile of Gettys clay loam, 15 to 40 percent slopes, in native grass, 2,640 feet east and 686 feet south of the northwest corner of sec. 20, T. 110 N., R. 75 W.

A1—0 to 3 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, medium and fine, granular structure; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; clear, smooth boundary.

AC—3 to 9 inches, grayish-brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline; clear, wavy boundary.

C1ca—9 to 23 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium and fine, subangular blocky structure; hard, firm, sticky and plastic; common medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—23 to 37 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few, fine, yellowish-brown (10YR 5/6) iron stains; common fine nests and striations of gypsum crystals; few fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—37 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky, plastic; few, fine, yellowish-brown (10YR 5/6) iron stains; common, fine nests of gypsum crystals; slight effervescence; moderately alkaline.

Free carbonates are at or near the surface. The average clay content between depths of 10 and 40 inches ranges from 35 to 45 percent. The A horizon is dark grayish brown or grayish brown in hue of 10YR or 2.5Y and ranges from 2 to 4 inches in thickness. The AC horizon is grayish brown or light grayish brown in hue of 10YR or 2.5Y and ranges from 5 to 10 inches in thickness. The C horizon ranges from grayish brown to pale olive in hue of 2.5Y or 5Y. Segregations of lime in the Cca horizon are common or many and are medium or coarse in size. Common to many fragments and particles of shale are in the lower part of the C horizon in some places.

Gettys soils are similar to Betts soil and are mapped with or are near Peno and Raber soils. They contain more clay than Betts soils. Gettys soils differ from Peno and Raber soils in lacking a Bt horizon and in having a thinner A horizon than Raber soils.

Gettys clay loam, 15 to 40 percent slopes (GeE).—This hilly to steep soil is on the sides of ridges and drainageways on uplands (fig. 6). Slopes are short, and short drains are numerous. Except in areas where the surface layer is loam or gravelly loam, this soil has the profile described as representative of the series. Few or common scattered stones and cobblestones are on the surface in most areas.

Included with this soil in mapping are areas of Betts, Peno, and Raber soils. Betts soils are on some of the ridges. Peno and Raber soils are on the mid and lower parts of the landscape. Inclusions make up 5 to 20 percent of mapped areas.

Surface runoff is rapid, and gullies form easily in the natural drainageways. Controlling erosion is the main concern in management.

All areas are in native grass and are used for grazing. Capability unit VIIe–3; Thin Upland range site; windbreak group 10.

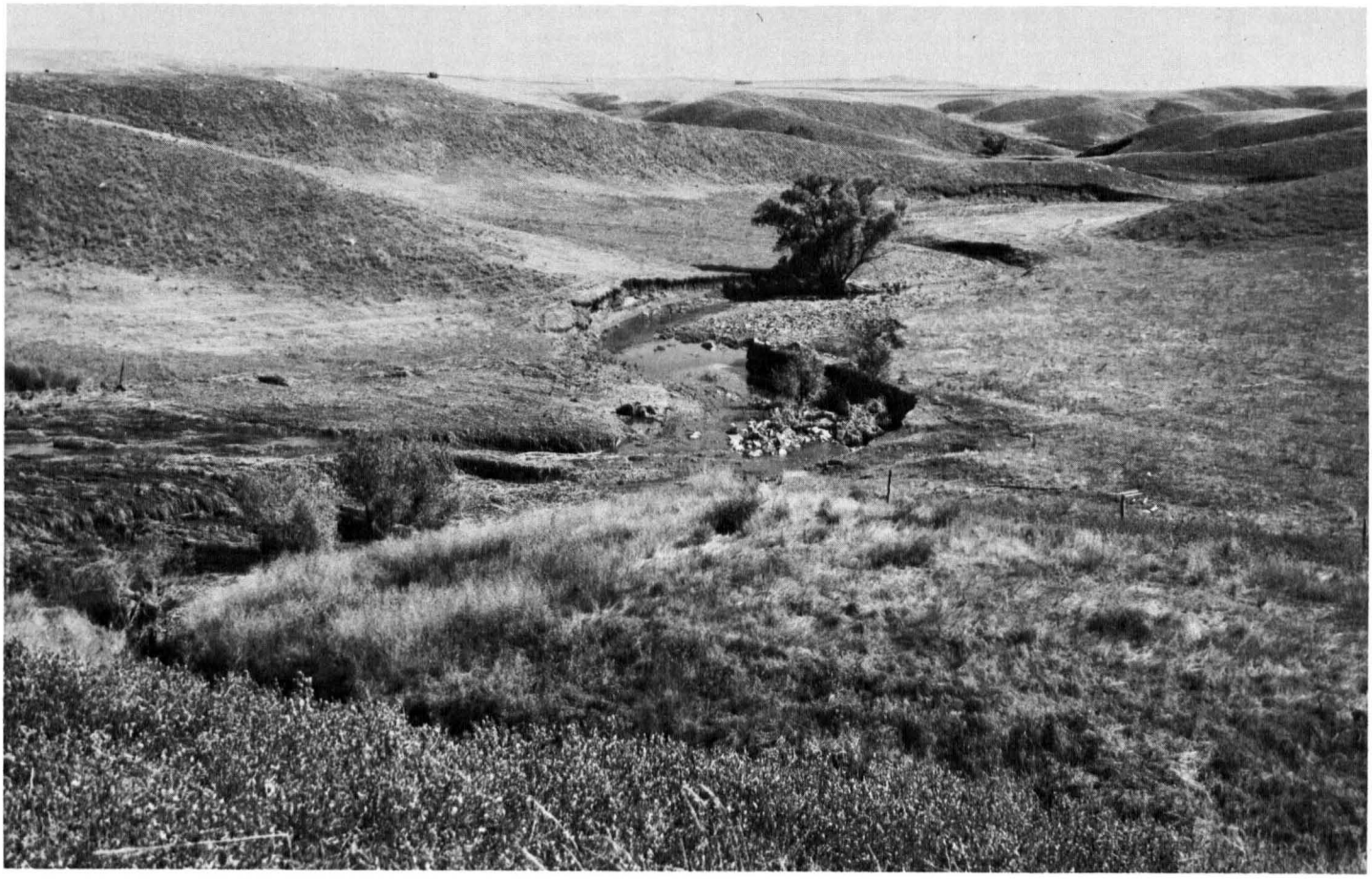

Figure 6.—**Natural drainageway in Gettys clay loam, 15 to 40 percent slopes.**

Glenham Series

The Glenham series consists of deep, well-drained, gently sloping to undulating silty soils on uplands. These soils formed in glacial till of loam or clay loam texture.

In a representative profile the surface layer is dark grayish-brown silt loam about 6 inches thick. The subsoil, about 16 inches thick, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. It is hard when dry and friable to firm when moist. The lower part is calcareous and contains spots and streaks of soft lime that extend into the underlying material. The underlying material is light brownish-gray and grayish-brown, calcareous clay loam.

Glenham soils are medium in fertility and moderate in organic-matter content. Permeability is moderate in the surface layer and subsoil and moderately slow in the underlying material. Surface runoff is medium, and available water capacity is high.

Many areas are cultivated. Small grain, corn, alfalfa, and sorghums are the principal crops. Other areas are in native grass and are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Glenham silt loam from an area of Highmore-Glenham silt loams, 2 to 5 percent slopes, in a cultivated area, 390 feet east and 80 feet south of fence from northwest corner of sec. 23, T. 111 N., R. 78 W.

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

B21t—6 to 9 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; mildly alkaline; clear, wavy boundary.

B22t—9 to 14 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, firm; mildly alkaline; clear, wavy boundary.

B3ca—14 to 22 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—22 to 34 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, coarse, subangular blocky structure; hard, friable; few yellowish-red (5YR 4/6) iron stains; common medium and fine segregations of lime; strong effervescence; strongly alkaline; gradual, wavy boundary.

C2—34 to 43 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive;

slightly hard, friable; few very fine segregations of lime; slight effervescence; strongly alkaline; clear, smooth boundary.

C3—43 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; slight effervescence; strongly alkaline.

Depth to free carbonates ranges from 12 to 18 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR, is silt loam or loam, and ranges from 4 to 6 inches in thickness. Clay content of the B2t horizon ranges from 25 to 35 percent. Segregations of lime in B3ca and C1ca horizons are few or common. The C horizon ranges from grayish brown to pale brown in hue of 10YR or 2.5Y. Iron stains, relic mottles, and gypsum crystals are in the lower part of the C horizon in some places.

Glenham soils are mapped with or are near Betts, Eakin, Highmore, Java, and Onita soils. They have a thicker A horizon than Betts soils and are deeper to free carbonates than Betts and Java soils. Glenham soils contain more sand and less silt in the B horizon than Eakin and Highmore soils. They have thinner A and B horizons and contain less clay in the B horizon than Onita soils.

Glenham-Highmore silt loams, 5 to 9 percent slopes (GhC).—This complex is 60 percent Glenham soils, 20 percent Highmore soils, and 20 percent other soils. Slopes commonly are short and irregular in the higher parts of the landscape and on the shoulders of drainageways. Highmore soils are on the sides of the ridges where slopes are smooth and more regular. Few or common glacial boulders and cobblestones are on the tops of ridges in some areas. The surface layer and subsoil of both soils are thinner than is typical for their respective series. In places the surface layer of the Glenham soil is loam. Spots of moderately eroded soils are in cultivated areas.

Included with these soils in mapping are areas of Eakin, Hoven, and Java soils. Eakin soils are intermingled with Highmore soils. Hoven soils are in small depressions, less than 2 acres in size, that are identified by wet spot symbols on the soil map. Java soils are on ridgetops. Small stony areas also are identified by spot symbols on the soil map.

Surface runoff is medium, and the soils are susceptible to erosion. Controlling erosion is the main concern in management.

Most areas are in native grass and are used for grazing. Some are cultivated. The soils are suited to most crops commonly grown in the county. Capability unit IIIe-2; Silty range site; windbreak group 3.

Highmore Series

The Highmore series consists of deep, well-drained, nearly level to undulating soils on uplands. These soils formed in silty glacial drift material (fig. 7).

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil, about 23 inches thick, is silty clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and brown in the lower part. It is hard when dry and friable when moist. The lower part is calcareous and contains spots and streaks of soft lime that extend into the underlying material. The underlying material is light olive-brown, calcareous silt loam to a depth of 42 inches. Below this is grayish-brown, calcareous loam.

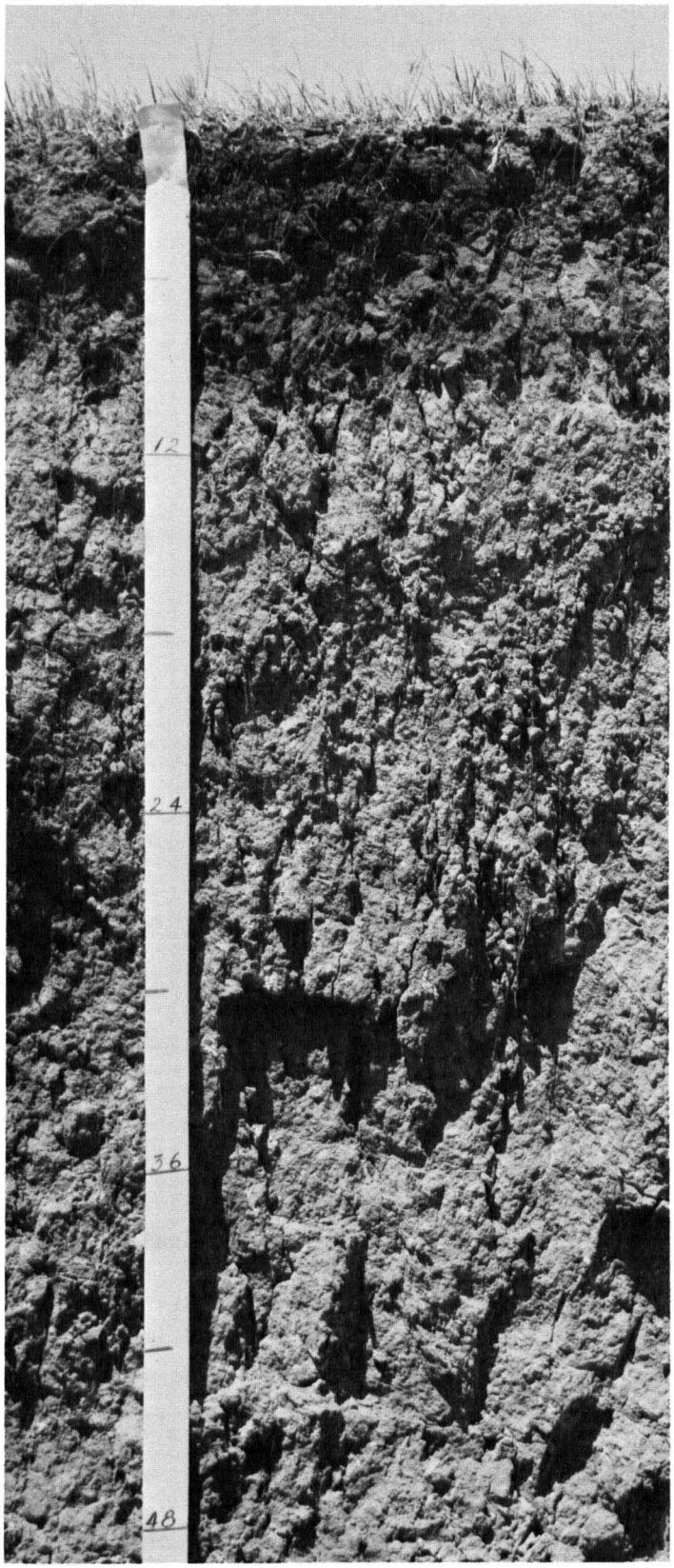

Figure 7.—**Profile of Highmore silt loam in area of Highmore-Eakin silt loams, 0 to 2 percent slopes. The darker colored surface layer and upper part of the subsoil are about 10 inches thick.**

Highmore soils are medium in fertility and moderate in organic-matter content. Permeability is moderate, and available water capacity is high. Surface runoff is slow or medium, depending on slope.

Most areas are cultivated. Winter wheat, oats, corn, alfalfa, and sorghums are the main crops. Some areas are in native grass and are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Highmore silt loam in an area of Highmore-Eakin silt loams, 0 to 2 percent slopes, in native grass, 1,220 feet northeast and 130 feet northward perpendicular to fence line along U.S. Highways 14 and 83 from the north-south center line of sec. 2, T. 111 N., R. 78 W.

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure in upper 2 inches and weak, fine, subangular blocky structure and weak, medium, granular structure in lower part; slightly hard, very friable; visible sand grains and a few pebbles as much as 1 inch in diameter; neutral; clear, smooth boundary.

B21t—7 to 15 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable; thin patchy clay films on faces of peds; common sand grains and a few granitic pebbles as much as 1 inch in diameter; mildly alkaline; clear, wavy boundary.

B22t—15 to 20 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky; visible sand grains and a few pebbles as much as 1 inch in diameter; few medium segregations of lime; slight effervescence; mildly alkaline; gradual, wavy boundary.

B3ca—20 to 30 inches, brown (10YR 5/3) light silty clay loam, dark brown (10YR 4/3) moist; weak, medium and fine, subangular blocky structure; hard, friable; common visible sand grains; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—30 to 42 inches, light olive-brown (2.5Y 5/4) silt loam, olive brown (2.5Y 4/4) moist; common mottles of gray (10YR 6/1); weak, fine, subangular blocky structure; slightly hard, very friable; common iron stains; common medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2—42 to 52 inches, grayish-brown (2.5Y 5/2) heavy loam, dark grayish brown (2.5Y 4/2) moist; many distinct mottles of gray (10YR 6/1); massive; soft, very friable; many iron stains; strong effervescence; moderately alkaline; abrupt, wavy boundary.

C3—52 to 60 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

Depth to free carbonate ranges from 12 to 24 inches. A few, scattered glacial boulders are on or near the surface in places. Few or common granite pebbles as much as 2 inches in diameter are throughout some soils of this series. The A horizon is dark grayish brown or very dark grayish brown in hue of 10YR and ranges from 5 to 8 inches in thickness. The B2t horizon is in hue of 10YR or 2.5Y. It has a clay content ranging from 25 to 35 percent and ranges from 5 to 15 percent in content of sand coarser than very fine sand. It has weak or moderate, medium, prismatic structure that parts to weak or moderate subangular blocky structure. The B2t horizon ranges from 7 to 18 inches in thickness. The C horizon commonly is silt loam and has thin layers of loam or very fine sandy loam in the lower part. Loam or clay loam glacial till is below a depth of 40 inches in some places.

Highmore soils are mapped with Eakin, Glenham, and Walke soils and are near Onita and Raber soils. They differ from Eakin soils in having a silty C horizon to a depth of more than 40 inches. They contain more silt and less sand in the B horizon than Glenham soils. They contain less clay in the B horizon than Onita, Raber, and Walke soils.

Highmore silt loam, 0 to 2 percent slopes (HeA).—The profile of this soil is similar to the one described as representative of the series, but in places the clay content of the subsoil is slightly higher. Slopes are long and smooth.

Included with this soil in mapping are small areas of Eakin and Onita soils. Eakin soils are on slight rises. Onita soils are in slight depressions or swales.

This Highmore soil is easy to work and has a high available water capacity. Surface runoff is slow. Conserving moisture is the main concern in management.

Most areas are cultivated. Winter wheat, oats, corn, alfalfa, and sorghum are the main crops. The soil is well suited to irrigation. Capability unit IIc-2; Silty range site; windbreak group 3.

Highmore-DeGrey silt loams, 0 to 2 percent slopes (HgA).—This complex is about 50 percent Highmore soil, 25 percent DeGrey soil, and 25 percent other soils. The soils in this complex are closely intermingled with the DeGrey soils in very slightly depressed parts of the landscape. The DeGrey soil is evident in cultivated areas because it is gray, as a result of the mixing of the surface and subsurface layers by plowing.

Included with these soils in mapping are areas of Cavo, Eakin, Hoven, Onita, and Walke soils. Of these, Eakin and Walke soils are the most extensive. The Eakin soils are on very slight rises, and Walke soils are near the DeGrey soils. Cavo soils are in some of the low areas. Hoven soils are in small depressions. Onita soils are in swales.

The Highmore soil is easy to work, but the DeGrey soil has poor tilth and its claypan subsoil takes in water slowly or very slowly. Surface runoff is slow. Conservation of moisture is the main concern in management. Improving tilth and water intake in the DeGrey parts of the complex also is a management need.

Many areas are cultivated. Because of the DeGrey soil, sorghum is better suited to these soils than corn. Capability unit IIc-2; Highmore soil in Silty range site, windbreak group 3; DeGrey soil in Claypan range site, windbreak group 9.

Highmore-DeGrey silt loams, 2 to 5 percent slopes (HgB).—This complex is about 60 percent Highmore soil, 20 percent DeGrey soil, and 20 percent other soils. Slopes are long and smooth, but the small, slight depressions of DeGrey soils make the surface uneven in some areas. The profile of the DeGrey soil is similar to the one described as representative of the series, but it is shallower over clay loam glacial till.

Included with these soils in mapping are areas of Cavo, Eakin, Onita, and Walke soils. Cavo soils are in some of the small slight depressions instead of the DeGrey soils. Eakin and Walke soils are closely intermingled with Highmore soils. Onita soils are in swales.

The Highmore soil is easy to work, but the DeGrey soil has poor tilth and its claypan subsoil takes in water slowly. Surface runoff is medium. Controlling erosion is the main concern in management, but improving tilth

and water intake also are management concerns on the DeGrey soil.

Some areas are cultivated. Sorghum is a better suited crop than corn on these soils because the DeGrey soil has a restrictive claypan subsoil. Other areas are in native grass and are used for grazing. Capability unit IIe-1; Highmore soil in Silty range site, windbreak group 3; DeGrey soil in Claypan range site, windbreak group 9.

Highmore-Eakin silt loams, 0 to 2 percent slopes (HkA).—This complex is about 65 percent Highmore soil, 20 percent Eakin soil, and 15 percent other soils. The two soils are intermingled in an erratic pattern. The profile of the Highmore soil is the one described as representative of the series. Slopes are long and smooth, except for a few low knolls or rises in some areas.

Included with these soils in mapping are areas of DeGrey, Glenham, Hoven, Onita, and Walke soils. Of these, Glenham and Onita soils are the most common. The Glenham soil is on some of the low knolls, and Onita soil is in slight depressions or swales. DeGrey and Walke soils also are in some of the low areas. Hoven soils are in small depressions less than 2 acres in size. They are identified by a wet spot symbol on the soil map.

These Highmore and Eakin soils are easy to work and have a high available water capacity. Surface runoff is slow. Conserving moisture is the main concern in management.

Most areas are cultivated. The soils are well suited to all crops commonly grown in the area. Capability unit IIc-2; Silty range site; windbreak group 3.

Highmore-Eakin silt loams, 2 to 5 percent slopes (HkB).—This complex is about 50 percent Highmore soil, 40 percent Eakin soil, and 10 percent other soils. The Eakin soil commonly is in the higher parts of the landscape. The profiles of both soils are similar to those described as representative of their respective series except for small eroded spots in some cultivated areas. Slopes are smooth and 300 to 600 feet long.

Included with these soils in mapping are areas of DeGrey, Glenham, Onita, and Walke soils. Of these, Glenham and Onita soils are the most common. The Glenham soil is on low ridges and knolls, and the Onita soil is in swales. DeGrey and Walke soils are on the lower parts of the landscape or at the heads of drainageways in some areas.

Surface runoff is medium, and the risk of erosion is moderate. Controlling erosion is the main concern in management.

Most areas are cultivated. The soils are well suited to all crops commonly grown in the county. Capability unit IIe-1; Silty range site; windbreak group 3.

Highmore-Glenham silt loams, 2 to 5 percent slopes (HlB).—This complex is 50 percent Highmore soil, 30 percent Glenham soil, and 20 percent other soils. Highmore soil is on the sides of low ridges and knolls. The Glenham soil is on the higher parts of the landscape. Its profile is similar to the one described as representative of the series, but in places the soil is moderately eroded and the surface and subsoil layers have been mixed by plowing. Slopes are short and irregular on the higher parts of the landscape, but in many areas on the sides of the low ridges and knolls they are long and smooth. The gently undulating parts of the complex include small areas where slopes are as much as 7 percent.

Included with these soils in mapping are areas of Eakin, Hoven, Java, and Onita soils. Eakin soils are intermingled with Highmore soils. Java soils are in the higher parts of the landscape with Glenham soils. Hoven soils are in small depressions which are identified by wet spot symbols on the soil map. Onita soils are in swales. The small areas of stony soils that occur also are identified by spot symbols on the soil map.

Surface runoff is medium. The risk of erosion is moderate in cultivated areas. Controlling erosion is the main concern in management.

Most areas are cultivated. The soils are well suited to all crops commonly grown in the county. Capability unit IIe-1; Silty range site; windbreak group 3.

Highmore-Walke silt loams, 0 to 2 percent slopes (HmA).—This complex is 70 percent Highmore soil, 20 percent Walke soil, and 10 percent other soils. The Highmore soil is on very slight rises, and the Walke soil is on the level parts of the complex. The Walke soil commonly is more than 40 inches deep over loamy glacial till. Slopes are long and smooth.

Included with these soils in mapping are areas of DeGrey and Eakin soils. DeGrey soils are in slight depressions. Eakin soils are on slight rises with Highmore soils.

The Highmore and Walke soils have a high or moderate available water capacity, but the compact subsoil of the Walke soil takes in water slowly. Conserving moisture is the main concern in management.

Most areas are cultivated. Corn, small grain, sorghums, and alfalfa are the main crops. Capability unit IIc-2; Highmore soil in Silty range site, windbreak group 3; Walke soil in Clayey range site, windbreak group 4.

Hoven Series

The Hoven series consists of deep, poorly drained, level silty soils that have a claypan subsoil. These soils formed in local alluvium and are in upland depressions.

In a representative profile the surface layer is gray silt loam about 6 inches thick. The subsoil, about 18 inches thick, is gray and dark-gray clay. It is extremely hard when dry, extremely firm when moist, and sticky and plastic when wet. The underlying material is grayish-brown, calcareous silty clay and silty clay loam.

Hoven soils are low to medium in fertility and have moderate organic-matter content. Permeability is very slow, and runoff ponds. Available water capacity is moderate or high.

Most areas are in native grass and are used for grazing or hay. The native vegetation is mostly mid grasses.

Representative profile of Hoven silt loam, in native grass, along U.S. Highway 14, 100 feet northward and perpendicular to fence, and 660 feet northeast from the north-south center line of sec. 1, T. 111 N., R. 78 W.

A2—0 to 6 inches, gray (10YR 6/1) silt loam, very dark grayish brown (10YR 3/2) moist; common fine mottles of yellowish brown (10YR 5/8); weak, medium and fine, platy structure; soft, very friable; neutral; abrupt, smooth boundary.

B21t—6 to 8 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; gray (10YR 6/1) coats on column tops and vertical faces of peds; strong, medium,

columnar structure; extremely hard, extremely firm, sticky and plastic; moderately alkaline; gradual, smooth boundary.

B22t—8 to 16 inches, dark-gray (10YR 4/1), clay, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, blocky; extremely hard, extremely firm, sticky, plastic; moderately alkaline; gradual, wavy boundary.

B3—16 to 24 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; weak, medium and coarse, subangular blocky structure; extremely hard, very firm, sticky and plastic; moderately alkaline; gradual, wavy boundary.

C1—24 to 28 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; massive; very hard, firm, sticky and plastic; slight effervescence; strongly alkaline; abrupt, wavy boundary.

C2—28 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 15 to 40 inches. Exchangeable sodium exceeds 15 percent in some part of the B or C horizon. In places the A2 horizon is not mottled. It has weak or moderate, thin to thick, platy structure and ranges from 2 to 6 inches in thickness. The B2t horizon ranges from very dark gray to grayish brown in hue of 10YR or 2.5Y. It is silty clay or clay, and the clay content ranges from 40 to 55 percent. The B21t horizon has moderate or strong, medium or coarse, columnar structure that commonly parts to strong, medium or fine, blocky. The B3 and C horizons range from dark gray to light brownish gray in hue of 10YR of 2.5Y. In places the B3 horizon or upper part of the C horizon has few or common fine segregations of lime. The C horizon is clay, silty clay, clay loam, or silty clay loam. In places it has few, faint mottles.

Hoven soils are near or are mapped with Cavo, Jerauld, Macken, and Onita soils. They are more poorly drained than Cavo and Jerauld soils. They contain more sodium than Macken soils. They are more poorly drained and contain more sodium than Onita soils.

Hoven silt loam (0 to 1 percent slopes) (Hn).—This soil is in flat-bottomed depressions or potholes in the uplands. In some areas, the surface is uneven. Many small mounds rise a few inches above the intervening, small low spots. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of a soil that is similar, but the surface and subsurface layers combined are 6 to 10 inches thick.

This Hoven soil has poor tilth and takes in water very slowly. Surface runoff ponds, and areas commonly are flooded in spring and also following rainstorms in summer. During wet periods some areas are ponded for several months.

Most areas are in native grass and are used for grazing or hay. A few of the smaller depressions in cultivated areas are cropped along with adjoining soils. Capability unit VIs-1; Closed Depression range site; windbreak group 10.

Hoven-Onita silt loams (0 to 2 percent slopes) (Ho).—This complex is about 50 percent Hoven soil, 30 percent Onita soil, and 20 percent other soils. Areas are long and narrow and consist of small depressions and adjacent swales. The Hoven soil is in depressions, and the Onita soil in the adjacent swales. The most extensive soil included in mapping is a soil that has a thick silty surface layer similar to that of the Onita soil and a claypan subsoil similar to that of the Hoven soil.

The Hoven soil has poor tilth and takes in water very slowly. Surface runoff ponds on the Hoven soil and is slow on the Onita soil.

Most areas are in native grass and are used for grazing or hay. Some of the smaller areas surrounded by cultivated soils are farmed as a matter of convenience. Capability unit VIs-1; Hoven soil in Closed Depression range site, windbreak group 10; Onita soil in Overflow range site, windbreak group 1.

Hurley Series

The Hurley series consists of moderately deep, moderately well drained, nearly level to gently sloping silty soils that have a claypan subsoil. These soils formed in clay materials weathered from the underlying shale. They are on uplands.

In a representative profile the surface layer is gray silt loam about 2 inches thick. The subsoil, about 20 inches thick, is clay that is dark grayish brown in the upper part, grayish brown in the middle part, and light brownish gray in the lower part. The upper and middle parts are extremely hard or very hard when dry, very firm when moist, and sticky and plastic when wet. The lower part is calcareous and contains many, fine spots of salts. The underlying material is light brownish-gray shaly clay to a depth of 34 inches. Below this is bedded shale.

Hurley soils are low in fertility and moderately low in organic-matter content. Permeability is very slow, and surface runoff is slow or medium, depending on slope. Available water capacity is low or very low.

Most areas are in native grass and are used for grazing. The native vegetation is a mixture of mid and short grasses.

Representative profile of Hurley silt loam, 0 to 6 percent slopes, in native grass, 180 feet north and 250 feet west of the southeast corner of sec. 32, T. 109 N., R. 74 W.

A2—0 to 2 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, very fine, platy and moderate, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

B21t—2 to 4 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; gray (2.5Y 6/0) coatings on column tops; moderate, fine, columnar structure parting to strong, fine and very fine, blocky; extremely hard, very firm, sticky and plastic; neutral; clear, smooth boundary.

B22t—4 to 7 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist: weak, medium, prismatic structure parting to strong, very fine, blocky; very hard, very firm, sticky and plastic; moderately alkaline; clear, wavy boundary.

B23t—7 to 11 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, blocky structure; very hard, very firm, sticky and plastic; slight effervescence; moderately alkaline; clear, smooth boundary.

B3casa—11 to 22 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak, medium and coarse, subangular blocky structure; hard, firm, sticky and plastic; many, fine segregations of salts; few medium segregations of lime; strong effervescence; strongly alkaline; clear, smooth boundary.

C1—22 to 34 inches, light brownish-gray (2.5Y 6/2) shaly clay, grayish brown (2.5Y 5/2) moist; massive; hard, firm, sticky and plastic; shale fragments comprise

30 to 40 percent of soil mass; common nests of gypsum crystals; slight effervescence; mildly alkaline; gradual, smooth boundary.

C2—34 to 60 inches, light brownish-gray (2.5Y 6/2) clay shale, grayish brown (2.5Y 5/2) moist; bedded; hard, firm; common, distinct, yellowish-red (5YR 4/8) iron stains; common nests of gypsum cystals between seams of shale; slightly acid.

Depth to free carbonates ranges from 4 to 12 inches. Depth to bedded shale ranges from 20 to 40 inches. Cracks, ½ to 1 inch wide and several feet long, extend downward through the B horizon when the soil is dry. Exchangeable sodium is more than 15 percent in some part of the B horizon above a depth of 15 inches. The A2 horizon is gray or dark gray in hue of 10YR and ranges from 1 to 4 inches in thickness. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR or 2.5Y and from 60 to 70 percent in clay content. The B21t horizon has moderate or strong, medium or fine, columnar structure that parts to moderate or strong, medium to very fine, blocky. Nests and striations of segregated salts in the B3 and C horizons are few to many. The C horizon ranges from gray to light olive gray in hue of 2.5Y or 5Y.

Hurley soils are near Chantier, Lakoma, Opal, Promise, and Swanboy soils and are similar to Durrstein, Hoven, and Jerauld soils. They are deeper over bedded shale than Chantier soils and are better drained than Durrstein and Hoven soils. They differ from Jerauld soils in having bedded shale in the C horizon at a depth of less than 40 inches. They have more sodium in the B horizon and are shallower over accumulations of salts than Lakoma, Opal, and Promise soils. They differ from Swanboy soils in having a columnar-structured B horizon and in having bedded shale at a depth of less than 40 inches.

Hurley silt loam, 0 to 6 percent slopes (HuB).—This soil is on uplands. Slopes commonly are less than 3 percent but range up to as much as 6 percent in some areas. The surface is uneven in most areas because mounds rise a few inches above the intervening low spots. In places the underlying shale is at a depth below 40 inches.

Included with this soil in mapping are areas of Opal and Promise soils on rises. Also included are Slickspots, which make up as much as 20 percent of some areas.

This Hurley soil has poor tilth and takes in water very slowly. Available water capacity is low or very low. The claypan subsoil restricts roots. The soil is not suitable for cultivation.

Most areas are in native grass and are used for grazing. Capability unit VIs-1; Thin Claypan range site; windbreak group 10.

Java Series

The Java series consists of deep, well-drained, gently undulating to rolling loamy soils on uplands. These soils formed in glacial till of loam or clay loam texture.

In a representative profile the surface layer is dark grayish-brown loam about 3 inches thick. The subsoil, about 12 inches thick, is dark grayish-brown light clay loam in the upper part and pale-brown calcareous loam in the lower part. The upper part is slightly hard when dry and firm when moist. The underlying material is light-gray and pale-brown calcareous clay loam and has spots and streaks of soft lime.

Java soils are medium in fertility and moderately low in organic-matter content. Permeability is moderate in the upper part of the profile and moderately slow in the underlying material. Surface runoff is medium, and available water capacity is high.

Some areas are under cultivation. Small grain, corn, and alfalfa are the main crops. Many areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Java loam from an area of Java-Glenham loams, 2 to 9 percent slopes, in native grass, 1,584 feet north and 75 feet west from the southeast corner of sec. 36, T. 111 N., R. 78 W.

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

B2—3 to 8 inches, dark grayish-brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, firm; neutral; clear, wavy boundary.

B3ca—8 to 15 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate, medium, subangular blocky structure; slightly hard, friable; few fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—15 to 24 inches, light-gray (10YR 7/1) light clay loam, light brownish gray (10YR 6/2) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2ca—24 to 34 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable; many medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C3—34 to 60 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; slightly hard, friable; few fine segregations of lime; slight effervescence; strongly alkaline.

Depth to free carbonates ranges from 6 to 10 inches, but in cultivated areas the soil commonly is calcareous at the surface. The A horizon is dark grayish brown or grayish brown in hue of 10YR and ranges from 2 to 4 inches in thickness. The B2 horizon is loam or light clay loam and has a clay content that ranges from 18 to 30 percent. It has weak or moderate, medium or coarse, prismatic structure that parts to weak, fine or medium, subangular blocky. The C horizon ranges from grayish brown to very pale brown in hues of 10YR or 2.5Y. It commonly is loam, but in places is clay loam.

Java soils are mapped with Betts and Glenham soils. They have thicker horizons than Betts soils, which are very dark grayish brown or darker colored when moist. They have thinner A and B horizons and are calcareous nearer the surface than Glenham soils.

Java-Betts loams, 9 to 15 percent slopes (JbD).—The Java soil makes up about 60 percent of this rolling complex and the Betts soil 40 percent. The Java soil is on the sides of the ridges and knolls. The Betts soil is on the higher parts of the landscape, on the crests of ridges and knolls. Slopes are short and irregular. Few to many boulders are on the surface in most areas.

Included with these soils in mapping are areas of Cavo and Glenham soils. Cavo soils are along some of the drainageways. Glenham soils are intermingled with Java soils in some areas.

These soils take in water readily and have high available water capacities. The Betts soil is low in fertility. Both soils are moderately low in organic-matter content. Surface runoff is medium to rapid. Controlling erosion is the main concern in management.

Most areas are in native grass and are used for grazing. Capability unit VIe-3; windbreak group 10; Java

soil in Silty range site, Betts soil in Thin Upland range site.

Java-Glenham loams, 2 to 9 percent slopes (JgC).—These soils are gently undulating to undulating. The Java soil makes up about 50 percent of this complex, the Glenham soil 35 percent, and other soils 15 percent. The Java soil commonly is on the higher parts of the landscape on ridges and knolls. It has the profile described as representative of the series. The Glenham soil is on the side of ridges and knolls. Slopes are short and convex.

Included with these soils in mapping are areas of Betts, Cavo, Eakin, Hoven, and Onita soils. Betts soils are on some of the ridgetops and knolls. Cavo soils are in the lower parts of the landscape. Eakin soils are on the sides of ridges in some areas. Hoven soils are in small depressions less than 2 acres in size and are identified by a wet spot symbol on the soil map. Onita soils are in swales. Also included in some areas are stony areas, more than 1 acre in size, which are identified by a stony symbol on the soil map.

These Java and Glenham soils are easy to work and have high available water capacities. Surface runoff is medium, and erosion is a hazard. Controlling erosion is the main concern in management.

Many areas are in native grass and are used for grazing. Some are under cultivation. The soils are suited to most of the crops commonly grown in the county. Capability unit IVe-3; Silty range site; Java soil in windbreak group 8, Glenham soil in windbreak group 3.

Jerauld Series

The Jerauld series consists of deep, moderately well drained, nearly level to sloping silty soils that have a claypan subsoil. These soils formed in firm glacial till on uplands.

In a representative profile the surface layer is gray silt loam about 3 inches thick. The subsoil, about 16 inches thick, is clay that is very dark grayish brown in the upper part, dark grayish brown in the middle part, and grayish brown in the lower part. It is very hard when dry and very firm when moist. The lower part is calcareous. The underlying material is grayish-brown and olive-gray calcareous clay. In it are spots and streaks of salt crystals.

Jerauld soils are low in fertility and moderate in organic-matter content. Permeability is very slow, and surface runoff is slow or medium, depending on slope. Available water capacity is low.

Most areas are in native grass and are used for grazing. The native vegetation is mid and short grasses.

Representative profile of Jerauld silt loam, 0 to 2 percent slopes, in native grass, 2,620 feet north and 57 feet east of fence from the southwest corner of sec. 32, T. 112 N., R. 75 W.

A2—0 to 3 inches, gray (10YR 5/1) silt loam, very dark brown (10YR 2/2) moist; weak, coarse, platy structure parting to moderate, fine, granular; soft, very friable; neutral; abrupt, smooth boundary.

B21t—3 to 6 inches, very dark grayish-brown (10YR 3/2) light clay, very dark brown (10YR 2/2) moist; gray (10YR 6/1) coatings on column tops; moderate, fine, columnar structure parting to moderate, fine, blocky; very hard, very firm; thin patchy clay films; moderately alkaline; clear, wavy boundary.

B22t—6 to 10 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, fine, blocky; very hard, very firm; thin patchy clay films; moderately alkaline; clear, wavy boundary.

B3—10 to 19 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; very hard, very firm; few fine segregations of salts; slight effervescence; moderately alkaline; clear, wavy boundary.

C1sa—19 to 29 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; very hard, very firm; few fine clusters of salt crystals; few fine segregations of lime; slight effervescence; moderately alkaline; clear, wavy boundary.

C2sa—29 to 38 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; massive; hard, firm; common fine clusters and striations of salts; moderately alkaline; clear, wavy boundary.

C3—38 to 60 inches, olive-gray (5Y 5/2) clay, dark olive gray (5Y 3/2) moist; massive; hard, firm; moderately alkaline.

Depth to free carbonates ranges from 6 to 12 inches. Some part of the B2t horizon is more than 15 percent exchangeable sodium. The A2 horizon is gray, light gray, or light brownish gray in hue of 10YR and ranges from 1 to 3 inches in thickness. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR, is clay or silty clay, and has an estimated clay content ranging from 40 to 60 percent. The B21t horizon is weak or moderate, medium or fine, columnar structure. The B22t horizon has weak, medium, prismatic structure parting to moderate or strong, medium or fine, blocky; the B3 and C horizons contain few to many segregations of salts. The C horizon commonly is clay, but it is silty clay or clay loam in some places. In places the lower part has few or common fragments of shale.

Jerauld soils are mapped with or are near Cavo, Oko, and Raber soils. They are similar to Hoven and Hurley soils. They have a thinner A horizon than Cavo soils. They are better drained than Hoven soils and are deeper over bedded shale than Hurley soils. They contain more sodium in the B horizon than Oko and Raber soils.

Jerauld silt loam, 0 to 2 percent slopes (JlA).—In some small areas this soil is gently sloping, but slopes are mostly less than 2 percent. The surface is uneven because small mounds rise a few inches above the intervening low spots. A few scattered boulders are on the surface in some areas. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of Cavo, Demky, Hoven, Oko, Peno, and Raber soils. Cavo, Demky, Oko, Peno, and Raber soils are on slight rises. Hoven soils are in small depressions less than 2 acres in size. Also included are some areas of Slickspots. Only one or two of these included soils are in some areas, but all are in others. They make up as much as 30 percent of some areas.

This Jerauld soil has poor tilth and takes in water very slowly. The restrictive claypan subsoil and the presence of accumulated salts make the soil unsuitable for cultivation.

Most areas are in native grass and are used for grazing. Capability unit VIs-1; Thin Claypan range site; windbreak group 10.

Lakoma Series

The Lakoma series consists of moderately deep, well-drained, strongly sloping to steep clayey soils on up-

lands. These soils formed in clayey materials weathered from the underlying shale.

In a representative profile the surface layer is dark grayish-brown clay about 3 inches thick. The subsoil, about 9 inches thick, is dark grayish-brown and grayish-brown clay. The upper part is hard when dry, friable when moist, and sticky and plastic when wet. The lower part is calcareous. The underlying material is grayish-brown shaly clay to a depth of 28 inches. It is calcareous and contains spots and streaks of soft lime. Light olive-gray bedded shale begins below a depth of 28 inches.

Lakoma soils are low to medium in fertility and moderately low in organic-matter content. Permeability is slow, and surface runoff is medium or rapid, depending on slope. Available water capacity is low or very low.

All areas are in native grass and are used for grazing. The native vegetation is a mixture of tall, mid, and short grasses.

The Lakoma soils in Hughes County are mapped only with Opal and Sansarc soils.

Representative profile of Lakoma clay in an area of Sansarc-Lakoma clays, 9 to 40 percent slopes, in native grass, 2,240 feet west and 60 feet north of the center of sec. 20, T. 110 N., R. 76 W.

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B21—3 to 6 inches, dark grayish-brown (10YR 4/2) crushing to grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; hard, friable, sticky and plastic; mildly alkaline; clear, wavy boundary.

B22—6 to 12 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, very coarse, prismatic structure; hard, firm, sticky and plastic; few medium segregations of lime; slight effervescence; mildly alkaline; gradual, wavy boundary.

C1ca—12 to 28 inches, grayish-brown (2.5Y 5/2) shaly clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; fragments of shale make up 20 to 30 percent of mass; common medium segregations of lime; strong effervescence; mildly alkaline; clear, wavy boundary.

C2—28 to 60 inches, light olive-gray (5Y 6/2) bedded shale, olive gray (5Y 4/2) moist; very hard and brittle, very firm; mildly alkaline.

Free carbonates are at or within 7 inches of the surface. Depth to bedded shale ranges from 20 to 40 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR or 2.5Y and ranges from 3 to 5 inches in thickness. The B2 horizon is grayish brown or light brownish gray in hues of 10YR and 2.5Y and ranges from 6 to 9 inches in thickness. It has weak, medium to very coarse, prismatic structure that commonly parts to weak or moderate, medium or fine, subangular blocky. Some profiles of this series have a B3ca horizon. The C horizon above the shale ranges from grayish brown to pale olive in hue of 2.5Y or 5Y. Gypsum and other salts are in seams of the upper part of the shale in some places.

Lakoma soils are mapped with Opal and Sansarc soils. They differ from Opal soils in having thinner horizons that are very dark grayish brown or darker when moist and in being more friable. They are deeper over shale than Sansarc soils.

Lowry Series

The Lowry series consists of deep, well-drained, nearly level to sloping silty soils on uplands and terraces. These soils formed in wind-deposited silts.

In a representative profile the surface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil, about 13 inches thick, is dark grayish-brown and grayish-brown silt loam. It is slightly hard when dry and very friable when moist. The lower part is calcareous. The underlying material is pale-brown and light brownish-gray calcareous silt loam to a depth of 51 inches. In it are many streaks and spots of soft lime. Below this is light brownish-gray, calcareous loam.

Lowry soils are medium in fertility and moderate in organic-matter content. Permeability is moderate, and surface runoff is slow or medium, depending on slope. Available water capacity is high.

Most areas are cultivated. Corn, small grain, and alfalfa are the main crops. Some areas are irrigated. Other areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Lowry silt loam, 2 to 5 percent slopes, in native grass, 2,390 feet east and 30 feet north of road ditch from the southwest corner of sec. 24, T. 112 N., R. 81 W.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, fine and medium, platy structure parting to very weak, fine, granular; slightly hard, very friable; neutral; abrupt, smooth boundary.

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

B2—8 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak, medium and coarse, prismatic structure; slightly hard, very friable; mildly alkaline; clear, wavy boundary.

B3—14 to 21 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to weak, medium, subangular blocky; slightly hard, very friable; few fine segregations of lime; slight effervescence; moderately alkaline; clear, wavy boundary.

C1ca—21 to 34 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, very friable; common fine and few coarse segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C2ca—34 to 51 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, very friable; many medium and coarse segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C3—51 to 60 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; few fine striations of segregated lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 8 to 20 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR and ranges from 4 to 10 inches in thickness. The B horizon ranges from dark grayish brown to brown in hue of 10YR, is less than 18 percent clay, and ranges from 10 to 20 inches in thickness. The C horizon ranges from grayish brown to pale brown in hue of 10YR or 2.5Y. It is silt loam, very fine sandy loam, or loam and gradually increases

in content of fine sand with increasing depth. The Cca horizon contains few to many, fine to coarse, soft masses and striations of segregated lime. Fine sand or clay is between depths of 40 and 60 inches in some places.

Lowry soils formed in similar materials and are near Agar, Dorna, and Sully soils. They contain less clay in the B horizon than Agar soils. They are silty to a greater depth than Dorna soils. They have a thicker A horizon than Sully soils and are deeper to lime.

Lowry silt loam, 0 to 2 percent slopes (LoA).—This soil is on benches and uplands along the Missouri River. It has a profile similar to the one described as representative of the series, but in some places the material between depths of 40 and 60 inches is gravel, fine sand, clay, or shale. Slopes are long and uniform.

Included with this soil in mapping are areas of Onita soils along drainageways. Also included near the Hidden Valley School in T. 108 N., R. 74 W. are areas of soils similar to Oahe soils, but more silty.

This Lowry soil is free of stones and is easy to work. Available water capacity is high, and surface runoff is slow. Controlling soil blowing is the main concern in management.

Most areas are under cultivation, and some are irrigated (fig. 8). The soil is suited to all crops commonly grown in the county. Capability unit IIe-1; Silty range site; windbreak group 3.

Lowry silt loam, 2 to 5 percent slopes (LoB).—This soil is on uplands near the Missouri River. It has the profile described as representative of the series, but in places in the southeastern part of the county, sand and gravel are at a depth of 40 to 60 inches. Slopes are long and smooth.

Included with this soil in mapping are areas of Agar, Dorna, and Onita soils. Agar soils are on the lower parts of the landscape. Dorna soils are in places where clay or shale is at a depth of less than 40 inches. Onita soils are in swales. Also included, in T. 108 N., R. 74 W., are areas of soils similar to Oahe soils, but more silty.

This Lowry soil is free of stones and is easy to work. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management.

Many areas are cultivated, and the soil is well suited to all crops commonly grown in the county. Capability unit IIe-1; Silty range site; windbreak group 3.

Lowry silt loam, 5 to 9 percent slopes (LoC).—Scattered areas of this soil are on uplands near the Missouri River. Slopes are mostly smooth and convex. In some small areas they are less than 5 percent. The surface layer and subsoil are slightly thinner than in the profile described for the series, and in some areas sand and gravel are at a depth of 40 to 60 inches.

Included in the mapped areas are Agar and Sully soils. Agar soils are in places where slopes are long and smooth. Sully soils are on the tops of ridges and knolls.

Figure 8.—**Irrigated corn on Lowry silt loam, 0 to 2 percent slopes.**

This Lowry soil is free of stones and is easy to work. Surface runoff is medium. Water erosion and soil blowing are hazards. Control of erosion and of soil blowing are the main concerns in management.

Most areas are in native grass and are used for grazing, but the soil is suited to all crops commonly grown in the county. Capability unit IIIe-1; Silty range site; windbreak group 3.

Lowry-Urban land complex, 2 to 5 percent slopes (LuB).—About half of this complex is Lowry soil. The rest is covered with buildings and streets. Areas are mostly in the residential part of the city of Pierre. The soil profile in undisturbed areas is similar to the one described as representative of the Lowry series, but in many areas the original profile has been altered by cuts and fills. Topsoil has been added in some areas to establish lawns and gardens. Slopes are long and smooth.

The Lowry soil takes in water readily and has high available water capacity and medium runoff. In unprotected areas it is susceptible to erosion.

The soil is well suited to gardens, lawns, and landscaping. Limitations are slight for shallow excavations and for dwellings with basements.

Investigation to a depth of 8 to 10 feet is necessary, however, to determine the depth to gravel, sand, clay, or shale. Deeper borings are essential on sites planned for larger buildings. Not assigned to interpretive groups.

Lowry-Urban land complex, 5 to 9 percent slopes (LuC).—This complex is 50 percent or more Lowry soil. The rest is covered with buildings and streets. Areas are mostly in the residential part of the city of Pierre. The soil profile in undisturbed areas is similar to the one described as representative of the Lowry series, but the soil in many areas has been altered by cutting and filling. Topsoil has been added in some areas to establish lawns and gardens. Except where altered by land shaping for buildings and streets, slopes are mostly long and smooth.

This Lowry soil has medium surface runoff. In protected areas it is highly susceptible to erosion.

The soil is well suited to gardens, lawns, and landscaping. Limitations are slight for shallow excavations and for dwellings with basements. Investigation to a depth of 8 to 10 feet should be made, however, to determine the depth to gravel, sand, clay, or shale. Deeper borings are essential on sites planned for larger buildings. Not assigned to interpretive groups.

Macken Series

The Macken series consists of deep, poorly drained, level clayey soils in upland depressions. These soils formed in local alluvium.

In a representative profile the surface layer is gray silty clay about 3 inches thick. The subsoil, about 34 inches thick, is dark-gray and gray silty clay. It is extremely hard when dry, very firm when moist, and sticky and plastic when wet. Mottles of reddish brown are in the upper part, and iron-manganese concretions are in the lower part. The underlying material is gray and light olive-gray, calcareous silty clay.

Macken soils are medium in fertility and moderate in organic-matter content. Permeability is slow, and available water capacity is low or moderate. Surface runoff ponds.

All areas are in native grass and are used for grazing or hay. The native vegetation is mainly mid grasses.

Representative profile of Macken silty clay in native grass, located 1,840 feet south and 12 feet east of fence from the northwest corner of sec. 10, T. 111 N., R. 79 W.

O—1 inch to 0, dark-gray (10YR 4/1) granular mulch of partially decomposed plant remains and organic matter, black (10YR 2/1) moist; clear, smooth boundary.

A1—0 to 3 inches, gray (10YR 5/1) silty clay, black (10YR 2/1) moist; common, fine, distinct mottles of reddish brown (5YR 5/4); weak, medium, platy structure parting to weak, fine, subangular blocky; hard, firm, slightly sticky and slightly plastic; slightly acid; clear, smooth boundary.

B21—3 to 9 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; common, fine, distinct mottles of reddish brown (5YR 5/4); moderate, medium and fine, subangular blocky structure; extremely hard, very firm, sticky and plastic; neutral; gradual, wavy boundary.

B22g—9 to 24 inches, gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; few, fine, distinct mottles of reddish brown (10YR 5/4); moderate, medium, subangular blocky structure; extremely hard, very firm, sticky and plastic; few fine threads of salts; few fine iron-manganese concretions; neutral; gradual, wavy boundary.

B3g—24 to 37 inches, gray (5Y 5/1) silty clay, very dark gray (5Y 3/1) moist; weak, medium, subangular blocky structure; extremely hard, very firm, sticky and plastic; few fine iron-manganese concretions; mildly alkaline; gradual, wavy boundary.

C1gca—37 to 44 inches, gray (5Y 5/1) silty clay, olive gray (5Y 4/2) moist; massive; extremely hard, very firm, sticky and plastic; few very fine segregations of lime; slight effervescence; moderately alkaline; clear, wavy boundary.

C2gca—44 to 60 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 5/2) moist; massive; very hard, firm, plastic and sticky; common very fine segregations and striations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 22 to 40 inches. The A horizon is gray or dark gray in hue of 10YR, is silty clay or silty clay loam, and is 2 to 4 inches thick. The B2 horizon is in hues of 10YR through 5Y. It is silty clay or clay and ranges from 45 to 60 percent in clay content. It commonly has weak or moderate, medium or coarse, prismatic structure parting to moderate or strong, medium or fine, subangular blocky or blocky. The C horizon ranges from gray to light olive gray in hue of 2.5Y or 5Y. It commonly is silty clay or clay but is silty clay loam in some places.

Macken soils are similar to Hoven soils. They contain less sodium than Hoven soils and lack the columnar-structured B horizon that is typical of those soils.

Macken silty clay (Ma).—This level soil is in depressions on uplands. It has the profile described as representative of the series, but the mulch of plant remains and organic matter is not present in some areas and the surface layer is silty clay loam in some. Included with this soil in mapping are areas of Hoven soils, on the outer edges of depressions, that make up as much as 20 percent of some areas.

This Macken soil has poor tilth and takes in water slowly. Surface runoff ponds, and areas are flooded in spring and after heavy summer rains. The soil is seldom dry below a depth of 2 feet.

All areas are in native grass are used for grazing or hay. Capability unit VIs-1; Closed Depression range site; windbreak group 10.

528-308 O—74——3

Millboro Series

The Millboro series consists of deep, well-drained, nearly level silty soils that have a clayey subsoil. These soils formed in clayey sediment and are on high benches or terraces.

In a representative profile the surface layer is dark-gray silty clay loam about 7 inches thick. The subsoil, about 21 inches thick, is dark grayish-brown silty clay in the upper part and grayish-brown, calcareous silty clay in the lower part. It is very hard when dry, very firm when moist, and sticky and plastic when wet. The underlying material is grayish-brown, calcareous clay that contains fine spots of soft lime in the upper part and fine spots and streaks of gypsum and other salts in the lower part.

Millboro soils are medium in fertility and moderate in organic-matter content. Permeability is slow, and surface runoff is slow. Available water capacity is low or moderate.

Many areas are under cultivation. Winter wheat is the principal crop, but some corn and alfalfa also are grown. Other areas are in native grass and are used for grazing and hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Millboro silty clay loam, 0 to 2 percent slopes, in native grass, 2,565 feet west and 120 feet south of fence from the northeast corner of sec. 33, T. 110 N., R. 76 W.

A1—0 to 7 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate, fine, granular and weak, fine, blocky structure; slightly hard, friable, slightly sticky and slightly plastic; neutral; clear, smooth boundary.

B2t—7 to 15 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and coarse, blocky; very hard, very firm, sticky and plastic; neutral; clear, wavy boundary.

B3ca—15 to 28 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; moderate, medium and coarse, blocky structure; very hard, very firm, sticky and plastic; shiny pressure faces on surfaces of peds; common medium segregations of lime; strong effervescence; mildly alkaline; clear, wavy boundary.

C1—28 to 38 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; very hard, very firm, sticky and plastic; few, fine segregations of lime; slight effervescence; mildly alkaline; clear, wavy boundary.

C2—38 to 60 inches, grayish-brown (2.5Y 5/2) clay, grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; common fine segregations of gypsum and other salts; slight effervescence; moderately alkaline.

Depth to bedded shale is more than 60 inches. Depth to free carbonates ranges from 6 to 16 inches. The A horizon ranges from dark gray to grayish brown in hue of 10YR and from 4 to 8 inches in thickness. It is silty clay loam or silty clay. The B horizon is in hue of 10YR or 2.5Y. The B2t horizon is silty clay or clay, and the estimated clay content ranges from 55 to 65 percent. The B3ca horizon contains few or common, fine to coarse, soft masses of segregated lime. The C horizon ranges from grayish brown to pale olive in hue of 2.5Y or 5Y.

Millboro soils are similar to the nearby Promise soils. They have a greater increase in clay content between the A and B horizons than Promise soils and commonly are deeper over free carbonates.

Millboro silty clay loam, 0 to 2 percent slopes (MbA).—This soil is on high benches along the Missouri River. Slopes are long and smooth. They are mostly less than 2 percent, but are as much as 4 percent in some areas. A few shallow drainageways cross some areas. In a few places the surface layer is silt loam.

Included with this soil in mapping are areas of Dorna, Mosher, and Promise soils. Dorna soils are in places where silty material has been deposited over the more clayey material. Mosher soils are in slight depressions. Promise soils are on slight rises.

When cultivated, this Millboro soil loses tilth and blows easily. It takes in water slowly. Surface runoff is slow. Improving tilth and water intake and controlling soil blowing are the main concerns in management.

About half the acreage is cultivated. The soil is suited to all the crops commonly grown in the county. It is better suited to sorghum than to corn. Some areas are in native grass and are used for grazing or hay. Capability unit IIIs-3; Clayey range site; windbreak group 4.

Mosher Series

The Mosher series consists of deep, moderately well drained, nearly level silty soils that have a claypan subsoil. These soils formed in alluvium and are on stream terraces and uplands.

In a representative profile the surface layer is dark-gray silt loam about 5 inches thick. Below this is a subsurface layer of gray silt loam about 3 inches thick. The subsoil, about 15 inches thick, is dark grayish-brown silty clay in the upper part and grayish-brown silty clay loam in the middle and lower parts. The upper part is extremely hard when dry and very firm when moist. The lower part is calcareous and contains spots and streaks of salts that extend into the underlying material. The underlying material is layered with grayish-brown and light brownish-gray clay loam, silty clay, and silty clay loam.

Mosher soils are medium in fertility and moderate in organic-matter content. Permeability is very slow, and surface runoff is slow. Available water capacity is moderate.

Most areas are in native grass and are used for grazing or hay. Corn, tame grasses, alfalfa, and small grain are the crops grown in the few areas under cultivation. The native vegetation is mid and short grasses.

Representative profile of Mosher silt loam, 0 to 2 percent slopes, in native grass, 2,375 feet south and 165 feet east of fence from the northwest corner of sec. 36, T. 111 N., R. 75 W.

A1—0 to 5 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; moderate, fine, granular structure; soft, very friable; neutral; clear, wavy boundary.

A2—5 to 8 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) moist; weak, fine, granular structure and weak, medium, subangular blocky structure; soft, very friable; many fine pores; neutral; abrupt, wavy boundary.

B21t—8 to 11 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; gray (10YR 5/1) coats on column tops; moderate, fine, columnar structure parting to strong, fine, blocky; extremely hard, very firm; thin patchy clay films; moderately alkaline; gradual, smooth boundary.

B22t—11 to 18 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; strong, fine, blocky structure; very hard, very firm; thin patchy clay films; moderately alkaline; clear, wavy boundary.

B3sa—18 to 23 inches, grayish-brown (10YR 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; hard, firm; thin patchy clay films; few fine segregations and striations of lime and salts; slight effervescence; strongly alkaline; gradual, wavy boundary.

C1sa—23 to 32 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; common fine segregations of salts; slight effervescence; strongly alkaline; clear, smooth boundary.

C2sa—32 to 43 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; massive; hard, friable; common fine segregations of salts; strong effervescence; moderately alkaline; clear, smooth boundary.

C3—43 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, brown (10YR 4/3) moist; massive; slightly hard, friable; few fine segregations of salts; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 12 to 20 inches. Exchangeable sodium is more than 15 percent in some part of the B or C horizons. The A1 horizon is dark gray or gray in hue of 10YR and ranges from 3 to 6 inches in thickness. The A2 horizon ranges from 2 to 4 inches in thickness. The B2t horizon is in hue of 10YR or 2.5Y, has a clay content ranging from 35 to 60 percent, and has moderate or strong, fine or medium, columnar structure. The B22t horizon commonly has weak or moderate, prismatic structure parting to moderate or strong, subangular blocky or blocky. The B3 and C horizons range from grayish brown to pale brown in hue of 10YR or 2.5Y and contain few to many segregations of salts. In places the lower part of the C horizon is stratified material of coarser or finer texture.

Mosher soils are near Promise and Ree soils. They contain more sodium in the B horizon than those soils.

Mosher silt loam, 0 to 2 percent slopes (MoA).—This soil is on low terraces along entrenched streams and along drainageways on uplands. The terrain is uneven in many areas. Small mounds rise a few inches above the intervening low spots. This soil has the profile described as representative of the series. In a few places, however, the surface layer is loam.

Included with this soil in mapping are areas of Ree soils on slight rises and of Slickspots in some of the low spots. Also included in some areas is a soil that is similar to Walke soils, but is underlain by alluvium instead of glacial till. Included soils make up as much as 30 percent of some areas.

The claypan subsoil takes in water slowly and releases it slowly to plants. Deep-rooted crops are affected by accumulations of salts in the underlying material. Surface runoff is slow and commonly ponds in the low spots. Many areas have a water table between depths of 5 and 8 feet.

Most areas are in native grass and are used for grazing. Alfalfa is the main crop in cultivated areas. Capability unit IVs-2; Claypan range site; windbreak group 9.

Munjor Series

The Munjor series consists of deep, well-drained, nearly level loamy soils on bottom lands. These soils formed in stratified alluvium.

In a representative profile the surface layer is grayish-brown, calcareous fine sandy loam about 7 inches thick. The underlying material is calcareous, light brownish-gray fine sandy loam, thinly stratified with loamy fine sand and silty clay loam. Below a depth of 40 inches is calcareous, light brownish-gray loam.

Munjor soils are low in fertility and in organic-matter content. Surface runoff is slow or very slow, and permeability is moderately rapid. Available water capacity is moderate or high. The water table commonly fluctuates between depths of 5 and 10 feet.

Most areas are cultivated. Principal crops are corn, small grains, alfalfa, and tame grasses. Other areas are in native vegetation and are used for grazing. The native vegetation is a mixture of tall, mid, and short grasses and scattered deciduous trees.

Representative profile of Munjor fine sandy loam on Laframboise Island about 0.65 mile southeast from northernmost point of former cropped area and 60 feet north of trail road along timbered area.

Ap—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, coarse, granular structure; soft, very friable; slight effervescence; moderately alkaline; abrupt, smooth boundary.

C1—7 to 17 inches; light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; weak, coarse, subangular blocky structure; soft, very friable; strong effervescence; moderately alkaline; clear, smooth boundary.

C2—17 to 20 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) moist; weak, coarse, platy structure; loose; strong effervescence; moderately alkaline; clear, smooth boundary.

C3—20 to 37 inches, light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; weak, coarse, platy structure; soft, very friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C4—37 to 40 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, platy structure; hard, friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C5—40 to 60 inches, light brownish-gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The A horizon is grayish brown or light brownish gray in hue of 10YR, is fine sandy loam or loam, and ranges from 4 to 8 inches in thickness. The C horizon ranges from grayish brown to very pale brown in hues of 10YR or 2.5Y. Between depths of 10 and 40 inches it is sandy loam that is less than 18 percent clay. It is thinly stratified with fine sand, clay, or silty clay in some places.

Munjor soils have a thinner and lighter colored A horizon and contain more sand than Bon soils, which also are on bottom lands.

Munjor fine sandy loam (0 to 2 percent slopes) (Mu).—This soil is on bottom lands and islands along the Missouri River. The terrain is uneven in some areas because of old flood channels and low ridges or hummocks. In some areas the surface layer is darker colored than is typical. In some, the surface layer is loam.

Included with this soil in mapping are areas of loamy soils that contain less sand and more clay than Munjor soils, and on low ridges or hummocks, a soil that is sandier than Munjor soil. Near the entrance to the Farm Island Recreation Area is about 40 acres of a soil that is 10 to 20 inches of clay sediment over stratified sands and

silts. These included soils make up as much as 30 percent of some areas.

This Munjor soil is easy to work and takes in water readily. It receives runoff from adjacent soils in some years. Surface runoff is slow or very slow. In most places the water table is at a depth of 5 to 10 feet, but in some low areas it is at a depth of 2 to 5 feet. Control of soil blowing is the main concern in management.

Many areas are cultivated. Corn, small grain, alfalfa, and tame grasses are the main crops. The soil is well suited to irrigation. Some areas have an excellent potential for recreational development. Capability unit IIIe-7; Overflow range site; windbreak group 2.

Oahe Series

The Oahe series consists of well-drained, gently sloping to sloping loamy soils that are moderately deep over sand and gravel. These soils formed in alluvium and are on stream terraces.

In a representative profile the surface layer is dark grayish-brown loam about 7 inches thick. The subsoil, about 10 inches thick, is loam that is dark grayish brown in the upper part and grayish brown in the lower part. The upper part is hard when dry and very friable when moist. The lower part is calcareous and has spots and streaks of soft lime that extend into the underlying material. The underlying material is light brownish-gray, calcareous gravelly loam to a depth of 24 inches. Below this is loose sand and gravel.

Oahe soils are medium in fertility and moderate in organic-matter content. Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel. Surface runoff is medium, and available water capacity is low.

A few areas are cultivated. Corn and alfalfa are principal crops. Most areas are in native grass and are used for grazing or hay. The native vegetation consists of a mixture of mid and short grasses.

Representative profile of Oahe loam from an area of Oahe-Orton loams, 2 to 9 percent slopes, under cultivation, 1,775 feet south and 75 feet west of the northeast corner of sec. 2, T. 110 N., R. 75 W.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) moist; moderate, fine, granular structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

B2—7 to 11 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure; hard, very friable; mildly alkaline; clear, wavy boundary.

B3ca—11 to 17 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, medium, subangular blocky structure; hard, friable; common fine segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—17 to 24 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; many fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC2—24 to 60 inches, multicolored sand and gravel; single grained; loose; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 10 to 20 inches, and depth to sand and gravel from 20 to 40 inches. The A horizon ranges from very dark gray to dark grayish brown in hue of 10YR and from 4 to 7 inches in thickness. It commonly is loam, but is sandy loam or gravelly loam in some places. The B2 horizon ranges from 18 to 30 percent in clay content and from 4 to 14 inches in thickness. It has weak, medium, prismatic structure that commonly parts to weak or moderate, medium, subangular blocky structure. In places there is no B3ca horizon. Segregations of lime in the B3ca and Cca horizons range from few to many and are fine or medium in size. The C horizon above the sand and gravel ranges from grayish brown to pale brown in hues of 10YR or 2.5Y and is loam, sandy loam, gravelly loam, or gravelly sandy loam.

Oahe soils are mapped with or are near Canning, Orton, and Schamber soils. They contain less clay in the B horizon than Canning soils. They contain less sand and more clay in the B horizon than Orton soils. They are deeper over sand and gravel than Schamber soils.

Oahe-Orton loams, 2 to 9 percent slopes (OaC).—This complex is about 50 to 60 percent Oahe soil, 30 percent Orton soil, and 10 to 20 percent other soils. Most areas are terrace escarpments and terrace remnants along Chapelle, Medicine Knoll, and Spring Creeks. The Oahe soil is on the lower parts of the landscape, and the Orton soil is on the steeper sides and the crests of ridges and knolls. The Orton soil has a profile similar to the one described as representative of its series, but the surface layer is sandy loam or gravelly loam in places. The soils are mostly gently sloping to undulating, but are nearly level in places.

Included with these soils in mapping are areas of Ree and Schamber soils. Ree soils are in places where gravel is at a depth of more than 40 inches. Schamber soils occur with the Orton soil on the tops of ridges and knolls.

The Oahe and Orton soils are easy to work, but they are droughty and susceptible to erosion and soil blowing. Controlling erosion and soil blowing are the main concerns in management.

A few areas are cultivated, but most areas are in native grass and are used for grazing. Capability unit IVe-5; windbreak group 6; Oahe soil in Silty range site, Orton soil in Sandy range site.

Oko Series

The Oko series consists of deep, well-drained, gently sloping to rolling loamy soils that have a clayey subsoil. These soils formed in clayey glacial till on uplands.

In a representative profile the surface layer is very dark grayish-brown clay loam about 5 inches thick. The subsoil, about 15 inches thick, is clay that is dark grayish brown in the upper part and grayish brown in the lower part. The upper part is hard when dry, friable when moist, and sticky and plastic when wet. The lower part is calcareous and contains spots and streaks of soft lime. The underlying material is grayish-brown and light brownish-gray, calcareous clay and has many very fine spots and streaks of salts in the upper part.

Oko soils are medium in fertility and moderate in organic-matter content. Permeability is slow, and surface runoff is medium. Available water capacity is low to moderate.

Most areas are in native grass and are used for grazing or hay. The native vegetation consists of a mixture of mid and short grasses. Small grain is the principal crop grown in the few areas under cultivation.

Representative profile of Oko clay loam from an area of Oko-Jerauld complex, 2 to 9 percent slopes, in native

grass, 925 feet west and 280 feet north of the southeast corner of sec. 18, T. 110 N., R. 75 W.

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate, fine, granular and weak, fine, subangular blocky structure; slightly hard, friable; mildly alkaline; clear, wavy boundary.

B21t—5 to 9 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable, sticky and plastic; moderately alkaline; clear, wavy boundary.

B22tca—9 to 20 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; very hard, very firm, sticky and plastic; very dark grayish-brown (2.5Y 3/2) coats on some vertical faces of peds; common medium segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1sa—20 to 31 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium and coarse, subangular blocky structure; very hard, very firm, slightly sticky and plastic; many very fine segregations and striations of salts; few, very fine segregations of lime; slight effervescence; moderately alkaline; clear, wavy boundary.

C2—31 to 40 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm; strong effervescence; moderately alkaline; clear, smooth boundary.

C3—40 to 60 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; few distinct mottles of yellowish red (5YR 4/8); massive; hard, firm; common nests of gypsum crystals; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 5 to 12 inches. The A horizon ranges from very dark grayish brown to grayish brown in hue of 10YR, from heavy loam to light clay, and from 3 to 5 inches in thickness. The B2t horizon is in hues of 10YR or 2.5Y. It ranges from 45 to 60 percent in clay content and has weak or moderate, medium or coarse, prismatic structure that parts to moderate or strong, medium or fine, subangular blocky or blocky. In some places this soil has a B3ca horizon. The B22tca, B3, or C horizons have segregations of lime that range from few to many and from very fine to coarse. The C horizon ranges from grayish brown to pale olive in hues of 2.5Y or 5Y. It is clay or clay loam and has few or common fragments of shale in the lower part. The B22tca and C horizons are moderately alkaline or strongly alkaline.

Oko soils are mapped with Jerauld and Raber soils and are near Peno and Promise soils. They contain less sodium in the B horizon than Jerauld soils and more clay in the B horizon than Peno and Raber soils. They are less clayey in the B horizon than Promise soils.

Oko clay loam, 2 to 5 percent slopes (OcB).—This soil is on uplands where most slopes are long and smooth. In some areas it is nearly level. It has a profile similar to the one described as representative of the series, but in places the surface layer is thinner and in some places it is clay. A few glacial boulders are on the surface in some areas.

Included with this soil in mapping are areas of Jerauld, Opal, and Raber soils. Jerauld soils are on the lower parts of the landscape. Opal soils are in places where shale is at a depth of less than 40 inches. Raber soils are in the higher parts of some areas.

This soil takes in water slowly. It loses tilth easily in areas under cultivation. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in cultivated areas.

Most areas are in native grass and are used for grazing. Capability unit IIIe-4; Clayey range site; windbreak group 4.

Oko clay loam, 5 to 9 percent slopes (OcC).—This soil is on uplands, commonly below steeper areas of Gettys soils. It has a profile similar to the one described as representative of the series, but in places the surface layer is clay or silty clay. Slopes are long and smooth. A few scattered glacial boulders are on the surface in some areas.

Included with this soil in mapping are areas of Cavo, Jerauld, Opal, and Peno soils. Cavo and Jerauld soils are on the lower parts of the landscapes and along drainageways. Opal soils are in places where shale is at a depth of less than 40 inches. Peno soils are in the higher parts of some areas on ridgetops.

This soil loses its tilth if cultivated, and it takes in water slowly. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management.

A few areas are under cultivation, but most are in native grass and are used for grazing or hay. Capability unit IVe-4; Clayey range site; windbreak group 4.

Oko-Jerauld complex, 2 to 9 percent slopes (OdC).—This complex is 60 percent Oko soil, 30 percent Jerauld soil, and 10 percent other soils. The soils are intermingled in an erratic pattern. The profile of the Oko soil is the one described as representative of the series, but in places the surface layer is clay. Slopes are long and smooth. Well-defined drainageways are common. A few scattered glacial boulders are on the surface of ridges in some areas.

Included with these soils in mapping are areas of Cavo and Peno soils. Cavo soils are on the lower parts of the landscape and along drainageways. Peno soils are on some of the ridgetops.

These Oko and Jerauld soils have poor tilth and take in water slowly or very slowly. Crop growth is affected by the dense claypan subsoil and by the accumulations of salts in the Jerauld soil. Surface runoff is medium. Controlling erosion is the main concern in management.

Most areas are in native grass and are used for grazing. Capability unit IVe-4; Oko soil in Clayey range site, windbreak group 4; Jerauld soil in Thin Claypan range site, windbreak group 10.

Onita Series

The Onita series consists of deep, moderately well drained, nearly level and level silty soils. These soils formed in local alluvium on uplands and are in swales and along drainageways.

In a representative profile the surface layer is dark-gray silt loam about 15 inches thick. The subsoil, about 27 inches thick, is dark grayish-brown silty clay loam in the upper part, grayish-brown silty clay in the middle part, and grayish-brown and brown silty clay loam in the lower part. It is hard when dry, friable when moist, and slightly sticky and plastic when wet. The lower part is calcareous. The underlying material is pale-brown, calcareous silty clay loam to a depth of 54 inches. Below this is light brownish-gray, calcareous clay loam.

Onita soils are high in fertility and in organic-matter content. Permeability is moderately slow, and available

water capacity is high. Surface runoff is slow, and many areas receive additional moisture in the form of runoff from adjacent soils.

Many areas are under cultivation. The soils are suited to all crops grown in the county. Some areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of tall, mid, and short grasses.

Representative profile of Onita silt loam, 0 to 2 percent slopes, under cultivation, along U.S. Highway 14-83, about 2,904 feet west and 60 feet south of fence from east section line of sec. 9, T. 111 N., R. 78 W.

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

A12—7 to 15 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; weak, coarse, prismatic structure; slightly hard, very friable; neutral; clear, smooth boundary.

B21t—15 to 22 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, fine, blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; neutral; mildly alkaline; gradual, wavy boundary.

B22t—22 to 29 inches, grayish-brown (10YR 5/2) light silty clay, very dark grayish brown (10YR 3/2) crushing to dark grayish brown (10YR 4/2) moist; strong, fine, blocky structure; hard, friable, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; mildly alkaline; abrupt, wavy boundary.

B31—29 to 34 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, blocky structure; hard, friable, slightly sticky and slightly plastic; thin patchy clay films; slight effervescence; moderately alkaline; clear, wavy boundary.

B32ca—34 to 42 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; moderate, fine, blocky structure; hard, friable, slightly sticky and slightly plastic; few medium segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—42 to 54 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

IIC2—54 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; few medium segregations of lime; strong effervescence; strongly alkaline.

Depth to free carbonates ranges from 22 to 40 inches. The A horizon is dark gray or dark grayish brown in hue of 10YR and ranges from 8 to 15 inches in thickness. The B horizon ranges from very dark grayish brown to brown in hue of 10YR or 2.5Y and in thickness from 17 to 39 inches. The B2t horizon has a clay content ranging from 35 to 50 percent and has weak or moderate, medium, prismatic structure that parts to moderate or strong, medium or fine, blocky or subangular blocky. In places this soil does not have a B3ca horizon. The C horizon ranges from grayish brown to pale brown in hues of 10YR or 2.5Y. It commonly is silty clay loam or silt loam, but loam or clay loam glacial till is at depths below 40 inches in places.

Onita soils are near Agar, Eakin, Glenham, and Highmore soils and are mapped with Hoven soils. They have a thicker A horizon and more clay in the B horizon than Agar, Eakin, Glenham, and Highmore soils. They have less sodium in the B horizon and are better drained than Hoven soils.

Onita silt loam, 0 to 2 percent slopes (OnA).—This soil is in swales and along drainageways in the uplands. It has the profile described as representative of the series, but in areas near Lowry soils the subsoil contains slightly less clay. Areas are long and narrow.

Included with this soil in mapping are areas of Hoven soils in depressions less than 2 acres in size and some areas of a soil that has a thinner surface layer than the Onita soil.

This Onita soil is high in fertility and has a high available water capacity. Surface runoff is slow, and the areas receive additional moisture in the form of runoff from adjacent soils. In most years the additional moisture is beneficial, but spring planting is delayed in years of excessive moisture. In dry years, crop growth is affected by the lack of moisture late in the growing season. Conserving moisture is the main concern in management.

Many areas are cultivated. Corn, small grain, and alfalfa are the main crops. This soil is well suited to all crops commonly grown in the county. Capability unit IIc-3; Overflow range site; windbreak group 1.

Onita-Hoven silt loams, 0 to 1 percent slopes (OoA).—This complex is about 60 percent Onita soil, 25 percent Hoven soil, and 15 percent other soils. The Onita soil is in swales, and the Hoven soil is in depressions. Areas are long and narrow. The upland swales terminate in or connect small, shallow depressions.

Included with these soils in mapping is a soil that has a thinner surface layer than the Onita soil and a weakly expressed claypan subsoil.

Surface runoff is slow on the Onita soil and ponds on the Hoven soil. Areas of this complex receive runoff water from adjacent soils. Generally, the additional moisture is beneficial to the Onita soil but ponds on the Hoven soil where it remains until it has evaporated. Spring planting commonly is delayed by wetness. In addition, the Hoven soil has poor tilth and its claypan subsoil takes in water very slowly.

The use of the adjacent soils usually determines the use of these soils. Many areas are in native grass and are used for grazing or hay. Some are under cultivation. Corn, small grain, and alfalfa are the main crops. Capability unit IIc-3; Onita soil in Overflow range site, windbreak group 1; Hoven soil in Closed Depression range site, windbreak group 10.

Opal Series

The Opal series consists of moderately deep, well-drained, gently sloping to strongly sloping clayey soils on uplands. These soils formed in clay material weathered from the underlying bedded shale.

In a representative profile the surface layer is dark grayish-brown clay about 5 inches thick. The subsoil, about 19 inches thick, is clay that is grayish brown in the uuper part and olive gray in the lower part. The upper part is extremely hard when dry, very firm when moist, and sticky and plastic when wet. The lower part is calcareous. The underlying material is olive-gray, calcareous shaly clay to a depth of 28 inches. Below this is gray, bedded shale.

Opal soils are medium in fertility and moderate in organic-matter content. Permeability is very slow, and surface runoff is medium. Available water capacity is low or very low.

Most areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses. Winter wheat and sorghums are the principal cultivated crops.

Representative profile of Opal clay, 5 to 9 percent slopes, in native grass, 400 feet west and 80 feet north of the southeast corner of sec. 5, T. 110 N., R. 76 W.

A11—0 to 2 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; hard, friable, sticky and plastic; neutral; clear, smooth boundary.

A12—2 to 5 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular and weak, fine, subangular blocky structure; very hard, firm, sticky and plastic; neutral; clear, smooth boundary.

B21—5 to 10 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; extremely hard, very firm, sticky and plastic; neutral; clear, wavy boundary.

B22—10 to 16 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; moderate, medium and coarse, subangular blocky structure; extremely hard, very firm, sticky and plastic; slight effervescence; mildly alkaline; gradual, wavy boundary.

B3—16 to 24 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; weak, medium and coarse, subangular blocky structure; very hard, firm, sticky and plastic; slight effervescence; mildly alkaline; gradual, wavy boundary.

C1—24 to 28 inches, olive-gray (5Y 5/2) shaly clay, olive gray (5Y 4/2) moist; massive; very hard, firm, sticky and plastic; fragments of shale make up 20 to 40 percent of the mass; slight effervescence; mildly alkaline; clear, wavy boundary.

C2—28 to 60 incres, gray (5Y 5/1) bedded shale, very dark gray (5Y 3/1) moist; light olive-gray (5Y 6/2) lenses between plates; brittle; common fine iron stains; neutral.

Depth to free carbonates ranges from 2 to 10 inches, and depth to bedded shale from 20 to 40 inches. Cracks as much as 1 inch wide and several feet long extend downward through the B horizon when the soil is dry. The A horizon is dark grayish brown or grayish brown in hues of 10YR or 2.5Y and ranges from 4 to 7 inches in thickness. The B2 horizon ranges from dark grayish brown to olive gray in hues of 2.5Y or 5Y and from 11 to 20 inches in thickness. It has weak, medium to very coarse, prismatic structure that parts to weak or moderate, fine to coarse, blocky or subangular blocky. In places the soil has a B3ca horizon. Nests of gypsum and other salts are in the C1 horizon and within seams of the underlying shale in some places.

Opal soils are near Hurley, Lakoma, Promise, and Sansarc soils. Compared with Hurley soils, they lack an A2 horizon, and they have less sodium in the B horizon. They have thicker horizons that are very dark grayish brown or darker when moist and harder consistence when dry than Lakoma soils. They are shallower over bedded shale than Promise soils and are deeper over bedded shale than Sansarc soils.

Opal clay, 2 to 5 percent slopes (OpB).—This soil is on uplands. It has a profile similar to the one described as representative of the series, but in some areas the upper 3 to 5 inches of the surface layer is clay loam. Also, in a few places the depth to lime is more than 10 inches. Slopes are long and smooth. A few scattered glacial boulders are on the surface in some areas.

Included with this soil in mapping are areas of Hurley and Promise soils. They commonly are in swales and along drainageways.

Tilth is poor, and the soil takes in water very slowly. Available water capacity is low or very low. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management when the soil is under cultivation.

Many areas are in native grass and are used for grazing. Some areas are under cultivation. Capability unit IIIe-4; Clayey range site; windbreak group 4.

Opal clay, 5 to 9 percent slopes (OpC).—This soil is on uplands. It has the profile described as representative of the series. Slopes are long and smooth. A few glacial boulders are on the surface in some areas.

Included with this soil in mapping are areas of Lakoma, Hurley, and Promise soils. Lakoma soils are on the higher parts of the landscape. Hurley and Promise soils are in swales and along drainageways.

Tilth is poor, and the soil takes in water very slowly. Available water capacity is low or very low. Surface runoff is medium, and the soil is susceptible to erosion and soil blowing. Controlling erosion and soil blowing are the main concerns in management.

Most areas are in native grass and are used for grazing. A few areas are under cultivation. Capability unit IVe-4; Clayey range site; windbreak group 4.

Opal-Lakoma clays, 9 to 15 percent slopes (OrD).—This complex is about 60 percent Opal soil and 40 percent Lakoma soil. Most areas are on the sides of deeply entrenched drainageways or creeks. The Opal soil is on the middle and lower parts of the landscape, and the Lakoma soil is on the higher parts. The Opal soil has a profile similar to the one described as representative of its series, but is not so deep over shale. The Lakoma soil has a profile similar to the one described as representative of its series, but on some of the ridgetops the surface layer is silty clay or gravelly loam. Few to common, scattered glacial boulders are on the surface in some of the areas.

Included with these soils in mapping are small areas of Sansarc and Swanboy soils. Sansarc soils are on some of the ridgetops. Swanboy soils are in the lower parts of the areas along drainageways. Also included in some areas are small seep spots and saline spots along some of the drainageways.

These Opal and Lakoma soils take in water very slowly or slowly. Available water capacity is low or very low. Surface runoff is medium, and the soils erode easily. Controlling erosion is the main concern in management.

All areas are in native grass and are used for grazing. Capability unit VIe-4; Clayey range site; windbreak group 10.

Orton Series

The Orton series consists of well-drained, gently sloping to steep loamy soils that are moderately deep over sand and gravel. These soils formed in alluvium and are on terraces and terrace escarpments.

In a representative profile the surface layer is dark grayish-brown loam about 3 inches thick. The subsoil, about 13 inches thick, is dark grayish-brown fine sandy loam in the upper part and brown, calcareous fine sandy loam in the lower part. It is slightly hard when dry and friable when moist. The underlying material is brown,

calcareous sandy loam to a depth of 24 inches. Below this is calcareous sand and gravel.

Orton soils are low in fertility and moderately low in organic-matter content. Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying sand and gravel. Surface runoff is slow to rapid, depending on slope. Available water capacity is low.

Most areas are in native grass and are used for grazing. The native vegetation is mainly a mixture of mid and short grasses. Small grain is the main crop in the few areas under cultivation.

The Orton soils in Hughes County are mapped only with Oahe and Schamber soils.

Representative profile of Orton loam from an area of Schamber-Orton complex, in native grass, 1,440 feet west and 330 feet south of the northeast corner of sec. 20, T. 110 N., R. 75 W.

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

B2—3 to 8 inches, dark grayish-brown (10Y 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

B3ca—8 to 16 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak, coarse, prismatic structure; slightly hard, friable; common fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—16 to 24 inches, brown (10YR 5/3) light sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable; common fine segregations of lime; strong effervescence; moderately alkaline; gradual, wavy boundary.

IIC2—24 to 60 inches, pale-brown (10YR 6/3) and grayish-brown (10YR 5/2) sand and gravel, dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) moist; single grained; loose; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 7 to 15 inches. Depth to loose sand or gravel is 20 to 40 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR. It is loam or fine sandy loam and ranges from 3 to 5 inches in thickness. The B2 horizon is dark grayish brown or grayish brown in hue of 10YR. It is light loam or fine sandy loam that is less than 18 percent clay and ranges from 4 to 10 inches in thickness. Segregations of lime in the B3ca or C1ca horizons are few or common and fine or medium. In places this soil has a B3 horizon instead of a B3ca horizon. The C1ca horizon above the sand and gravel ranges from grayish brown to pale brown in hue of 10YR or 2.5Y and from loamy sand to light loam.

Orton soils are mapped with Oahe and Schamber soils. They have less clay and more sand in the B horizon than Oahe soils. They are deeper over sand and gravel than Schamber soils.

Peno Series

The Peno series consists of deep, well-drained, gently undulating to rolling loamy soils on uplands. These soils formed in firm glacial till of clay loam texture.

In a representative profile the surface layer is dark-gray clay loam about 3 inches thick. The subsoil, about 13 inches thick, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. The upper part is hard when dry, friable when moist, and slightly sticky and slightly plastic when wet. The lower part is calcareous. The underlying material is grayish-brown, calcareous clay loam to a depth of 32 inches. It contains many spots and streaks of soft lime. Below 32 inches is pale-brown, calcareous clay loam.

Peno soils are medium in fertility and moderate in organic-matter content. Permeability is moderately slow, and surface runoff is medium. Available water capacity is moderate or high.

Most areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses. Small grain, corn, and alfalfa are the principal crops grown in the few cultivated areas.

Representative profile of Peno clay loam from an area of Peno-Gettys clay loams, 9 to 15 percent slopes, in native grass, 218 feet south and 50 feet west of fence from the northeast corner of sec. 20, T. 112 N., R. 74 W.

A1—0 to 3 inches, dark-gray (10YR 4/1) light clay loam, very dark grayish brown (10YR 3/2) moist; weak, very fine, platy and moderate, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B2t—3 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films; mildly alkaline; clear, wavy boundary.

B3—8 to 16 inches, grayish-brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, firm, sticky and plastic; common dark-gray (10YR 4/1) coats on vertical faces of peds; thin patchy clay films, few, fine pores; slight effervescence; moderately alkaline; clear, wavy boundary.

C1ca—16 to 32 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; very hard, firm, sticky and plastic; very dark grayish-brown (10YR 3/2) stains on faces of some peds; few, fine pores; few, fine fragments of shale; many coarse segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—32 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; very hard, firm, slightly sticky and slightly plastic; common, fine, yellowish-brown (10YR 5/6) iron stains; few medium segregations of lime; strong effervescence; moderate alkaline.

Depth to free carbonates ranges from 6 to 11 inches. Few or common, granitic pebbles, cobblestones, and stones that range to as much as 12 inches in diameter are throughout the soil in most places. The A horizon ranges from dark gray to grayish brown in hue of 10YR, and from 2 to 4 inches in thickness. The B2t horizon ranges from 35 to 45 percent in clay content and from 4 to 7 inches in thickness. In places the soil has a B3ca horizon. Segregations of lime in the Cca horizon range from few to many and are medium or coarse. The C horizon is clay loam or clay.

Peno soils are near Gettys, Oko, and Raber soils. They have a thicker horizon that is very dark grayish brown or darker when moist than Gettys soils. They have less clay in the B horizon than Oko soils. They have a thinner B horizon and are shallower over lime than Raber soils.

Peno-Gettys clay loams, 9 to 15 percent slopes (PeD).—This complex is 40 to 50 percent Peno soil, 35 to 45 percent Gettys soil, and 15 percent other soils. These two soils are closely intermingled with the Gettys soil that commonly is on the higher parts of the landscape. This complex is on ridges and on the sides of entrenched drainageways. It is mostly strongly sloping or rolling, but in some small areas it is steeper and in others it is less steep. Few to many glacial boulders are on the surface. Some are partly embedded in the soil.

Included with these soils in mapping are areas of Cavo, Jerauld, Oko, and Raber soils. Cavo, Jerauld, and Oko soils commonly are on the lower parts of the

landscape and along drainageways. Raber soils are near Peno soils.

Surface runoff is medium to rapid, and the soils are highly susceptible to erosion. The Gettys soil is low in fertility. The main concern in management is controlling erosion.

All areas are in native grass and are used for grazing. Capability unit VIe-3; windbreak group 10; Peno soil in Clayey range site, Gettys soil in Thin Upland range site.

Peno-Swanboy complex, 3 to 15 percent slopes (PnD).—This complex is about 50 percent Peno soil, 20 percent Swanboy soil, and 30 percent other soils. It is on uplands, commonly below steeper areas of Betts, Gettys, or Sansarc soils. The Peno soil is on low ridges and on rises between drainageways. The Swanboy soil is along some of the drainageways or on fans. Both soils have profiles similar to those described as representative of their respective series, but in places the Peno soil has a surface layer of silt loam. Drainageways from the adjacent steeper soils and numerous gullies cross this complex. Glacial boulders are common on the surface in some areas. Also in some areas shale is at a depth of less than 60 inches, and in a few places it is at a depth of slightly less than 40 inches.

Included with these soils in mapping are areas of Gettys, Oko, Opal, and Sansarc soils. Gettys soils are on the higher parts of the landscape; Oko soils are near and below Peno soils; and Opal and Sansarc soils are on the sides or shoulders of entrenched drainageways. Also intermingled with the Swanboy soils are spots of Slickspots.

Surface runoff is medium to rapid, and the soils are easily eroded. Also, the Swanboy soil has poor tilth, takes in water very slowly, and is not suitable for cultivation. Controlling erosion is the main concern in management.

All areas are in native grass and are used for grazing. Capability unit VIe-3; windbreak group 10; Peno soil in Clayey range site, Swanboy soil in Dense Clay range site.

Promise Series

The Promise series consists of deep, well-drained, nearly level to gently sloping clayey soils on uplands and stream terraces. These soils formed in clayey material that is more than 40 inches thick over bedded shale.

In a representative profile the surface layer is very dark gray silty clay and clay about 5 inches thick. The subsoil, about 18 inches thick, is dark grayish-brown and grayish-brown, calcareous clay. It is extremely hard when dry, very firm when moist, and sticky and plastic when wet. The underlying material is grayish-brown, calcareous clay. Spots and streaks of soft lime are in the upper part. Gypsum and other salts are in the lower part.

Promise soils are medium in fertility and moderate in organic-matter content. Permeability is slow or very slow. Surface runoff is slow or medium, depending on the slope. Available water capacity is low or moderate.

Many areas are in native grass and are used for grazing or for hay. The native vegetation is a mixture of mid and short grasses. Some areas are cultivated. Winter wheat and sorghums are the principal crops.

Representative profile of Promise clay, 0 to 2 percent slopes, in native grass, 150 feet east and 150 feet south of the northwest corner of sec. 5, T. 110 N., R. 76 W.

A11—0 to 2 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak, medium, subangular blocky and moderate, fine, granular structure; slightly hard, friable, sticky and plastic; mildly alkaline; clear, smooth boundary.

A12—2 to 5 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) moist; weak, fine, granular and moderate, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; mildly alkaline; clear, smooth boundary.

B2—5 to 14 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, prismatic structure parting to moderate, medium and coarse, subangular blocky; extremely hard, very firm, sticky and plastic; slight effervescence; moderately alkaline; gradual, wavy boundary.

B3ca—14 to 23 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, medium and fine, subangular blocky structure; extremely hard, very firm, sticky and plastic; few medium segregations of lime; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1ca—23 to 28 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium and coarse, subangular blocky structure; very hard, firm, sticky and plastic; few medium segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

C2—28 to 36 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; very hard, firm, sticky and plastic; few very fine segregations of lime, gypsum, and other salts; strong effervescence; moderately alkaline; gradual, wavy boundary.

C3—36 to 60 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; few fine segregations of gypsum and other salts; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 4 to 8 inches. Cracks that range from ½ to 2 inches wide and several feet long extend downward through the B horizon when the soil is dry. The A horizon ranges from very dark gray to grayish brown in hue of 10YR or 2.5Y and from 4 to 8 inches in thickness. The B horizon ranges from dark grayish brown to light olive gray in hue of 2.5Y or 5Y and from 55 to 65 percent in clay content. The B2 horizon has weak, medium or coarse, prismatic structure that parts to weak or moderate, medium or coarse, blocky or subangular blocky. The B horizon is extremely hard or very hard when dry and extremely firm or very firm when moist. The C horizon ranges from grayish brown to pale olive in hue of 2.5Y or 5Y. Bedded shale is between depths of 40 and 60 inches in some places.

Promise soils are near Lakoma, Mosher, Oko, and Opal soils. They are deeper over shale than Lakoma and Opal soils. They are more clayey throughout and have less sodium in the B horizon than Mosher soils. They have more clay in the A and B horizons than Oko soils.

Promise clay, 0 to 2 percent slopes (PrA).—This soil is on terraces, fans, and upland flats. It has the profile described as representative of the series, but the surface layer is silt loam or silty clay loam in a few places. Also, in some areas on terraces along stream channels the depth to lime is greater and the underlying material has thin strata of loamy or sandy materials. Slopes are long and smooth.

Included with this soil in mapping are areas of Hurley and Mosher soils in swales and slight depressions.

This Promise soil is difficult to work and loses tilth when cultivated. Also it blows easily when dry. Surface runoff is slow. When the soil is dry, water intake is rapid until the cracks close; thereafter the intake is slow or very slow. Controlling soil blowing and improving tilth and water intake are the important concerns in management.

Many areas are cultivated. Small grain, corn, and alfalfa are the main crops. Sorghum is better suited than corn on these clayey soils. Other areas are in native grass and are used for grazing and hay. Capability unit IIIs-3; Clayey range site; windbreak group 4.

Promise clay, 2 to 5 percent slopes (PrB).—This soil has a profile similar to the one described as representative of the series, but in places the surface layer is thinner and in some areas it is silty clay loam. Slopes are long and smooth.

Included with this soil in mapping are areas of Hurley and Opal soils. Hurley soils are in slight depressions and in swales. Opal soils are on or near the tops of ridges.

This Promise soil loses tilth when cultivated, and it blows easily. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management, but improving tilth and water intake also are important needs in cultivated areas.

Most areas are in native grass and are used for grazing or hay. A few areas are under cultivation. Corn, small grain, and alfalfa are the main crops. Sorghum is better suited than corn on these clayey soils. Capability unit IIIe-4; Clayey range site; windbreak group 4.

Promise-Mosher complex, 0 to 2 percent slopes (PsA).—This complex is about 70 percent Promise soil and 30 percent Mosher soil. The two soils are closely intermingled with the Mosher soils that are in slight depressions. The Promise soil has a profile similar to the one described as representative of the series, but in some areas the surface layer is silty clay loam. The Mosher soil has more clay in the subsoil and underlying material than is typical. In cultivated areas it is distinguished by the gray color of its surface layer, as a result of the mixing of the surface and subsurface layers by plowing. Slopes are long and smooth and are mostly less than 2 percent, but some are as much as 4 percent.

These soils have poor tilth and take in water slowly or very slowly. Crop growth is affected by the dense claypan subsoil and the accumulations of salts in the Mosher soil. Improving tilth and water intake are the main concerns in management.

Most areas are in native grass and are used for grazing or hay. A few areas are cultivated. Sorghum is a better suited row crop than corn on these soils. Capability unit IIIs-3; Promise soil in Clayey range site, windbreak group 4; Mosher soil in Claypan range site, windbreak group 9.

Raber Series

The Raber series consists of deep, well-drained, nearly level to rolling loamy soils on uplands. These soils formed in firm glacial till of clay loam texture.

In a representative profile the surface layer is dark grayish-brown loam about 4 inches thick. The subsoil, about 28 inches thick, is clay loam that is brown in the upper part and grayish brown and light brownish gray in the lower part. The upper part is hard when dry, friable to firm when moist, and slightly sticky and slightly plastic when wet. The lower part is calcareous and contains many spots and streaks of soft lime. The underlying material is grayish-brown and light brownish-gray, calcareous clay loam.

Raber soils are medium in fertility and moderate in organic-matter content. Permeability is moderately slow. Surface runoff is slow or medium, depending on the slope. Available water capacity is moderate or high.

Some areas are under cultivation. Small grain, corn, and alfalfa are the principal crops. Other areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Raber loam in an area of Eakin-Raber silt loams, 5 to 9 percent slopes, in native grass, 1,056 feet north and 30 feet east of fence from the southwest corner of sec. 34, T. 110 N., R. 74 W.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

B21t—4 to 7 inches, brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; mildly alkaline; gradual, smooth boundary.

B22t—7 to 13 inches, brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) crushing to dark brown (10YR 3/3) moist; weak, medium, prismatic structure parting to strong, medium and fine, subangular blocky and blocky; hard, firm, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; mildly alkaline; clear, wavy boundary.

B31ca—13 to 20 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; many medium and coarse segregations of lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

B32ca—20 to 32 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate, medium and fine, blocky structure; very hard, firm, sticky and plastic; many medium and coarse segregations of lime; violent effervescence; moderately alkaline; clear, wavy boundary.

C1—32 to 44 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; few, distinct, relict mottles of yellowish red (5YR 4/8); weak, medium, blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine segregations of lime; slight effervescence; moderately alkaline; clear, wavy boundary.

C2—44 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; hard, firm, slightly sticky and plastic; common fine iron stains; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 12 to 20 inches. In most places the soil has few or common granitic pebbles and cobblestones that range to as much as 6 inches in diameter. The A horizon is dark grayish brown or grayish brown in hue of 10YR and ranges from 4 to 7 inches in thickness. It commonly is loam, but is silt loam or clay loam in some areas. The B2t horizon ranges from dark grayish brown to brown in hues of 10YR and 2.5Y and from 8 to 12 inches in thickness. It is clay loam or light clay; the clay content ranges from 35 to 45 percent. This horizon has weak or moderate, fine or medium, prismatic structure that parts to moderate or strong, fine or medium, blocky or subangular blocky structure. The B3 and C horizons range from grayish brown to pale olive in hues of 2.5Y or 5Y. The B3ca horizon

and the Cca horizon, which occurs in places, have common or many segregations of lime.

Raber soils are mapped with Cavo, Eakin, Oko, and Peno soils and are near Demky and Jerauld soils. They have less sodium in the B horizon than Cavo, Demky, and Jerauld soils. They are less silty and more clayey in the B horizon than Eakin soils. They are less clayey in the B horizon than Oko soils. They have a thicker A horizon and B2t horizon than Peno soils and are deeper over free carbonates.

Raber-Cavo loams, 0 to 2 percent slopes (RcA).—This complex is about 50 percent Raber soil, 40 percent Cavo soil, and 10 percent other soils. The Raber soil is on very slight rises, and the Cavo soil is in slight depressions. Except for texture of the surface layer, the Cavo soil has a profile similar to the one described as representative of the series. Its surface is a series of low mounds. Scattered glacial boulders are on the surface in many areas of the complex.

Included with these soils in mapping are areas of Demky, Eakin, Hoven, Jerauld, and Onita soils. Demky soils, the most extensive, are commonly between the Raber and Cavo soils. Eakin soils are on some of the slight rises. Hoven soils are in small depressions that are identified by a wet spot symbol on the soil map. Jerauld soils are intermingled with Cavo soils in some areas. Onita soils are in swales.

The Raber soil has good tilth and moderate or high available water capacity. The Cavo soil has poor tilth and a claypan subsoil that takes in water slowly or very slowly and releases it slowly to plants. Conserving moisture and improving tilth and water intake are the main concerns in management.

Some areas are cultivated. Small grain and sorghum are better suited than corn. Other areas are in native grass and are used for grazing. Capability unit IVs-2; Raber soil in Clayey range site, windbreak group 3; Cavo soil in Claypan range site, windbreak group 9.

Raber-Cavo loams, 2 to 5 percent slopes (RcB).—This complex is about 60 percent Raber soils, 30 percent Cavo soil, and 10 percent other soils. The Raber soil is on the higher parts of the landscape, and the Cavo soil is in the lower parts in swales and along drainageways. The profiles of both soils are similar to the ones described as representative of their respective series, but the surface layer of the Cavo soil is loam. Slopes are mostly less than 400 feet long and are broken by concave swales and depressions. A few scattered boulders are on the surface of some of the ridges.

Included with these soils in mapping are areas of Demky, Eakin, Hoven, Jerauld, and Onita soils. Demky soils are the most extensive and commonly are between the Raber and Cavo soils. Eakin soils are in an erratic pattern on the higher parts of the landscape. Hoven soils are in small depressions less than 2 acres in size. Jerauld soils are in some of the low areas with the Cavo soil. Onita soils are in swales.

The Raber soil is easy to work and has moderate or high available water capacity. The Cavo soil has poor tilth, and its claypan subsoil takes in water slowly or very slowly and releases it slowly to plants. Surface runoff is medium. Improving tilth and water intake and controlling erosion are the main concerns in management.

Many areas are in native grass and are used for grazing. Some areas are cultivated. Small grain and sorghum are better suited than corn. Capability unit IVs-3; Raber soil in Clayey range site, windbreak group 3; Cavo soil in Claypan range site, windbreak group 9.

Raber-Peno clay loams, 2 to 9 percent slopes (RbC).—This complex is 40 to 50 percent Raber soil, 35 to 45 percent Peno soil, and 15 percent other soils. These gently undulating to undulating areas consist of knobs and ridges that have short convex slopes. Scattered glacial boulders are on the surface of some of the ridges. These two soils are closely intermingled. The Raber soil is on the sides of ridges and the Peno soil is on the tops. The Raber soil has a profile similar to the one described as representative of the series, but the surface layer is clay loam.

Included with these soils in mapping are areas of Cavo, Eakin, and Jerauld soils. Cavo and Jerauld soils are on the lower parts of the landscape and along drainageways. Eakin soils are on the sides of some of the ridges.

These Raber and Peno soils are easy to work and have high or moderate available water capacities. Surface runoff is medium. Controlling erosion is the main concern in management.

Many areas are in native grass and are used for grazing or for hay. Some areas are cultivated. Small grain, corn, and alfalfa are the main crops. Capability unit IIIe-2; Clayey range site; windbreak group 3.

Raber and Oko stony soils, 3 to 15 percent slopes (RdC).—Some areas of this mapping unit are mostly Raber soil, some are mostly Oko soil, and some contain both soils in proportions that differ from one place to another. These soils are gently undulating to rolling. Areas range from 5 to 40 acres in size. The sides and tops of ridges and knolls are covered with glacial boulders. These stony areas commonly are about 5 acres in size and occur throughout the mapping unit.

Included with these soils in mapping are areas of Cavo, Gettys, Jerauld, and Peno soils. Cavo and Jerauld soils are on the lower parts of the landscape and along drainageways. Gettys and Peno soils are on the upper sides and tops of ridges and knolls. These inclusions make up as much as 30 percent of some areas.

Raber and Oko soils have medium surface runoff. They are too stony for cultivation and hay. All areas are in native grass and are used for grazing. Capability unit VIIs-6; Clayey range site; windbreak group 10.

Ree Series

The Ree series consists of deep, well-drained, nearly level to gently sloping loamy soils on terraces and uplands. These soils formed in alluvium or in glacial outwash materials.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsoil, about 21 inches thick, is clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and pale brown in the lower part. The upper and middle parts are hard when dry, friable when moist, and slightly sticky and slightly plastic when wet. The lower part is calcareous. The underlying material is pale-brown, calcareous clay loam to a depth of 36 inches; light brownish-gray, calcareous loam between depths of

36 and 50 inches; and calcareous loose sand and gravel below a depth of 50 inches.

Ree soils are medium in fertility and moderate in organic-matter content. Permeability is moderate. Surface runoff is slow or medium. Available water capacity is moderate or high.

Most areas are cultivated. Small grain, corn, alfalfa, sorghum, and tame grass are the principal crops. Some areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

Representative profile of Ree loam, 0 to 2 percent slopes, in a cultivated area, 85 feet south of fence and 1,190 feet west of the northeast corner of sec. 28, T. 110 N., R. 75 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark gray (10YR 3/1) moist; moderate, fine, granular and weak, fine, subangular blocky structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

B21t—6 to 13 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films; neutral; clear, wavy boundary.

B22t—13 to 19 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable, slightly sticky and slightly plastic; thin patchy clay films; mildly alkaline; clear, wavy boundary.

B3ca—19 to 27 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; hard, firm, slightly sticky and slightly plastic; few fine segregations of lime; strong effervescence; moderately alkaline; clear, wavy boundary.

C1ca—27 to 36 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) moist; weak, coarse, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; many medium and fine segregations of lime; violent effervescence; moderately alkaline; gradual, wavy boundary.

C2—36 to 50 inches, light brownish-gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; massive; hard, friable; few fine segregations of lime; slight effervescence; moderately alkaline; abrupt, wavy boundary.

IIC3—50 to 60 inches, multicolored sand and gravel; single grained; loose; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 14 to 24 inches. The A horizon is dark grayish brown or grayish brown in hue of 10YR and ranges from 5 to 8 inches in thickness. It commonly is loam, but is silt loam or silty clay loam in places. The B2t horizon commonly is clay loam, but is silty clay loam in some areas. It ranges from 10 to 18 inches in thickness and from 27 to 35 percent in clay content. The B3 and C horizons range from grayish brown to pale brown in hue of 10YR or 2.5Y. The C horizon, to a depth of 40 inches or more, ranges from sandy loam to silty clay loam. In some places sand and gravel are below a depth of 60 inches.

Ree soils are mapped with Mosher soils and are near Canning and Onita soils. They are deeper over sand and gravel than Canning soils. Their B horizon contains less clay and less sodium than that of Mosher soils. They have a thinner A horizon and a less clayey B horizon than Onita soils.

Ree loam, 0 to 2 percent slopes (ReA).—This soil is on low terraces along streams and on upland flats. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Canning, Mosher, and Onita soils. Canning soils are on rises where gravel is at a depth of less than 40 inches. Mosher soils are in slight depressions. Onita soils are in swales. Also included, in some areas on low terraces, is a soil that is similar to Ree soils, but less clayey in the subsoil.

This Ree soil is easy to work and has high or moderate available water capacity. Surface runoff is slow. Conserving moisture is the main concern in management.

Most areas are cultivated. Corn, alfalfa, and small grain are the main crops. This soil is well suited to irrigation. Capability unit IIc-2; Silty range site; windbreak group 3.

Ree loam, 2 to 5 percent slopes (ReB).—This soil is on terraces and fans along streams and drainageways. Slopes are smooth and slightly concave. In places the surface layer is silt loam. On terraces along Medicine Knoll and Chapelle Creeks, the subsoil is silty clay loam or loam.

Included with this soil in mapping are areas of Canning, Mosher, and Onita soils. Canning soils are in places where gravel is at a depth of less than 40 inches. Mosher and Onita soils are in swales.

This Ree soil is easy to work and takes in water readily. Surface runoff is medium. Controlling erosion is the main concern in management.

About half the acreage is cultivated. Corn, alfalfa, small grain, sorghum, and tame grass are the main crops. Capability units IIe–1; Silty range site; windbreak group 3.

Ree-Mosher complex, 0 to 2 percent slopes (RmA).—This complex is about 60 percent Ree soil, 25 percent Mosher soil, and 15 percent other soils. The Ree soil is on slight rises, and the Mosher soil is in low, level areas. The terrain is smooth except where the small mounds rise a few inches above the small intervening low spots. In places the surface layer of the Ree soil is silt loam, and the subsoil is less clayey than the subsoil in the profile described as representative of the series. The Mosher soil has a profile similar to the one described as representative of the series, but the surface layer is loam in places.

Included with these soils in mapping are areas of a soil that is similar to Demky soils, but has underlying material of alluvium instead of clay loam glacial till. Also included are Slickspots, in depressions in areas of Mosher soils, that have salt accumulations within a few inches of the surface.

Surface runoff is slow. The Mosher soil is slow to dry out in the early part of the growing season. The water table is at a depth of 5 to 10 feet in some places. Conserving moisture is the main concern in management. Improving tilth and water intake are additional concerns on the Mosher soil.

About half the acreage is cultivated. Corn, small grain, alfalfa, sorghum, and tame grass are the main crops. Capability unit IIc-2; Ree soil in Silty range site, windbreak group 3; Mosher soil in Claypan range site, windbreak group 9.

Rough Broken Land

Rough broken land (15 to 40 percent slopes) (Ro) is on valley sides of the Missouri River (fig. 9). Slopes are irregular, and the areas are laced with many drainage-

Figure 9.—**Rough broken land along the Missouri River Valley.**

ways, some of which are gullied. Landslides are common. Slumping and erosion have caused mixing of soil materials so that in many areas the texture of the surface material ranges from gravelly sand to clay. Scattered glacial boulders are on the surface in parts of the areas.

No single soil dominates areas of Rough broken land. Betts, Gettys, Orton, Peno, and Schamber soils are on the higher parts of the landscape. Lakoma, Opal, Sansarc, and Swanboy soils commonly are on the middle and lower parts. Also included are small areas of Shale land on shoulders of drainageways, on cut banks, and in areas of the more recent landslides.

Surface runoff is rapid, and the areas are highly susceptible to erosion and slumping. Gullies, landslides, and escarpments make some areas nearly inaccessible to livestock.

All areas are in native grass and are used for grazing. Clumps of trees and shrubs grow in pockets created by some of the older landslides. Capability unit VIIs-6; Thin Upland range site; windbreak group 10.

Sansarc Series

The Sansarc series consists of shallow, well-drained, strongly sloping to steep clayey soils on uplands. These soils formed in materials weathered from the underlying shale.

In a representative profile the surface layer is dark grayish-brown clay about 2 inches thick. Below the surface layer is about 14 inches of grayish-brown, calcareous clay and shaly clay. Light olive-gray bedded shale is at a depth of 16 inches.

Sansarc soils are low in fertility and moderately low in organic-matter content. Permeability is slow, and surface runoff is rapid. Available water capacity is very low.

All areas are in native grass and are used for grazing. The native vegetation is a mixture of mid and short grasses.

Representative profile of Sansarc clay from an area of Sansarc-Lakoma clays, 9 to 40 percent slopes, in native grass, 2,560 feet south and 970 feet east of the northwest corner of sec. 20, T. 110 N., R. 76 W.

A1—0 to 2 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) moist; moderate, medium and coarse, granular structure; hard, friable; mildly alkaline; clear, smooth boundary.

C1—2 to 7 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; hard, friable; fine chips and particles make up 20 percent of mass; common roots; slight effervescence; moderately alkaline; clear, smooth boundary.

C2—7 to 16 inches, grayish-brown (2.5Y 5/2) shaly clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, very firm; chips and particles of shale make up 40 to

50 percent of mass; slight effervescence; moderately alkaline; abrupt, smooth boundary.

C3—16 to 60 inches, light olive-gray (5Y 5/2) bedded shale, olive gray (5Y 4/2) moist; shale plates are as much as 1 inch thick in the lower part; very hard but brittle, very firm; mildly alkaline.

Depth to bedded shale ranges from 8 to 20 inches. Free carbonates are at or near the surface. Colors throughout the soil are mostly inherent from the parent shale. The A horizon is dark grayish brown or grayish brown in hue of 10YR or 2.5Y and ranges from 2 to 4 inches in thickness. The C horizon above the shale ranges from grayish brown to pale olive in hue of 2.5Y or 5Y. Segregations of gypsum and other salts are in the C2 horizon and within seams of the shale in some places. Plant roots commonly penetrate into the upper part of the shale.

Sansarc soils are near Chantier, Lakoma, Opal, and Promise soils. They are more friable and contain less salts than Chantier soils. They are shallower over shale than Lakoma, Opal, and Promise soils.

Sansarc-Gettys complex, 9 to 34 percent slopes (ScE).—This complex is about 60 percent Sansarc soil, 30 percent Gettys soil, and 10 percent other soils. These soils are along the Missouri River and its tributaries. The Sansarc soil is on the sides of ridges and drainageways. The Gettys soil is on ridgetops. The profile of the Gettys soil is similar to the one described as representative of its series, but in places it is underlain by shale at a depth of 2 to 5 feet. Many small drainageways are in the areas and some of them are active gullies. Scattered glacial boulders are on the surface or are partly embedded in the soil in some areas.

Included with these soils in mapping are areas of Lakoma, Opal, Peno, and Swanboy soils. Lakoma and Opal soils are near the Sansarc soil. Peno soils are on or near the tops of ridges near the Gettys soil. Swanboy soils are along drainageways.

Surface runoff is rapid, and the soils are susceptible to erosion. The soils are too steep and erodible for cultivation.

All areas are in native grass and are used for grazing. Capability unit VIIs-2; windbreak group 10; Sansarc soil in Shallow range site, Gettys soil in Thin Upland range site.

Sansarc-Lakoma clays, 9 to 40 percent slopes (ScE).—This complex is about 40 percent Sansarc soil, 40 percent Lakoma soil, and 20 percent other soils. It is along the Missouri River and its tributaries. The Sansarc soil is on the tops and upper sides of ridges. The Lakoma soil is below the Sansarc soil on the middle parts of the landscapes. The profiles of both soils are the ones described as representative of their respective series. Many drainageways are in the areas, and many of these are active gullies. A few glacial boulders are on the surface in many of the areas.

Included with these soils in mapping are areas of Chantier, Gettys, Opal, Promise, and Swanboy soils. Chantier and Swanboy soils are on fans below the steeper areas and along drainageways. Gettys soils are on rounded knobs in the higher parts of some areas. Opal and Promise soils are in the lower parts of some areas or in sags on some of the ridges. Also included are small areas of Shale land on the shoulders of the drainageways and Slickspots in areas of Chantier and Swanboy soils.

Available water capacity is low or very low. Surface runoff is rapid, and the areas are highly susceptible to erosion. All areas are in native grass and are used for grazing (fig. 10). Capability unit VIIs-2; windbreak group 10; Sansarc in Shallow range site, Lakoma in Clayey range site.

Sansarc-Shale outcrop complex (15 to 40 percent slopes) (Sd).—This complex is 50 to 70 percent Sansarc soil, 25 to 35 percent Shale outcrop, and 5 to 15 percent other soils. It is on valley sides of the Missouri River and its tributaries. The Sansarc soil is less friable and is shallower over shale than is typical. Areas of Shale outcrop commonly are on rounded knobs that lack a soil cover and support little or no vegetation. A few, scattered glacial boulders are on the surface in many areas.

Included with these soils in mapping are areas of Chantier and Swanboy soils on fans and along drainageways and Slickspots intermingled with Chantier and Swanboy soils.

Surface runoff is rapid. Available water capacity is very low. Controlling erosion is difficult.

All areas are in native vegetation and are used for grazing. Sansarc soil in capability unit VIIs-2, Shallow range site, and windbreak group 10; Shale outcrop in capability unit VIIIs-2, not assigned to a range site or windbreak group.

Schamber Series

The Schamber series consists of well-drained through excessively drained, rolling to steep loamy soils that are very shallow over sand and gravel. These soils formed in gravelly material and are on terrace remnants and uplands.

In a representative profile the surface layer is dark grayish-brown gravelly loam about 2 inches thick. The underlying material is pale-brown, loose, calcareous gravelly sandy loam to a depth of 7 inches. Below this is calcareous sand and gravel.

Schamber soils are low in fertility and organic-matter content. Permeability is rapid, and surface runoff is medium or rapid. Available water capacity is very low or low.

All areas are in native grass and are used for grazing. The native vegetation is a mixture of mid and short grasses.

Representative profile of Schamber gravelly loam from an area of Schamber-Orton complex, in native grass, 324 feet north and 99 feet west of fence from the southeast corner of sec. 13, T. 108 N., R. 75 W.

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, medium, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.

C1—2 to 7 inches, pale-brown (10YR 6/2) gravelly sandy loam, brown (10YR 5/3) moist; massive; loose; slight effervescence; moderately alkaline; gradual, wavy boundary.

C2—7 to 60 inches, multicolored sand and gravel; single grained; loose; common, fine chips and particles of shale; slight effervescence; moderately alkaline.

Depth to loose sand and gravel is less than 10 inches. The A horizon ranges from dark grayish brown to pale brown in hue of 10 YR and from 1 to 4 inches in thickness. It is gravelly loam, loam, sandy loam, or gravelly sandy loam. The C horizon above the sand and gravel ranges from grayish brown to very pale brown in hue of 10YR. In places it has segregations of lime.

Figure 10.—**Range in excellent condition on Sansarc-Lakoma clays, 9 to 40 percent slopes.**

Schamber soils are shallower over loose sand and gravel than Oahe and Orton soils.

Schamber-Orton complex (9 to 40 percent slopes) (Sf).—This complex is about 65 to 75 percent Schamber soil, 15 to 25 percent Orton soil, and 10 percent other soils. It is on terrace remnants along creeks and along drainageways on uplands. The Schamber soil is in the upper parts of the areas, and the Orton soil is on the sides of ridges and knolls or on small, isolated benches. Both have the profiles described as representative of their respective series, but in places the surface layer is sandy loam. Few to many glacial boulders are on the surface in some of the areas.

Included with these soils in mapping are areas of Oahe and Ree soils on some of the isolated benches and low terraces and deep loamy soils that formed in alluvium on narrow bottom lands along some of the creeks and drainageways.

These Schamber and Orton soils have low or very low available water capacity and are too droughty and erodible for cultivation.

All areas are in native vegetation and are used for grazing. Clumps of American elm, bur oak, and native shrubs are along some of the drainageways and draws. They provide winter protection for livestock and wildlife. Capability unit VIIs-4; windbreak group 10; Schamber soil in Very Shallow range site, Orton soil in Sandy range site.

Shale Land

Shale land (9 to 40 percent slopes) (Sh) is about 75 percent or more outcrops of the underlying shale (fig. 11). Many, deep gullies dissect the rolling to steep areas.

Included with Shale land in mapping are small areas of Chantier, Sansarc, and Swanboy soils. Chantier and Swanboy soils are on fans below the barren shale areas. Sansarc soils are in spots where a thin covering of soil material has formed and is stabilized by sparse stands of grass.

Surface runoff is very rapid and the soil material is highly erodible. These areas have little or no economic value for agricultural uses. Capability unit VIIIs-2; not assigned to a range site or windbreak group.

Sully Series

The Sully series consists of deep, well-drained, nearly level to steep silty soils on uplands. These soils formed in windblown silts.

In a representative profile the surface layer is grayish-brown silt loam about 3 inches thick. The underlying material is light brownish-gray, calcareous silt loam. It is slightly hard when dry and very friable when moist.

Sully soils are low in fertility and organic-matter content (fig. 12). Permeability is moderate. Surface runoff is slow to rapid, depending on the slope. Available water capacity is high.

Figure 11.—Shale outcrop near the Missouri River.

Some areas are cultivated. Corn and small grain are the main crops. Many areas are in native grass and are used for grazing. The native vegetation is a mixture of mid and short grasses.

Representative profile of Sully silt loam, 9 to 15 percent slopes, in native grass, 2,376 feet north and 180 feet west of fence from the southeast corner of sec. 22, T. 112 N., R. 81 W.

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

C1—3 to 20 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure; slightly hard, very friable; few fine segregations of lime; slight effervescence; moderately alkaline; gradual, smooth boundary.

C2—20 to 60 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; common very fine segregations and striations of lime; strong effervescence; moderately alkaline.

Free carbonates are at or near the surface. The texture between depths of 10 and 40 inches is silt loam or very fine sandy loam. Clay content is less than 18 percent, and material coarser than very fine sand is less than 15 percent. The A horizon is dark grayish brown or grayish brown in hue of 10YR and is 2 to 4 inches thick. The C horizon ranges from grayish brown to very pale brown in hue of 10 YR. In some places the soil has a buried A horizon.

Sully soils have a thinner A horizon than the nearby Dorna and Lowry soils. They also differ from Dorna soils in not having clayey layers within a depth of 40 inches.

Sully silt loam, 0 to 2 percent slopes (SuA).—This soil is on benches about 50 to 75 feet above Lake Oahe and Lake Sharpe. It has a profile similar to the one described as representative of the series, but in places the surface layer is very fine sandy loam. In cultivated areas the surface layer commonly is calcareous. Slopes are long and smooth.

Included with this soil in mapping are areas of Lowry soils in slight depressions.

This Sully soil is easy to work and has high available water capacity, but it is low in fertility and blows easily. Controlling soil blowing is the main concern in management.

Most areas are cultivated. A few are irrigated. Corn, small grain, and alfalfa are the main crops. Capability unit IIIe-5; Thin Upland range site; windbreak group 8.

Sully silt loam, 2 to 9 percent slopes (SuC).—This soil is on uplands above Lake Oahe and Lake Sharpe. It has a profile similar to the one described as representative of the series, but in places the surface layer is very fine sandy loam. The surface layer commonly is calcareous in cultivated areas. Slopes are long and smooth.

Included with this soil in mapping are areas of Lowry soils, commonly in swales and slight depressions. Lowry soils make up as much as 20 percent of some areas.

This Sully soil is easy to work and has high available water capacity, but it is low in fertility and blows easily. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management.

Most areas are in native grass and are used for grazing. A few areas are cultivated. Capability unit IVe-3; Thin Upland range site; windbreak group 8.

Sully silt loam, 9 to 15 percent slopes (SuD).—This soil is on uplands in long, narrow areas mostly along drainageways. It has the profile described as representative of the series, but in places the surface layer is very fine sandy loam.

Included with this soil in mapping are areas of Betts, Lowry, and Schamber soils. Betts and Schamber soils are on the higher parts of the landscape on knolls and ridges. Lowry soils are in the lower areas along drainageways.

Surface runoff is rapid. This Sully soil is too steep and erodible for cultivation. Most areas are in native grass and are used for grazing. Gullies form easily along livestock trails. Capability unit VIe-3; Thin Upland range site; windbreak group 10.

Sully silt loam, 15 to 35 percent slopes (SuE).—This soil is on uplands in irregularly shaped areas on ridges and the sides of deeply entrenched drainageways. Deep gullies have formed in many areas. A few glacial boulders are on the surface in some areas. This soil has a profile similar to the one described as representative of the series, but in places the surface layer is very fine sandy loam and either shale or glacial till is at a depth of 40 to 60 inches. In a few places shale or glacial till is at a depth of less than 40 inches.

Included with this soil in mapping are areas of Betts, Lowry, Sansarc, and Schamber soils. Betts and Schamber soils are on knolls and ridges on the higher parts of the landscapes. Lowry soils are in the lower parts of some areas where slopes are concave. Sansarc soils are in places where shale is near the surface.

Surface runoff is rapid, and the soil erodes easily. All areas are in native grass and are used for grazing. Capability unit VIIe-3; Thin Upland range site; windbreak group 10.

Swanboy Series

The Swanboy series consists of deep, moderately well drained or well drained, nearly level to sloping clayey soils in upland valleys and on alluvial fans and stream terraces. These soils formed in alluvium of dense clay.

In a representative profile the surface layer is grayish-brown, calcareous silty clay about 1 inch thick, which includes a very thin crust. The next layer, about 6 inches thick, is grayish-brown, calcareous clay. It is extremely hard when dry, very firm when moist, and very sticky and very plastic when wet. The underlying material is grayish-brown and gray, calcareous clay that contains spots and streaks of gypsum and other salts.

Swanboy soils are low in fertility and organic-matter content. Permeability is very slow, and surface runoff is rapid. Available water capacity is low.

Nearly all areas are in native grass and are used for grazing or hay. The native vegetation is a thin stand of mid grasses and little or no understory of short grasses.

Representative profile of Swanboy clay, 0 to 6 percent slopes, in native grass, 210 feet south of railroad track and 90 feet east of the center of Farm Island road in sec. 12, T. 110 N., R. 79 W.

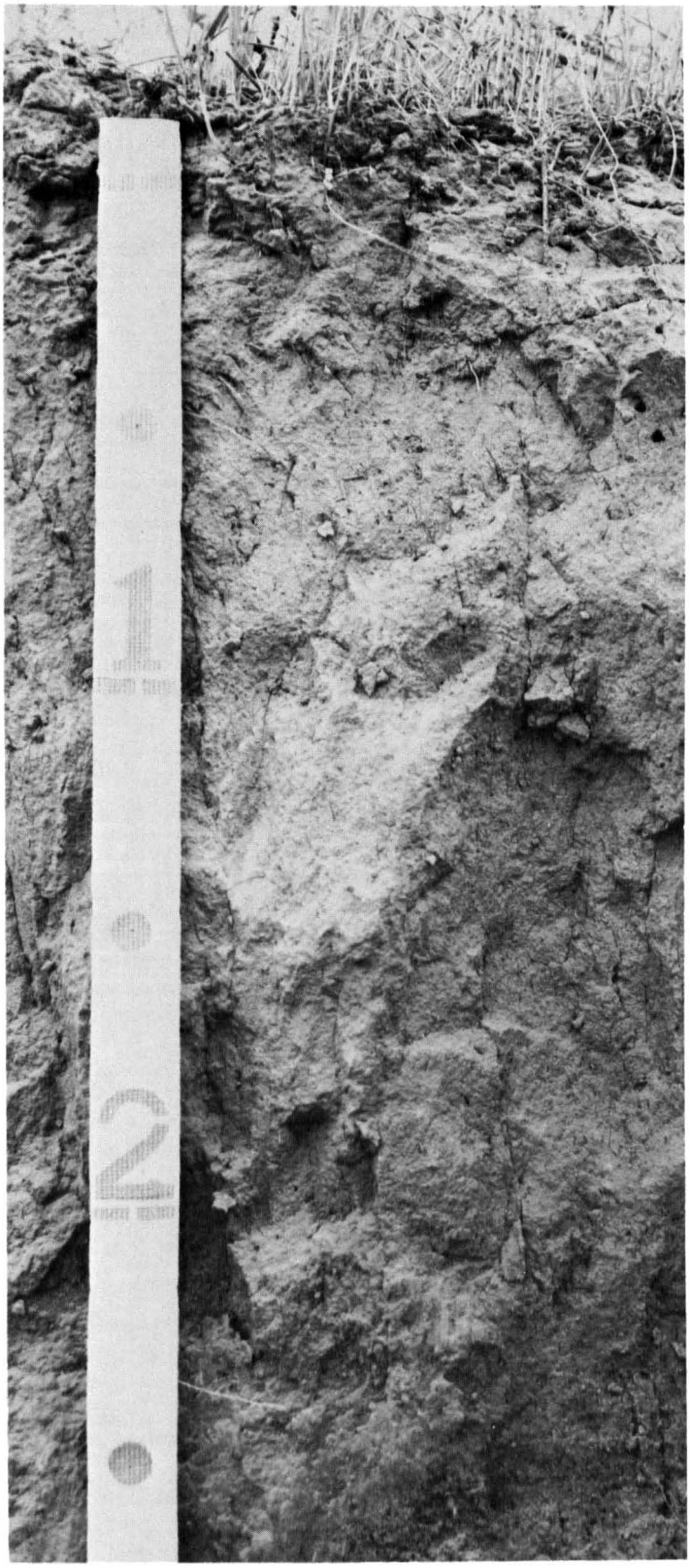

Figure 12.—Representative profile of Sully silt loam, 9 to 15 percent slopes. Light-colored areas indicate low organic-matter content.

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A1—0 to 1 inch, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; weak, medium, platy structure and a weak, one-quarter inch crust; hard, firm, sticky and plastic; slight effervescence; moderately alkaline; clear, smooth boundary.

B2—1 to 7 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; moderate, fine, blocky structure; extremely hard, very firm, very sticky and very plastic; slight effervescence; moderately alkaline; gradual, wavy boundary.

C1—7 to 16 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) crushing to dark grayish brown (2.5Y 4/2) moist; weak, medium, subangular blocky structure; extremely hard, very firm, sticky and plastic; few, fine salt segregations; slight effervescence; strongly alkaline; gradual, wavy boundary.

C2cssa—16 to 21 inches, gray (5Y 5/1) clay, olive gray (5Y 4/2) moist; massive; very hard, firm, sticky and plastic; many fine segregations of gypsum and other salts; slight effervescence; strongly alkaline; gradual, wavy boundary.

C3cssa—21 to 60 inches, gray (5Y 5/1) clay, olive gray (5Y 4/2) moist; massive; very hard, firm, sticky and plastic; common fine segregations of gypsum and other salts; slight effervescence; moderately alkaline.

Free carbonates are at or within a few inches of the surface. Soluble salts are at depths ranging from 5 to 15 inches, but typically about 7 to 9 inches. Soil colors are inherent from parent materials. Cracks ½ to 2 inches wide and several feet long extend downward to a depth of 20 inches when the soil is dry. The A horizon is dark grayish brown and grayish brown in hue of 2.5Y and is 1 or 2 inches thick. The B and C horizons, to a depth of 40 inches, range from 60 to 75 inches in clay content. The C horizon ranges from gray to light olive gray in hue of 2.5Y or 5Y. Bedded shale is at a depth of 40 to 60 inches in some places.

Swanboy soils are near Chantier, Opal, Promise, and Sansarc soils. They are deeper over shale than Chantier, Opal, and Sansarc soils. They have salt accumulations nearer the surface than Promise soils.

Swanboy clay, 0 to 6 percent slopes (SwB).—This soil is on fans and terraces below steeper soils. It has the profile described as representative of the series, but in smaller areas the surface layer is silt loam or silty clay loam. Slopes are mostly less than 4 percent and are slightly concave. Small drainageways and gullies cross many of the areas.

Included with this soil in mapping are areas of Chantier, Hurley, and Promise soils that are intermingled with this soil. Slickspots, scattered throughout the areas, are also included.

This Swanboy soil is difficult to work and takes in water very slowly. Some areas receive runoff water from adajacent steep soils. Runoff is rapid. The dense clay soil limits the development of plant roots. It is not suitable for cultivation.

All areas are in native grass and are used for grazing or hay. Capability unit VIs-5; Dense Clay range site; windbreak group 10.

Swanboy-Slickspots complex (0 to 6 percent slopes) (Sx).—This complex is about 70 percent Swanboy soils and 30 percent Slickspots. Most areas are nearly level, but the surface is uneven. Slickspots are in slight depressions. They have a thin crusty surface layer of gray clay or silty clay and accumulations of salts near the surface. The Swanboy soil is between the depressions. It has a profile similar to the one described as representative of the series, but in places the surface layer is silt loam or silty clay loam and in some areas the underlying material has thin layers of silty or loamy materials. Included in mapping are scattered, small areas of Hurley soils.

This complex has very poor tilth and takes in water very slowly. Surface runoff is rapid.

All areas are in native vegetation and are used for grazing. The Slickspot parts commonly are barren of vegetation (fig. 13). Swanboy soil in capability unit VIs-5, Dense Clay range site, windbreak group 10; Slickspots in capability unit VIIIs-2, not assigned to a range site or windbreak group.

Walke Series

The Walke series consists of deep, moderately well drained, nearly level silty soils that have a compact, clayey subsoil. These soils are on uplands. They formed in silty materials and are underlain by clay loam glacial till.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsurface layer, about 3 inches thick, is dark-gray and gray silty clay loam. The subsoil, about 22 inches thick, is silty clay loam that is dark grayish brown in the upper part, grayish brown in the middle part, and light yellowish brown in the lower part. The upper part is very hard when dry, very firm when moist, and sticky and plastic when wet. The lower part is calcareous. The underlying material is light brownish-gray, calcareous silty clay loam to a depth of 36 inches. Below this is light brownish-gray and grayish-brown, calcareous clay loam glacial till. The underlying material contains spots and streaks of soft lime.

Walke soils are medium in fertility and moderate in organic-matter content. Permeability is slow, and surface runoff is slow. Available water capacity is moderate or high.

Many areas are cultivated. Corn, small grain, and alfalfa are the principal crops. Some areas are in native grass and are used for grazing or hay. The native vegetation is a mixture of mid and short grasses.

The Walke soils in Hughes County are mapped only with Highmore and DeGrey soils.

Representative profile of Walke silt loam from an area of DeGrey-Walke silt loams, 0 to 2 percent slopes, in native grass, 2,400 feet west and 90 feet north of fence from southeast corner of sec. 6, T. 112 N., R. 75 W.

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular and weak, fine, subangular blocky structure; slightly hard, very friable; neutral; clear, wavy boundary.

B&A—7 to 10 inches, dark-gray (10YR 4/1) silty clay loam in (B) part, very dark grayish brown (10YR 3/2) moist, and many, gray (10YR 5/1) patches of bleached sand grains in (A) part; moderate, fine, subangular blocky structure; hard, firm; neutral; abrupt, wavy boundary.

B21t—10 to 15 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to strong, medium and fine, subangular blocky; very hard, very firm, sticky and plastic; thin patchy clay films on faces of peds; mildly alkaline; clear, wavy boundary.

B22t—15 to 24 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; thin patchy clay films on faces of peds; mildly alkaline; clear, wavy boundary.

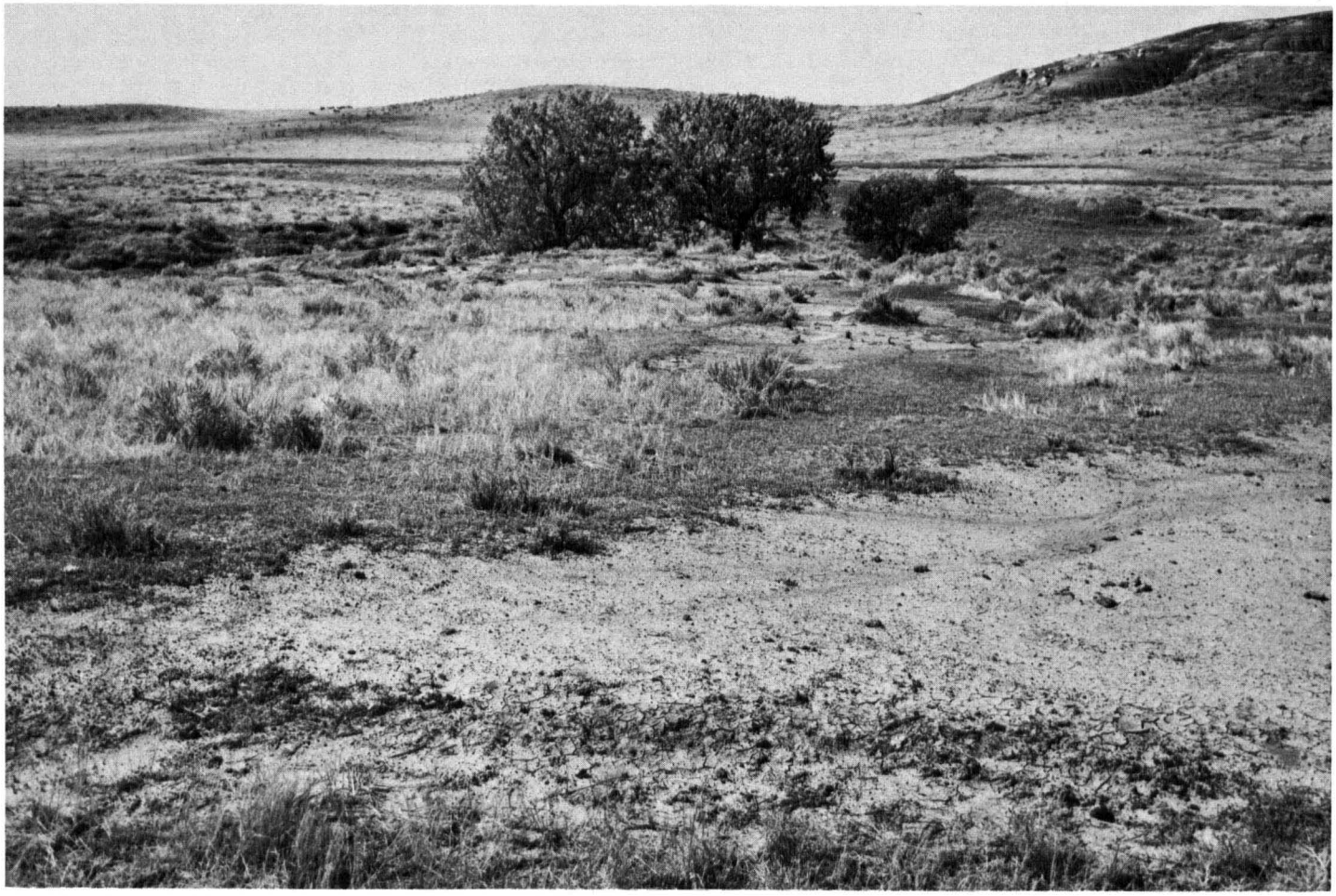

Figure 13.—Swanboy-Slickspots complex. Barren part is Slickspots.

B3—24 to 32 inches, light yellowish-brown (2.5Y 6/3) silty clay loam, olive brown (2.5Y 4/3) moist; weak, fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; slight effervescence; moderately alkaline; clear, wavy boundary.

C1ca—32 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay loam, light olive brown (2.5Y 5/3) moist; weak, fine subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common fine segregations of lime; strong effervescence; moderately alkaline; clear, smooth boundary.

IIC2ca—36 to 46 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; many fine and medium segregations of lime; strong effervescence; moderately alkaline; gradual, smooth boundary.

IIC3—46 to 60 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, slightly sticky and slightly plastic; few fine segregations of lime, gypsum, and other salts; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 12 to 24 inches. Depth to the underlying clay loam glacial till ranges from 20 to 40 inches and commonly is below the B horizon. The A1 horizon ranges from dark gray to grayish brown in hue of 10YR and from 4 to 7 inches in thickness. In places the soil has a very thin A2 horizon. The B&A horizon is 2 to 4 inches thick. The B2t horizon is silty clay loam or silty clay that ranges from 35 to 50 percent in clay content and from 8 to 14 inches in thickness. The B3 and C horizons range from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. In some places the soil has a B3ca horizon.

Walke soils are mapped with DeGrey and Highmore soils, are near Agar and Eakin soils, and are similar to Demky soils. They have more clay in the B horizon than Agar, Eakin, and Highmore soils. They differ from DeGrey soils in having a B&A horizon and in not having columnar structure in the B horizon. They have more silt and less sand in the B horizon than the Demky soils.

Use and Management of the Soils

Raising livestock is the main farm enterprise in Hughes County. General practices of good soil management for cultivated crops, tame pasture, and range are suggested in the pages that follow. This section also contains information on the suitability of the soils for windbreaks, descriptions of wildlife areas and suggestions for the improvement of wildlife habitat, and information on recreational uses of the soils. Data from engineering tests and interpretations of soil properties that affect highway construction and other engineering structures are shown in tables.

The capability grouping used by the Soil Conservation Service is explained, and the capability units in the

survey area are defined. Suggested use and management of each soil in the county and its classification by capability unit can be found in the mapping unit descriptions in the section "Descriptions of the Soils."

General Management for Crops [3]

About 44 percent of the land area in Hughes County is cultivated. Much of this cultivated land is concentrated in the Highmore-DeGrey, Highmore-Eakin, Lowry-Agar, and Ree-Canning soil associations. Corn, spring wheat, alfalfa, oats, and winter wheat are the main crops. Other crops grown include sorghum, barley, rye, flax, and tame grasses.

Successful, long-term cultivation of a soil depends on managing that soil according to its capabilities and its limitations for crops. Conserving moisture, controlling erosion and soil blowing, and maintaining or improving tilth, fertility, and organic-matter content are the main concerns in management.

The use of a sound soil-conserving cropping system that is tailored to the properties of each soil is basic in meeting these objectives. Some soils can be used continuously for a single crop for several years without ill effects. Other soils deteriorate rapidly if used continuously for a single crop, especially if the crop produces little residue. Considering soil properties in planning a cropping system not only helps meet the basic needs of management but also helps reduce insect, disease, and weed infestations.

Moisture is conserved by reducing evaporation and surface runoff, increasing intake of moisture, and controlling weeds. Practices that help conserve moisture are stubble mulching, crop residue management, contour farming, contour stripcropping, terracing, field windbreaks, minimum tillage, and chiseling or subsoiling. Fallowing and then growing winter wheat help to control weeds and conserve moisture.

Many of these practices also help control erosion and soil blowing. Other practices that help control erosion are cover crops, close-sown crops, and grass covered waterways. Wind stripcropping is effective in controlling soil blowing. Emergency tillage can be used to reduce soil blowing until more lasting measures are put into effect.

A tillage pan forms easily in many of the soils in the county. Minimum tillage, avoiding tillage when the soil is wet, and alternating the depth of tillage help prevent the formation of such pans. Chiseling and subsoiling break up existing pans and improve intake of moisture. Timely tillage is especially important on claypan soils, such as Cavo and DeGrey, and on clayey soils, such as Promise and Opal. Stubble mulching, crop residue management, use of grasses and legumes in the cropping system, use of green manure crops, and applications of animal manure are among the practices that help maintain or improve tilth, fertility, and organic-matter content. Use of commercial fertilizer also should be considered on many of the soils in order to maintain or improve fertility.

[3] By WALTER N. PARMETER, conservation agronomist, Soil Conservation Service.

Generally, a combination of several of the above-mentioned measures is needed in order to meet the management objectives of a specific soil. Measures to improve drainage, remove stones, and reduce salinity are other management needs on certain soils in the county.

Irrigated crops

About 4,000 acres in the county is irrigated. Most of the irrigated acreage consists of Agar, Highmore, Lowry, Ree, and Sully soils. Corn, grain sorghum, alfalfa, and tame grasses are the main irrigated crops. Lake Oahe and Lake Sharpe are the major sources of irrigation water. Shallow wells supply water along Medicine Knoll Creek. Sprinklers are commonly used, but gravity systems are also used.

Successful irrigation requires suitable soils, enough water of good quality, and an efficient means of delivering water. Good management requires a knowledge of how to apply water, when to apply it, and how to distribute it evenly. Also, the use of commercial fertilizer can be considered so that the growing crops fully utilize the additional moisture supplied by irrigation. Help in planning an irrigation system can be obtained from the Soil Conservation Service or from the Agricultural Extension Service of South Dakota State University.

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 used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops, or other crops 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 for engineering.

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

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 subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for 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 crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or 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-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

A complete description of the capability classification is given in Agriculture Handbook 210, Land Capability Classification (*4*).

Management by capability units

In the following pages each of the capability units in Hughes County is described, and suggestions for the use and management of the soils in each unit are given. The capability units are not numbered consecutively because not all of the units in the statewide system are represented in the county.

The names of the soil series in each unit are mentioned in the description of each unit, but this does not mean that all the soils in a given series are in that unit. Also, a soil that is part of a mapping unit complex may have a different capability unit than when it is mapped alone. This is because a complex of soils is treated as a whole in crop management. The capability classification of each soil in Hughes County is given in the "Guide to Mapping Units."

CAPABILITY UNIT IIe-1

This unit consists of deep, well-drained, nearly level and gently sloping silty and loamy soils of the Agar, Dorna, Eakin, Glenham, Highmore, Lowry, and Ree series. These soils have a silt loam or loam surface layer and a subsoil of silty clay loam, clay loam, or silt loam. Also in this unit are the DeGrey soils mapped with Highmore soils. They are moderately well drained and have a claypan subsoil. Except for Glenham soils, slopes are long and smooth and areas commonly are free of stones. Some cultivated soils are slightly eroded.

Most of these soils are easy to work, medium in fertility, and moderate in organic-matter content. Available water capacity is high or moderate, and permeability is moderate. Surface runoff is medium except in areas of nearly level Dorna and Lowry soils, where it is slow. These two soils blow easily. Controlling erosion and soil blowing are the main concerns in management. Other management needs are conserving moisture and maintaining tilth, fertility, and the organic-matter content.

DeGrey soils have poor tilth and take in water slowly or very slowly. Improving tilth and water intake are management needs in areas of these soils.

All the soils are suited to all crops commonly grown in the county. Winter wheat, corn, spring-sown small grain, and alfalfa are the main crops. Sorghum and tame grasses also are grown.

Stubble mulching and crop residue management help to control erosion and soil blowing. Contour farming, contour stripcropping, and terraces help to control erosion and conserve moisture. The long smooth slopes are well suited to these mechanical practices. Wind stripcropping reduces soil blowing in areas used for winter wheat and then fallowed. Deep chiseling and use of alfalfa in the cropping system improve water intake, especially in areas of DeGrey soils.

CAPABILITY UNIT IIe-2

Eakin-Raber silt loams, 2 to 5 percent slopes, the only soils in this unit, are deep, well-drained, gently undulating soils on uplands. They have a surface layer of silt loam and a subsoil of silty clay loam or clay loam. Slopes are short and irregular in many areas. In some cultivated areas the soils are slightly eroded.

These soils are easy to work and are medium in fertility and moderate in organic-matter content. They have moderate or moderately slow permeability and moderate or high available water capacity. Surface runoff is medium. Controlling erosion is the main concern in management. Other management needs are conserving moisture, controlling soil blowing, and maintaining tilth, fertility, and the organic-matter content.

These soils are well suited to all crops grown locally. Small grain, corn, alfalfa, and sorghum are the main crops.

Stubble mulching and crop residue management, together with the use of grasses and legumes in the cropping system, help to control erosion and meet other management objectives. Contour farming, contour stripcropping, and terraces also help in controlling erosion and conserving moisture, but these practices are difficult to apply because slopes are short and irregular in many areas.

CAPABILITY UNIT IIc-2

This unit consists of deep, well-drained, nearly level silty and loamy soils of the Agar, Eakin, Highmore, Raber, and Ree series and deep, moderately well drained silty soils of the DeGrey, Mosher, and Walke series. Agar, Eakin, Highmore, Raber, and Ree soils have a silt loam surface layer and a subsoil of silty clay loam or clay loam. DeGrey, Mosher, and Walke soils have a claypan, or a compact subsoil.

Agar, Eakin, Highmore, Raber, and Ree soils are easy to work, medium in fertility, and moderate in organic-matter content. Available water capacity is high or moderate, and permeability is moderate or moderately slow. Surface runoff is slow. Conserving moisture is the main concern in management. Other management needs are controlling soil blowing and maintaining good tilth, fertility, and organic-matter content.

The compact subsoil in DeGrey, Mosher, and Walke soils takes in water slowly or very slowly. Increasing the water intake is the chief need.

All the soils are suited to all crops commonly grown in the county. Wheat, corn, and alfalfa are the main crops. Oats, barley, rye, sorghum (fig. 14), and tame grass also are grown. Small grain and sorghum are better suited than corn on the DeGrey, Mosher, and Walke soils.

Stubble mulching and managing crop residue help in conserving moisture and in meeting other objectives of management. Wind stripcropping helps to control soil blowing. Chiseling and growing deep-rooted crops, such as alfalfa, increase water intake in the DeGrey, Mosher, and Walke soils.

CAPABILITY UNIT IIc-3

This unit consists of deep, well drained or moderately well drained, nearly level silty and loamy soils of the Bon and Onita series and deep, poorly drained, level soils of the Hoven series. Onita soils have a silt loam surface layer and a subsoil of silty clay and silty clay loam. The Hoven soil in this unit has a claypan subsoil.

Bon and Onita soils are high in fertility, organic-matter content, and available water capacity. Permeability is moderate or moderately slow. Surface runoff is slow. The soils receive additional moisture in the form of runoff from adjacent soils or from stream overflow. Wetness delays spring planting in some years. In other years moisture shortages occur late in the growing season.

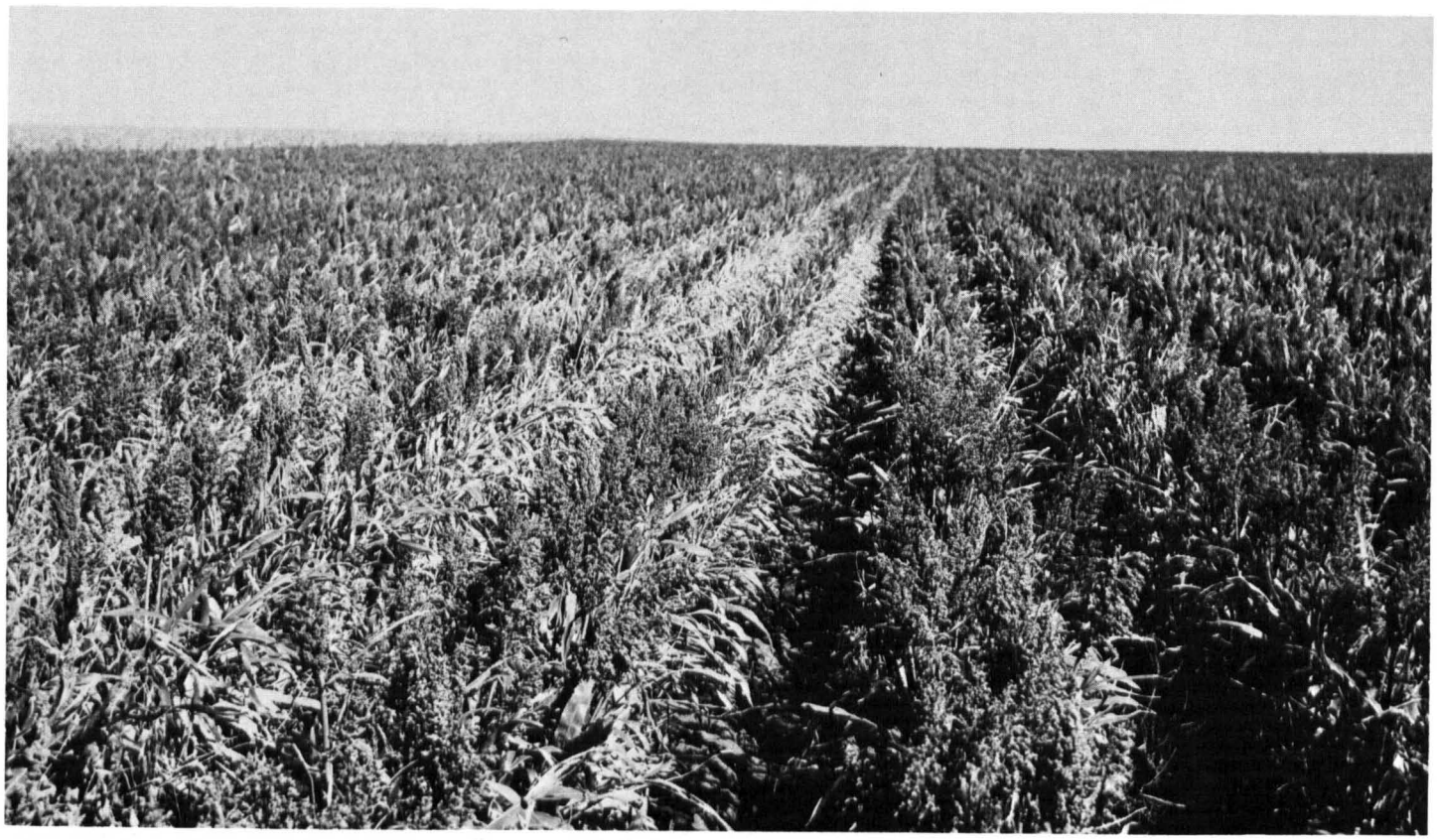

Figure 14.—Grain sorghum on Highmore-Eakin silt loams, 0 to 2 percent slopes.

Conserving moisture is the main concern in management.

In areas of the Hoven soil, tilth is poor, permeability is very slow, and surface runoff ponds. Such areas are not suited to cultivation even though many are farmed as a matter of convenience.

Bon and Onita soils are well suited to all crops commonly grown in the county. Corn, small grain, and alfalfa are the main crops.

Crop residue management and stubble mulching help to conserve moisture and maintain or improve tilth.

CAPABILITY UNIT IIIe-1

Lowry silt loam, 5 to 9 percent slopes, the only soil in this unit, is a deep, well-drained soil that has a surface layer and subsoil of silt loam. In some cultivated areas it is slightly to moderately eroded. Slopes are mostly smooth and uniform.

This soil is free of stones and is easy to work. Available water capacity is high, permeability is moderate, and surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management. Also important are conserving moisture and maintaining fertility and the organic-matter content.

Corn, oats, wheat, sorghum, alfalfa, and tame grasses are suitable crops. The main crops in cultivated areas are corn, oats, and alfalfa.

Stubble mulching and crop residue management in combination with contour farming, contour stripcropping, or terracing help to control erosion and soil blowing. Without these mechanical practices fewer row crops and the use of close-sown crops help in keeping soil losses within allowable limits. Grasses and legumes in the cropping system help in maintaining fertility and the organic-matter content. Grass-covered waterways help prevent the formation of gullies.

CAPABILITY UNIT IIIe-2

This unit consists of deep, well-drained, undulating and gently undulating silty and loamy soils of the Eakin, Glenham, Highmore, Peno, and Raber series. These soils have a surface layer of silt loam, loam, or clay loam and a subsoil of silty clay loam or clay loam. Slopes commonly are irregular in shape and short to medium in length.

These soils are easy to work, but in places have a few stones or cobblestones on the surface. They are medium in fertility and have moderate amounts of organic matter. Permeability is moderate or moderately slow, available water capacity is high or moderate, and surface runoff is medium. Controlling erosion is the main concern in management. Other management needs are conserving moisture, controlling soil blowing, and maintaining fertility and the organic-matter content.

Many areas are in native grass. Some are cultivated. Corn, small grain, and alfalfa are the main crops. Sorghum and tame grasses also are suitable.

Stubble mulching, crop residue management, contour farming, contour stripcropping, and terraces all help to control erosion as well as to meet other management needs. Where slopes are too irregular for contouring and terracing, using close-sown crops and grasses and legumes in the cropping system help control erosion. Grass-covered waterways help prevent the formation of gullies.

CAPABILITY UNIT IIIe-4

This unit consists of deep and moderately deep, well-drained, gently sloping loamy and clayey soils of the Oko, Opal, and Promise series. These soils have a surface layer of clay loam or clay and a clay subsoil. Opal soils are underlain by shale at a depth of 20 to 40 inches. Slopes are long and smooth.

These soils are difficult to work, but they are medium in fertility and have a moderate amount of organic matter. Permeability is slow or very slow, available water capacity is low or moderate in Oko and Promise soils and low or very low in the Opal soil, and surface runoff is medium. The clayey subsoil restricts the development of roots. Controlling erosion and soil blowing are the main concerns in management. Other management needs are conserving moisture, maintaining fertility and the organic-matter content, and improving the tilth and water intake.

Many areas are in native grass. Some are cultivated. Corn, wheat, other small grain, sorghum, and alfalfa are among the crops grown. Sorghum is better suited than corn on these clayey soils.

Stubble mulching, crop residue management, and contour stripcropping help to control erosion and soil blowing. Terracing and grass-covered waterways also help in controlling erosion. Use of grasses and legumes in the cropping system, timely tillage, and chiseling improve tilth and water intake.

CAPABILITY UNIT IIIe-5

Sully silt loam, 0 to 2 percent slopes, is the only soil in this unit. It is a deep, well-drained, nearly level silty soil that is calcareous at or near the surface.

This soil is easy to work, but it is low in fertility and organic-matter content and it blows easily. Permeability is moderate, and available water capacity is high. Surface runoff is slow. Controlling soil blowing is the main concern in management. Other needs are conserving moisture, improving fertility, and increasing organic-matter content.

Most areas are cultivated. Some are irrigated. Corn, small grain, and alfalfa are the main crops.

Stubble mulching, managing crop residue, and wind stripcropping help to control soil blowing. Legumes and grasses in the cropping system, green-manure crops, animal manure, and commercial fertilizer improve fertility and increase the organic-matter content.

CAPABILITY UNIT IIIe-6

Canning loam, 2 to 5 percent slopes, is the only soil in this unit. It has a surface layer of loam and subsoil of clay loam. It is underlain by sand and gravel at a depth of 20 to 40 inches.

This soil is easy to work, is medium in fertility, and has a moderate amount of organic matter. Nevertheless, it is somewhat droughty. Surface runoff is medium. Controlling erosion and soil blowing and conserving moisture are the main concerns in management. Maintaining tilth, fertility, and organic-matter content also are management needs.

Most areas are in native grass. Some are cultivated. Small grain and early maturing sorghums are better suited than deep-rooted crops, such as corn and alfalfa.

Stubble mulching, crop residue management, and the use of close-sown crops that include grasses and legumes help in meeting management objectives. Contour stripcropping is desirable if row crops are grown.

CAPABILITY UNIT IIIe-7

Munjor fine sandy loam is the only soil in this unit. It is a deep, well-drained, nearly level soil on bottom lands.

This soil is easy to work but is low in fertility and organic-matter content. Available water capacity is moderate or high, permeability is moderately rapid, and surface runoff is slow. Controlling soil blowing is the chief concern in management. Conserving moisture and improving the fertility and organic-matter content are other important management needs.

Corn, small grain, and alfalfa are the main crops. Sorghum and tame grasses are other suitable crops.

Stubble mulching, crop residue management, and wind stripcropping help to control soil blowing. Use of green manure crops, animal manure, and commercial fertilizer improve fertility and organic-matter content.

CAPABILITY UNIT IIIs-1

Demky-Cavo silt loams, 0 to 2 percent slopes, are the only soils in this unit. These are deep, moderately well drained, nearly level soils that have a silt loam surface layer. Demky soils have a compact, slowly permeable subsoil of clay loam. Cavo soils have a claypan subsoil that has slow or very slow permeability. The surface is uneven, having many slight depressions.

These soils have moderate or high available water capacities, but their subsoil releases moisture slowly to plants. Crop growth is affected late in summer, especially in dry years. The Cavo soil has poor tilth and is difficult to work. Surface runoff is slow. Conserving moisture and improving water intake are the main concerns in management. Improving tilth is a management need on the Cavo soil. Other management needs are controlling soil blowing and maintaining fertility and the organic-matter content.

Demky soils are suited to most crops grown in the county. Some corn is grown, but sorghum is a better suited row crop because of the Cavo soils in the complex.

Stubble mulching and crop residue management help to conserve moisture and improve water intake. Grasses and legumes in the cropping system, use of animal manure, and chiseling improve tilth and also aid in achieving other management objectives.

CAPABILITY UNIT IIIs-2

Canning loam, 0 to 2 percent slopes, is the only soil in this unit. It is a well-drained, nearly level loamy soil that is moderately deep over sand and gravel. The subsoil is clay loam.

This soil is easy to work, medium in fertility, and moderate in organic-matter content, but is somewhat droughty. Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel. Surface runoff is slow. Conserving moisture is the main concern in management. Other management needs are controlling soil blowing and maintaining tilth, fertility, and the organic-matter content.

Under dryland farming, small grain, sorghum, and tame grasses are better suited than such deep-rooted crops as corn and alfalfa.

Stubble mulching and crop residue management help to conserve moisture as well as to meet other management objectives. Wind stripcropping is desirable in controlling soil blowing on some large acreages.

CAPABILITY UNIT IIIs-3

This unit consists of deep, well-drained, nearly level silty and clayey soils of the Dorna, Millboro, Mosher, and Promise series. These soils have a clayey subsoil or clayey underlying material at a shallow depth. The Mosher soils have a claypan subsoil.

These soils are medium in fertility and moderate in organic-matter content, but they have poor to fair tilth. Permeability is slow or very slow, available water capacity is moderate or low, and surface runoff is slow. The clayey subsoil releases moisture slowly and restricts roots. Conserving moisture, improving tilth and water intake, and controlling soil blowing are of major concern in management. Maintaining fertility and organic-matter content are other concerns.

Many areas are cultivated. Small grain, corn, sorghum, and alfalfa are the main crops. Sorghum is a better suited row crop than corn.

Stubble mulching, crop residue management, and use of grasses and legumes in the cropping system help in meeting the objective of management. Timely tillage and deep chiseling also will help maintain tilth and improve water intake. Wind stripcropping helps control soil blowing and is especially desirable in a winter wheat-fallow cropping sequence.

CAPABILITY UNIT IVe-3

This unit consists of deep, well-drained, gently undulating and gently sloping to undulating and sloping loamy and silty soils of the Glenham, Java, and Sully series. Glenham and Java soils have a clay loam subsoil. Sully soils are silty throughout their profile. Java and Sully soils are calcareous within a depth of 10 inches. Slopes are short and irregular in areas of Glenham and Java soils.

These soils are easy to work even though a few stones are on the surface of Glenham and Java soils. Fertility is medium in Glenham and Java soils and low in the Sully soil. Permeability is moderate, and available water capacity is high. Surface runoff is medium, and the soils erode easily. In addition, the Sully soils blow easily. Controlling erosion and soil blowing are the main concerns in management. Conserving moisture and improving fertility and organic-matter content are other important management needs.

Many areas are in native grass. Some are cultivated. Corn, small grain, and alfalfa are the main crops. Sorghum and tame grasses also are suited.

Stubble mulching or crop residue management in combination with contour farming and terraces help to control erosion and soil blowing. Where slopes are too irregular for mechanical practices, use of close-sown crops and of grasses and legumes in the cropping system help in controlling erosion and in meeting other management needs.

CAPABILITY UNIT IVe-4

This unit consists of deep and moderately deep, well-drained, sloping and gently sloping loamy and clayey soils of the Oko and Opal series. These soils have a clayey subsoil. Opal soils are underlain by shale at a depth of 20 to 40 inches. Also in this unit are Jerauld soils, which are mapped with Oko soils. Jerauld soils are moderately well drained and have a claypan subsoil. Slopes are mostly long and smooth in this unit.

The Oko and Opal soils are medium in fertility and have moderate amounts of organic matter, but they have poor tilth and are difficult to work. Permeability is slow or very slow. Available water capacity is moderate or low in Oko soils and low or very low in Opal soils. Surface runoff is medium. Controlling erosion and soil blowing are the main concerns in management. Conserving moisture, improving tilth and water intake, and maintaining fertility and the organic-matter content are other management needs.

The Jerauld soil is low in fertility and low in available water capacity. Permeability is very slow in the claypan subsoil. This soil is not suitable for cultivation.

Most areas are in native grass. A few are cultivated. Small grain, alfalfa, and tame grasses are the main crops. Sorghum is a better suited row crop than corn on these clayey soils.

Stubble mulching and crop residue management in combination with contour stripcropping or terracing help to control erosion and soil blowing. Use of close-sown crops and of grasses and legumes in the cropping system also help in controlling erosion as well as in meeting other needs of management. Timely tillage and deep chiseling help maintain tilth and improve water intake.

CAPABILITY UNIT IVe-5

Oahe-Orton loams, 2 to 9 percent slopes, are the only soils in this unit. These are well-drained, gently sloping to undulating loamy soils that are moderately deep over sand and gravel. They have a subsoil of loam or fine sandy loam.

These soils are easy to work, but have low available water capacity and are droughty. Also, the Orton soil is low in fertility and moderately low in organic-matter content. Permeability is moderate or moderately rapid in the surface layer and subsoil and rapid in the underlying material. Surface runoff is medium or slow. Controlling erosion and soil blowing are the main concerns in management. Also important are conserving moisture and maintaining or improving fertility and the organic-matter content.

Most areas are in native grass. A few are cultivated. Small grain, sorghum, and tame grasses are better suited than such deep-rooted crops as corn and alfalfa.

Stubble mulching and crop residue management in combination with contour stripcropping help to control erosion and to meet other management needs. Terraces are not satisfactory because the soils are only moderately deep over sand and gravel. Where slopes are too irregular for contour farming, use of close-sown crops and tame grasses is beneficial in controlling erosion.

CAPABILITY UNIT IVs-2

This unit consists of deep, moderately well drained, nearly level silty soils of the Cavo, DeGrey, Mosher, Demky, Raber, and Walke series. Cavo, DeGrey, and Mosher soils have a claypan subsoil. The rest have a compact subsoil of clay loam or silty clay loam.

Cavo, DeGrey, and Mosher soils are difficult to work and have slow or very slow permeability. Their claypan subsoil releases moisture slowly to plants and restricts the development of roots. Surface runoff is slow. Improving tilth and water intake is the main concern in management. Conserving moisture, controlling soil blowing, and maintaining or improving fertility and the organic-matter content are other management needs.

The Demky, Raber, and Walke soils in this unit are in better tilth than Cavo, DeGrey, and Mosher soils and have a moderate or high available water capacity. Permeability is slow in the Demky and Walke soils and moderately slow in the Raber soil. Because these soils are mapped with Cavo and DeGrey soils, their use and management is governed by the limitations of those soils.

Many areas are in native grass. Some are cultivated. Small grain, sorghum, alfalfa, and tame grasses are the main crops. Some corn is grown, but it is not so well suited as sorghum.

Stubble mulching, crop residue management, green manure crops, application of animal manure, use of grasses and legumes in the cropping system, and deep chiseling are among the practices that help meet management objectives. Timely tillage also is important in preserving tilth. Wind stripcropping helps control soil blowing.

CAPABILITY UNIT IVs-3

Raber-Cavo loams, 2 to 5 percent slopes, are the only soils in this unit. These are deep, gently undulating, loamy soils that have a clay loam subsoil. Cavo soils have a claypan.

Cavo soils are difficult to work and have slow or very slow permeability. The claypan subsoil releases moisture slowly to plants and restricts roots. Surface runoff is medium. Improving tilth and water intake, controlling soil blowing, and improving fertility and the organic-matter content are other management needs.

Raber soils have good tilth and moderate or high available water capacity, but their use in this unit is governed by the limitations of the Cavo soil. Controlling erosion is the main management concern on the Raber soil.

Many areas are in native grass. Some are cultivated. Small grain, sorghum, and tame grasses are the best suited crops. Corn and alfalfa also are grown.

Stubble mulching, crop residue management, green manure crops, animal manure, use of grass and legumes in the cropping system, and chiseling help to meet management objectives. Contour farming, contour stripcropping, and terraces help to control erosion in places where the conformation of slopes does not prevent these mechanical practices.

CAPABILITY UNIT Vw-1

Only Alluvial land, wet, is in this unit. It is a mixture of poorly drained soils on bottom lands and islands. Surface runoff is very slow. The water table is within a depth of 3 feet, and the soils are too wet for cultivation. Alluvial land, wet, supports native trees and tall grasses. It provides habitat for deer and other wildlife. The high water table limits its use for recreation.

CAPABILITY UNIT VIe-3

This unit consists of deep, well-drained through excessively drained, gently sloping to strongly sloping and rolling loamy and silty soils of the Betts, Gettys, Java, Peno, and Sully series. Also in this unit are the clayey Swanboy soils, which are mapped with Peno soils.

These soils are too steep and erodible for cultivation. Surface runoff is medium or rapid. Betts, Gettys, Sully, and Swanboy soils are low in fertility. All but Swanboy soils have moderate or moderately slow permeability and moderate or high available water capacity. Controlling erosion is the main concern in management.

Nearly all areas are in native grass and are used for range. Proper range use helps to control erosion.

CAPABILITY UNIT VIe-4

Opal-Lakoma clays, 9 to 15 percent slopes, are the only soils in this unit. These are well-drained, strongly sloping clayey soils that are moderately deep over shale.

These soils are too steep and erodible for cultivation. They have very slow or slow permeability. Available water capacity is low or very low. Surface runoff is medium. Controlling erosion is the chief concern in management.

All areas are in native grass and are used for range. Proper range use helps to control erosion.

CAPABILITY UNIT VIe-8

Only Alluvial land, sandy, is in this unit. It consists of sandy alluvium of fine sand, loamy fine sand, and coarse sandy loam texture.

Alluvial land, sandy, has low available water capacity and low fertility. Permeability is rapid, and surface runoff is very slow. The loose sandy material blows easily where the surface is disturbed and where vegetation is lacking. It is not suitable for cultivation. Controlling soil blowing is the main concern in management.

All areas are in native vegetation of trees and tall grasses. They provide habitat for wildlife and have a potential for recreational uses. Maintaining an adequate cover of vegetation helps to control soil blowing.

CAPABILITY UNIT VIw-3

Only Alluvial land, undifferentiated, is in this unit. It is along the channels of creeks and some of the larger drainageways. The texture ranges from sandy loam to clay.

This land is flooded almost annually. In addition, in some areas it has a water table that fluctuates between depths of 2 and 10 feet. The risks of flooding and other periodic wetness make it unsuitable for cultivation.

All areas are in native vegetation of tall and mid grasses and stringers and clumps of native trees and shrubs. Proper range use helps to control streambank erosion and other damage caused by flooding.

CAPABILITY UNIT VIw-4

Only the Durrstein-Egas complex is in this unit. These are deep, poorly drained silty soils. Durrstein soils have a claypan subsoil and are shallow over accumulations of salts. Egas soils have accumulations of salts at or near the surface.

These soils have slow or very slow permeability and low or moderate available water capacity. Surface runoff is slow. The fluctuating water table is at a depth of 3 to 10 feet in the Durrstein soil and 2 to 5 feet in the Egas soil. Both soils are too wet and too high in salts for cultivation.

Most areas are in native grass. Alfalfa is the main crop in the few cultivated areas. Proper range use helps to maintain desirable forage plants on these soils.

CAPABILITY UNIT VIs-1

This unit consists of deep and moderately deep, moderately well drained or poorly drained, level to gently sloping silty and clayey soils of the Hoven, Hurley, Jerauld, Macken, and Onita series. Hoven, Hurley, and Jerauld soils have a claypan subsoil. Macken soils have a surface layer and subsoil of silty clay.

Hoven, Hurley, Jerauld, and Macken soils are difficult to work and have very slow or slow permeability. Available water capacity ranges from low or very low in the Hurley soil to moderate or high in the Hoven soil. Surfaces runoff ponds on Hoven and Macken soils and is slow or medium on Hurley and Jerauld soils. These four soils are slow to dry out in spring. In addition, Hoven and Macken soils are flooded for extensive periods in years of heavy rainfall. Poor tilth and the restrictive nature of the claypan and clayey subsoils make these soils unsuitable for cultivation.

Onita soils are high in fertility and available water capacity. Permeability is moderately slow. These soils are suited to cultivated crops, but their use is governed by the Hoven soil.

Most areas are in native grass and are used for grazing or hay. Small acreages in broad areas of cropland are farmed as a matter of convenience. Proper range use helps to maintain desirable forage plants. Most areas are suitable as sites for dugouts to supply water for livestock.

CAPABILITY UNIT VIs-5

This unit consists of shallow and deep, well drained and moderately well drained, gently sloping to sloping clayey soils of the Chantier and Swanboy series. Chantier soils are shallow over shale.

These soils have very poor tilth and are low in fertility and organic-matter content. Permeability is very slow, available water capacity is very low or low, and surface runoff is medium or rapid. The soils are easily eroded and are not suited to cultivated crops. Maintaining an adequate cover of vegetation is the main concern in management.

All areas are in native grass. Proper range use helps to maintain a plant cover and control erosion.

CAPABILITY UNIT VIIe-3

This unit consists of deep, well-drained through excessively drained, hilly to steep loamy and silty soils of the Betts, Gettys, and Sully series. These soils have a thin surface layer of loam, clay loam, or silt loam and underlying material of clay loam or silt loam. They are calcareous at or near the surface.

These soils have moderate or moderately slow permeability and high or moderate available water capacity. They are low in fertility and in organic-matter content. Surface runoff is rapid, and the soils are easily eroded. All are too steep and erodible for cultivation. Controlling erosion is the main concern in management.

All areas are in native grass and are used for range. Proper range use helps to control erosion.

CAPABILITY UNIT VIIs–2

This unit consists of shallow, well-drained, strongly sloping to steep clayey soils of the Sansarc series. These soils are underlain by shale. Also in this unit are deep loamy soils of the Gettys series and moderately deep clayey soils of the Lakoma series.

These soils are not suitable for cultivation. All are low in fertility and are low or moderately low in organic-matter content. Sansarc and Lakoma soils have slow permeability and very low or low available water capacity. Controlling erosion is the main concern in management.

All areas are in native grass and are used for range. Slopes are too steep and irregular for haying equipment and other machinery. Proper range use helps to control erosion.

CAPABILITY UNIT VIIs–4

Only Schamber-Orton complex is in this unit. Schamber soils have a gravelly loam surface layer and are very shallow over sand and gravel. Orton soils have a loam surface layer and a subsoil of fine sandy loam. They are moderately deep over sand and gravel. Both soils are rolling to steep.

These soils are too droughty, too steep, and too erodible for cultivation. They have low or very low available water capacity and are low in fertility. Surface runoff is medium or rapid. Conserving moisture and controlling erosion are the chief concerns in management.

All areas are in native grass and are used for range. Proper range use helps to conserve moisture and control erosion.

CAPABILITY UNIT VIIs–6

Raber and Oko stony soils, 3 to 15 percent slopes, and Rough broken land are in this unit. Oko and Raber soils are deep, gently undulating to rolling loamy soils that have many stones on the surface. Rough broken land is deep to very shallow and hilly to steep. The soils range from gravelly sand to clay and are stony in places.

Permeability is very slow to rapid, available water capacity is very low to high, and fertility is low to medium. Surface runoff is medium to rapid. All of the areas are too stony or are too steep for cultivation or for the use of haying equipment or other machinery. Controlling erosion is difficult in many areas.

All areas are in native grass and are used for range. Proper range use helps to control erosion.

CAPABILITY UNIT VIIIs–2

This unit consists of Shale land, Shale outcrop, and Slickspots. Shale land and Shale outcrop are areas dominated by eroding outcrops of soft clay shales. Slickspots are clay or silty clay over clay material that is high in salts. Areas are barren or nearly barren of vegetation and are of little or no value for grazing.

Predicted Yields

Table 2 lists, for each soil in the county judged suitable for crops, the predicted average yields per acre for corn, spring wheat, winter wheat, oats, alfalfa, and grain sorghum (milo). The predictions are for dryfarmed soils under two levels of management.

The yield predictions under column A are those that can be expected under management as commonly practiced in the county. The two most commonly used cropping systems are winter wheat alternated with summer fallow and row crops alternated with spring wheat or oats. Some legumes and tame grasses are used but not in a regular sequence from field to field. Some practices are used to meet management problems but not sufficiently to meet all the needs of a particular soil.

The predicted yields shown in column B are those that can be expected under improved management. This includes using such practices as are needed to control erosion and soil blowing and to conserve moisture. It also includes use of crop residue together with green manure crops and animal manure to maintain or improve tilth and organic-matter content; use of clean, high-quality seed of adapted crop varieties; use of effective weed control measures; planting, cultivating, and harvesting at the proper time; and use of commercial fertilizer in amounts indicated by soil tests and field trials.

The predicted yields are based on yield information obtained from farmers, from the South Dakota Crop and Livestock Reporting Service (*6*), from the local offices of the Extension Service of South Dakota State University and the Soil Conservation Service, and from others familiar with the county. The yields for any given year range higher or lower depending on the climatic conditions in that year. Also, these predicted yields are subject to change with changes in agricultural technology.

Pasture [4]

Only a few thousand acres in the county are used as tame pasture, but this pasture supplements the grazing of nearby range areas and is an important part of many farms and ranches. Many pastures are grazed too closely and have poor stands of desirable grasses. Thus, the soil is exposed to erosion and soil blowing.

Grazing tame pastures according to the amount of forage produced is basic to good pasture management. The largest return is gained by withholding livestock from a pasture until specific heights of growth are reached, depending on the kinds of tame grasses in the pasture.

Other pasture practices that help in meeting the objectives of management include rotation grazing, clipping, brush and weed control, use of fertilizer as needed, development of livestock water facilities, and reseeding to adapted grasses to improve the stand and increase production.

Sudangrass is suited to temporary summer pasture, but perennial grasses are desirable for pasture plantings designed to last for 2 or more years. Bunch grasses, such as crested wheatgrass and Siberian wheatgrass, are not suited to plantings where slopes are more than 5 percent unless planted with sod-forming grasses.

In the following paragraphs, soils of Hughes County are grouped into pasture suitability groups. Only those groups of the statewide system that are present in the county are described, and only those soils suited to tame pasture are placed in a pasture group. The names of the soil series represented are mentioned in the description of

[4] By Walter N. Parmeter, conservation agronomist, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of principal dryfarmed crops under two levels of management*

[Yields in columns A are those to be expected under management commonly practiced; yields in columns B are those to be expected under improved management. Absence of a yield figure indicates that the soil is not suited to cultivation or that the crop is not commonly grown on the soil. Yields for soil complexes are weighted averages based on the proportionate extent and relative productivity of the soils in the complex]

Soil	Corn		Spring wheat		Winter wheat		Oats		Alfalfa		Grain sorghum	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*
Agar silt loam, 0 to 2 percent slopes	28	38	18	24	25	34	40	55	1.5	2.0	35	50
Agar silt loam, 2 to 5 percent slopes	26	36	17	23	23	32	34	52	1.4	1.8	33	46
Agar-Eakin silt loams, 2 to 5 percent slopes	25	34	16	22	21	30	34	52	1.2	1.6	32	45
Bon loam	30	44	20	26	24	35	44	60	2.0	2.6	45	60
Canning loam, 0 to 2 percent slopes	19	25	12	19	18	26	32	44	.9	1.3	25	35
Canning loam, 2 to 5 percent slopes	18	24	11	17	17	25	31	42	.8	1.2	22	32
Cavo-Demky silt loams, 0 to 2 percent slopes	14	21	12	17	18	24	26	34	1.0	1.4	20	28
DeGrey-Walke silt loams, 0 to 2 percent slopes	14	21	13	18	18	24	26	34	1.0	1.4	20	28
Demky-Cavo silt loams, 0 to 2 percent slopes	16	23	14	19	20	25	28	40	1.1	1.5	22	34
Dorna silt loam	24	30	14	20	18	26	30	40	1.2	1.5	30	40
Dorna silt loam, thin solum	18	26	12	18	16	25	28	36	1.0	1.3	25	36
Eakin-Raber silt loams, 0 to 2 percent slopes	26	36	17	23	22	32	38	55	1.4	1.7	32	42
Eakin-Raber silt loams, 2 to 5 percent slopes	24	33	16	22	21	30	35	50	1.3	1.6	30	40
Eakin-Raber silt loams, 5 to 9 percent slopes	21	30	14	20	19	27	33	43	1.2	1.5	26	35
Glenham-Highmore silt loams, 5 to 9 percent slopes	20	29	14	20	19	27	33	43	1.2	1.6	26	35
Highmore silt loam, 0 to 2 percent slopes	28	38	18	24	25	34	40	55	1.5	2.0	35	50
Highmore-DeGrey silt loams, 0 to 2 percent slopes	20	27	15	21	20	27	33	45	1.3	1.7	30	40
Highmore-DeGrey silt loams, 2 to 5 percent slopes	19	26	14	19	19	25	30	42	1.2	1.5	28	38
Highmore-Eakin silt loams, 0 to 2 percent slopes	27	37	18	24	24	33	40	55	1.5	2.0	35	50
Highmore-Eakin silt loams, 2 to 5 percent slopes	25	34	17	23	23	32	34	52	1.4	1.8	33	46
Highmore-Glenham silt loams, 2 to 5 percent slopes	23	32	16	22	22	31	34	52	1.4	1.8	32	45
Highmore-Walke silt loams, 0 to 2 percent slopes	25	33	17	23	24	32	38	52	1.4	1.8	34	48
Java-Glenham loams, 2 to 9 percent slopes	17	24	12	17	17	23	28	36	1.0	1.3	20	28
Lowry silt loam, 0 to 2 percent slopes	25	32	15	20	20	28	34	45	1.3	1.8	30	40
Lowry silt loam, 2 to 5 percent slopes	23	29	14	18	19	26	32	42	1.2	1.7	28	37
Lowry silt loam, 5 to 9 percent slopes	20	26	13	17	17	24	29	38	1.1	1.5	25	34
Millboro silty clay loam, 0 to 2 percent slopes	22	29	15	20	24	35	36	45	1.2	1.6	30	40
Mosher silt loam, 0 to 2 percent slopes	9	14	------	------	16	20	22	30	.9	1.2	15	20
Munjor fine sandy loam	19	30	------	------	12	20	25	36	1.0	2.2	------	------
Oahe-Orton loams, 2 to 9 percent slopes	15	21	10	14	------	------	25	32	.6	1.0	20	27
Oko clay loam, 2 to 5 percent slopes	15	21	13	18	22	30	30	45	1.1	1.3	32	42
Oko clay loam, 5 to 9 percent slopes	13	19	11	16	18	24	25	36	.8	1.0	28	35
Oko-Jerauld complex, 2 to 9 percent slopes	11	15	9	14	14	19	20	30	.7	.9	22	30
Onita silt loam, 0 to 2 percent slopes	35	45	19	24	35	40	44	56	1.9	2.5	45	55
Onita-Hoven silt loams, 0 to 1 percent slopes	28	35	16	21	30	38	36	48	1.3	1.6	38	45
Opal clay, 2 to 5 percent slopes	16	20	13	17	22	28	25	37	1.0	1.3	30	38
Opal clay, 5 to 9 percent slopes	13	16	12	16	18	24	22	30	.9	1.2	24	32
Promise clay, 0 to 2 percent slopes	20	25	15	20	24	33	35	45	1.3	1.5	35	45
Promise clay, 2 to 5 percent slopes	18	22	13	18	22	31	32	44	1.1	1.3	32	42
Promise-Mosher complex, 0 to 2 percent slopes	16	20	13	16	21	29	30	42	1.1	1.3	28	38
Raber-Cavo loams, 0 to 2 percent slopes	15	22	13	17	18	25	28	39	1.1	1.4	25	35
Raber-Cavo loams, 2 to 5 percent slopes	14	21	12	16	16	23	26	35	1.0	1.3	22	32
Raber-Peno clay loams, 2 to 9 percent slopes	19	27	13	17	17	24	28	38	.9	1.3	20	30
Ree loam, 0 to 2 percent slopes	26	34	18	22	22	32	38	53	1.3	1.8	35	50
Ree loam, 2 to 5 percent slopes	24	32	14	18	20	30	34	47	1.2	1.6	33	46
Ree-Mosher complex, 0 to 2 percent slopes	20	28	14	18	20	26	32	45	1.1	1.5	28	40
Sully silt loam, 0 to 2 percent slopes	16	25	11	17	------	------	24	30	.9	1.4	------	------
Sully silt loam, 2 to 9 percent slopes	12	20	10	15	------	------	20	26	.9	1.2	------	------

each group, but this does not mean that all the soils of a given series are in the group. To find the pasture group of a given soil, refer to the "Guide to Mapping Units" at the back of this survey.

PASTURE GROUP B

This group consists of deep, poorly drained soils of the Hoven and Macken series. These soils have a clayey subsoil and are in depressions on uplands. Surface runoff ponds on these soils and remains on the surface from a few days in some years to as long as several weeks in wet years. The additional moisture is beneficial except in wet years.

Creeping foxtail, reed canarygrass, and western wheatgrass are the principal species adapted to the soils of this group. Species can be planted alone or with each other.

PASTURE GROUP C

This group consists of deep, moderately well drained, nearly level to gently sloping silty soils of the Cavo, DeGrey, and Mosher series. These soils have a dense claypan subsoil. Permeability is slow or very slow, and the claypan subsoil releases moisture slowly to plants. Available water capacity is moderate, but plant roots penetrate the claypan with difficulty.

Suitable grasses and legumes are alfalfa, crested wheatgrass, pubescent wheatgrass, Siberian wheatgrass, sweetclover, and western wheatgrass.

PASTURE GROUP D

This group consists of well-drained, nearly level to undulating loamy soils of the Canning, Oahe, and Orton series. These soils are underlain by sand and gravel at a moderate depth. Available water capacity is moderate or low, and the soils are somewhat droughty.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and sweetclover.

PASTURE GROUP E

In this group are deep, moderately well drained, nearly level silty soils of the Demky and Walke series. These soils have a compact subsoil of clay loam or silty clay loam. Surface runoff is slow, and permeability is slow. Available water capacity is moderate or high, but roots develop slowly in the compact subsoil.

Suitable grasses and legumes include alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and sweetclover.

PASTURE GROUP F

This group consists of deep, well-drained, nearly level to undulating silty and loamy soils of the Agar, Dorna, Eakin, Glenham, Highmore, Lowry, Peno, Raber and Ree series. Surface runoff is slow or medium, and permeability is moderate or moderately slow. Available water capacity is high or moderate.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, smooth bromegrass, sweetclover, and switchgrass.

PASTURE GROUP G

In this group are deep, well-drained, nearly level to undulating or sloping loamy and silty soils of the Java and Sully series. These soils are calcareous at or within 10 inches of the surface. Their high lime content and low or medium fertility limit production and the choice of plants. The risk of erosion and soil blowing is moderate or severe.

Suitable grasses and legumes are alfalfa, intermediate wheatgrass, pubsecent wheatgrass, smooth bromegrass, sweetclover, and western wheatgrass. Alfalfa and sweetclover are suitable only if planted with sod-forming grasses.

PASTURE GROUP H

This group consists of well-drained, nearly level loamy soils of the Munjor series. These soils formed in sandy alluvium. They have a surface layer of fine sandy loam. They take in water easily and release it readily to plants. Available water capacity is moderate or high. Disturbed areas are subject to soil blowing.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, smooth bromegrass, switchgrass, and sweetclover. Alfalfa and sweetclover are suitable only if planted with sod-forming grasses.

PASTURE GROUP I

This group consists of deep and moderately deep, well-drained, nearly level to sloping silty, loamy, and clayey soils of the Millboro, Oko, Opal, and Promise series. These soils have a clayey subsoil that has slow or very slow permeability. Available water capacity is low or moderate, except in the Opal soil where it is low or very low. The clayey subsoil releases moisture slowly to plants and restricts roots.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, pubescent wheatgrass, smooth bromegrass, and sweetclover. Green needlegrass and western wheatgrass are native grasses well suited to seeding mixtures.

PASTURE GROUP J

In this group are deep, poorly drained, claypan soils of the Durrstein series. These soils have a fluctuating water table. They are shallow over moderate amounts of salts.

Suitable grasses and legumes are sweetclover, tall wheatgrass, and western wheatgrass.

PASTURE GROUP K

This group consists of deep, moderately well drained and well drained, nearly level loamy and silty soils of the Bon and Onita series. These soils are on bottom lands and in upland swales. They receive additional moisture from stream flooding and as runoff from adjacent sloping soils. Available water capacity is high. The greater moisture supply increases yields up to two times the forage yield on well-drained upland soils.

Suitable grasses and legumes are alfalfa, crested wheatgrass, intermediate wheatgrass, smooth bromegrass, sweetclover, and switchgrass.

Range [5]

Before settlement, most of Hughes County was covered with prairie vegetation. Open stands of trees were along

[5] By D. C. Smith, range conservationist, Soil Conservation Service.

the Missouri River and some of the larger creeks, and scattered stringers and clumps of trees and shrubs were in protected ravines or draws. In other areas the vegetation was grass.

When the county was settled, much of the grassland was plowed and farmed. Generally the better soils were selected for cultivation. Many soils that remain in native grass are shallow, steep, stony, poorly drained, or for some other reason are not well suited to cultivated crops.

At the present time, about 252,000 acres or about 53 percent of the land area in the county is in native grass. The Gettys-Betts and Sansarc associations are almost entirely range. The Betts-Durrstein, Cavo-Raber-Demky, and Raber-Peno associations also are mostly range. In other associations tracts of range are smaller and are intermingled with cultivated soils.

Many areas of range in the county have been closely grazed for a long period. This has caused changes in the plant cover which make it difficult to appraise the productive potential of range unless range site and range condition techniques are used.

Range sites and condition classes

A range site is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. In the absence of abnormal disturbance and physical site deterioration, it supports a plant community that differs from that of other sites in terms of kind or proportion of plant species or in total annual production.

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site. The climax plant community represents the natural potential of a site, and in most cases was the original vegetation of the site prior to settlement.

Range condition classes are an expression of the degree to which the present composition, expressed in percent, has departed from that of the climax plant community of a range site. Four classes are recognized: *excellent*, *good*, *fair*, and *poor*. A range is in *excellent* condition if 76 to 100 percent of the present vegetation is that of climax vegetation for that site. It is in *good* condition if the percentage is 51 through 75; in *fair* condition if the percentage is 26 through 50; and *poor* if the percentage is 25 or less.

The purpose of determining range condition is to provide an approximate measure of changes that have taken place in the plant cover, and thereby provide a basis for predicting the nature of plant community changes to be expected from management and treatment measures.

A range condition guide for each range site is used to help determine range condition. In this guide, range plants in the climax plant community of the site are classified according to their response to overgrazing into decreaser, increaser, and invader plants.

Decreaser plants are species in the climax plant community that decrease in relative abundance when the site is subject to continued excessive grazing use. Increaser plants are species in the climax plant community that increase in relative abundance when the site is subject to continued excessive grazing use. Invader plants are not members of the climax plant community, but do invade the site as a result of various kinds of disturbance.

Descriptions of range sites

The soils of Hughes County are grouped into 13 range sites which are described in the following paragraphs. In each description are given the principal plants and estimates of total annual yields. When the sites are in excellent condition, the kinds of grass that provide the major source of forage for cattle make up from 70 to 90 percent of the total annual yield. The names of the soil series represented in each site are given, but this does not mean that all the soils in a given series are in that site. To find the range site in which a given soil is placed and the page on which it is described, refer to the "Guide to Mapping Units" at the back of this survey.

SUBIRRIGATED RANGE SITE

Alluvial land, wet, the only mapping unit in this site, is on bottom lands. It has a water table that rises to or near the surface for short periods in spring and is within a depth of 3 feet during the growing season. Consequently, it is wet or moist during most of the growing season. It is sufficiently aerated, however, for such grasses as big bluestem, and the moisture supply is sufficient to produce luxuriant stands of tall grasses.

Big bluestem is dominant in the climax vegetation. Switchgrass, indiangrass, Canada wildrye, prairie sandreed, and prairie cordgrass are other tall grass. Also on this site are minor amounts of northern reedgrass, bluejoint reedgrass, western wheatgrass, inland saltgrass, sedges, and forbs, and in some areas, boxelder, cottonwood, dogwood, eastern redcedar, green ash, wild grape, and wild rose.

If the site is closely grazed, the tall grasses decrease and are replaced by western wheatgrass, inland saltgrass, and Kentucky bluegrass. Under continuous close grazing Kentucky bluegrass, inland saltgrass, and unpalatable weeds become dominant.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 4,000 pounds in unfavorable years to 5,000 pounds in favorable years.

SALINE LOWLAND RANGE SITE

This site consists of deep, poorly drained silty soils of the Durrstein and Egas series. These soils have a water table at a depth of 2 to 10 feet. Concentrations of salts are within 20 inches of the surface.

The climax vegetation consists of mid and tall grasses and sedges. Alkali cordgrass and slough sedge commonly dominate the site. Western wheatgrass, switchgrass, and inland saltgrass are in lesser amounts. Under continuous overuse, inland saltgrass, foxtail barley, and annual weeds become dominant.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 3,000 pounds in unfavorable years to 4,500 pounds in favorable years.

OVERFLOW RANGE SITE

This site consists of deep, well drained and moderately well drained loamy and silty soils of the Bon, Munjor, and Onita series and Alluvial land, undifferentiated. These soils regularly benefit from moisture received from floodwaters of streams and drainageways or in the form of runoff from adjacent sloping soils. The additional

moisture is enough to give this site a potential for producing dense stands of tall and mid grasses.

Big bluestem is dominant in the climax vegetation. Also significant are green needlegrass, switchgrass, Canada wildrye, western wheatgrass, side-oats grama, blue grama, sedges, and forbs; and in some areas green ash, American elm, hackberry, chokecherry, buffaloberry, plum, western snowberry, and wild rose.

If the site is overgrazed, western wheatgrass increases and replaces the taller grasses. Under continued overuse, western wheatgrass and Kentucky bluegrass become the dominant species. Many areas are used for hay and can be mowed annually without deterioration.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 3,000 pounds in unfavorable years to 4,500 pounds in favorable years.

CLOSED DEPRESSION RANGE SITE

This site consists of deep, poorly drained silty and clayey soils of the Hoven and Macken series. These soils have a surface layer of silt loam or silty clay and a subsoil of clay or silty clay. Runoff ponds, and permeability is slow or very slow. The soils are wet during years of above average precipitation and are droughty during dry periods. These alternate periods of wetness and dryness cause instability in the climax vegetation.

When this site is in excellent condition, western wheatgrass is dominant with a lesser amount of slim sedge. In wet years western wheatgrass declines as a result of ponding and is replaced by slim sedge, flat sedge, and foxtail barley. Overgrazing while the site is wet encourages the increase of smartweed and curly dock.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 3,000 pounds in unfavorable years to 4,000 pounds in favorable years.

SANDS RANGE SITE

Alluvial land, sandy, the only mapping unit in this site, is deep and somewhat excessively drained, and is on bottom lands. It takes in water easily and releases it readily to plants.

The climax plant cover is mainly warm-season grasses consisting of sand bluestem, big bluestem, little bluestem, switchgrass, and indiangrass. Prairie sandreed is the principal increaser. Also on this site are small amounts of Canada wildrye and prairie junegrass, which are cool-season grasses, and other forbs and woody plants. Many areas have an open stand of trees consisting mainly of cottonwood and green ash.

If this site is overgrazed, bluestems decrease and are replaced by prairie sandreed. Under continued overgrazing, bare areas become common and soil blowing is a serious hazard.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 2,300 pounds in dry years to 3,200 pounds in favorable years.

SANDY RANGE SITE

This site consists of well-drained loamy soils of the Orton series. These soils have a surface layer of loam, a subsoil of fine sandy loam, and are moderately deep over sand and gravel. They take in water readily and release it to plants.

The climax vegetation is a mixture of mid and tall, warm season grasses, dominantly of big bluestem, little bluestem, and sand bluestem. Prairie sandreed is the main increaser grass. Also in the plant community are small amounts of needleandthread, western wheatgrass, blue grama, side-oats grama, and sand dropseed and in some areas small amounts of Canada wildrye and prairie junegrass.

If the site is overgrazed, bluestem grasses decrease and are replaced by prairie sandreed, needleandthread, western wheatgrass, and side-oats grama. Under continued overuse, these grasses are replaced by sand dropseed and blue grama.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 2,000 pounds in unfavorable years to 3,000 pounds in favorable years.

SILTY RANGE SITE

This site consists of well-drained silty and loamy soils of the Agar, Canning, Dorna, Eakin, Glenham, Highmore, Java, Lowry, Oahe, and Ree series. Except for Canning and Oahe soils, these are deep soils that have high or moderate available water capacity. Canning and Oahe soils are moderately deep over sand and gravel and have moderate or low available water capacity.

The climax vegetation consists mainly of green needlegrass and western wheatgrass (fig. 15) and lesser amounts of needleandthread, blue grama, buffalograss, side-oats grama, needleleaf sedge, and threadleaf sedge. Also present are such forbs and woody plants as western snowberry and leafplant amorpha.

If the site is overgrazed, green needlegrass and western wheatgrass are replaced by blue grama and needleandthread, which under continuous overgrazing, are in turn replaced by sand dropseed and red three-awn.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 2,300 pounds in unfavorable years to 3,200 pounds in favorable years.

CLAYEY RANGE SITE

This site consists of deep, moderately well drained and well drained silty, loamy, and clayey soils of the Demky, Lakoma, Millboro, Oko, Opal, Peno, Promise, Raber, and Walke soils. All these soils have a subsoil that is high in content of clay. Permeability ranges from very slow to moderately slow. Available water capacity ranges from very low in the Opal soil to moderate or high in Demky, Peno, Raber, and Walke soils. The compact subsoil restricts roots.

The climax plant cover is mainly western wheatgrass and green needlegrass and an understory of buffalograss, blue grama, threadleaf sedge, and needleleaf sedge. Also on this site are small amounts of side-oats grama and a number of forbs.

If the site is overgrazed for extensive periods, western wheatgrass and green needlegrass decrease and are replaced by blue grama. Under further overuse, buffalograss replaces blue grama and annual weeds invade bare areas.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 1,900 pounds in unfavorable years to 2,900 pounds in favorable years.

Figure 15.—Silty range site in good condition.

CLAYPAN RANGE SITE

This site consists of deep, moderately well drained silty soils of the Cavo, DeGrey, and Mosher series. These soils have a silty surface and subsurface layer 4 to 10 inches thick over a claypan subsoil that is extremely hard or very hard when dry. Available water capacity is moderate, but permeability is slow or very slow. The dense claypan subsoil restricts the movement of moisture and the growth of roots.

The climax plant cover consists of western wheatgrass, green needlegrass, needleandthread, blue grama, side-oats grama, and buffalograss.

If the site is continuously overused, western wheatgrass, needleandthread, green needlegrass, and side-oats grama are replaced by blue grama and buffalograss. If overuse continues, pricklypear, forbs, and annual weeds increase and some bare ground is exposed.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 1,600 pounds in unfavorable years to 2,400 pounds in favorable years.

THIN UPLAND RANGE SITE

This site consists of deep, well-drained to excessively drained loamy and silty soils of the Betts, Gettys, and Sully series and Rough broken land. These soils have a thin surface layer and are calcareous at or near the surface. Fertility is low. Available water capacity is moderate or high in the Betts, Gettys, and Sully soils. Surface runoff is rapid in most areas.

The climax plant cover is a mixture of warm-season and cool-season grasses consisting of western wheatgrass, little bluestem, green needlegrass, needleandthread, side-oats grama, blue grama, plains muhly, and threadleaf sedge. Also on this site are such forbs and woody plants as leadplant amorpha and skunkbush sumac.

If the site is overgrazed, little bluestem, western wheatgrass, and green needlegrass decline and are replaced by needleandthread and side-oats grama. Under further overuse, these latter grasses are in turn replaced by blue grama and threadleaf sedge.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 1,800 pounds in dry years to 2,700 pounds in favorable years.

SHALLOW RANGE SITE

This site consists of shallow, well-drained clayey soils of the Sansarc series. These soils are underlain by soft shale. Permeability is slow, and surface runoff is rapid. Available water capacity is very low, and fertility is low.

The climax plant cover consists of little bluestem, side-oats grama, western wheatgrass, stonyhills muhly, blue grama, and tall dropseed. Also on this site are forbs and woody shrubs.

If the site is overused, little bluestem decreases and is replaced by side-oats grama and blue grama. Under continued overuse, considerable bare ground appears and the risk of erosion becomes high.

If this site is in excellent condition, the annual air-dry weight, yield per acre, ranges from 1,200 pounds in unfavorable years to 2,000 pounds in favorable years.

DENSE CLAY RANGE SITE

This site consists of shallow and deep, moderately well drained and well drained clayey soils of the Chantier and Swanboy series. These soils have a thin, crusty surface layer and a dense clayey subsoil that is extremely hard when dry. Segregations of salts are within 10 inches of the surface in the Chantier soil. These soils take in water very slowly, and the available water capacity is low or very low. The dense clayey materials severely restrict roots.

The climax plant cover consists of western wheatgrass and green needlegrass and forbs, such as American vetch, wild parsley, and wild onion. The site lacks an understory of short grasses.

If the site is overused, green needlegrass decreases and is replaced by western wheatgrass. Under continued overuse, western wheatgrass thins out and bare ground appears.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 800 pounds in unfavorable years to 2,000 pounds in favorable years. The Chantier soil commonly is less productive than the Swanboy soil.

THIN CLAYPAN RANGE SITE

This site consists of deep, moderately well drained silty soils of the Hurley and Jerauld series. These soils have a thin surface layer over a dense claypan subsoil. Accumulations of salts commonly are in the lower part of the subsoil. These soils have very slow permeability and low or very low available water capacity. The growth of plant roots is severely restricted by the claypan subsoil.

The climax plant cover consists of western wheatgrass, needleandthread, blue grama, buffalograss, inland saltgrass, pricklypear, and broom snakeweed.

If the site is overused, blue grama and buffalograss become dominant. If overuse continues, inland saltgrass and pricklypear increase. Much bare ground appears in dry years, and annual weeds increase in wet years.

If this site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 800 pounds in unfavorable years to 1,600 pounds in favorable years.

VERY SHALLOW RANGE SITE

This site consists of well-drained through excessively drained gravelly loam soils of the Schamber series. These soils are very shallow over loose sand and gravel. Permeability is rapid, and available water capacity is low or very low.

The climax plant cover consists of needleandthread, blue grama, side-oats grama, threadleaf sedge, and forbs. Dotted gayfeather is the most common forb.

If the site is overused, the site deteriorates rapidly to a thin stand of blue grama and threadleaf sedge.

If the site is in excellent condition, the total annual yield per acre, air-dry weight, ranges from 700 pounds in unfavorable years to 1,400 pounds in favorable years.

Windbreaks [6]

Hughes County has about 2,000 acres of native woodland. Most of the native woodland is on bottom lands and islands of the Missouri River, on bottom land of the larger creeks, and along some of the drainageways and protected draws that receive moisture from adjacent sloping soils.

The principal species of native trees and shrubs are American elm, boxelder, buffaloberry, bur oak, chokecherry, eastern cottonwood, eastern redcedar, gooseberry, green ash, hawthorne, juneberry, skunkbush, snowberry, wild plum, and wild rose.

These native wooded areas provide protection for livestock and habitat for wildlife. In addition, they are valuable for erosion control, recreation, and watershed protection, and they add beauty to the countryside.

Windbreaks have been planted in the county since the early days of settlement. Most of them were planted to provide protection for farmsteads. In most recent years windbreaks have been planted to protect fields and feedlots and also to provide wildlife habitat (fig. 16). Supplementary plantings are needed in many of the existing windbreaks to make them more effective. Additional plantings are also needed to protect fields, farmsteads, and feedlots.

Among the benefits gained from planting windbreaks are distributing and holding snow (fig. 17); protecting farmsteads and feedlots from cold, wintry winds; protecting field crops, gardens, and orchards from damaging winds; reducing moisture evaporation; controlling soil blowing and erosion; and providing habitat for birds and other wildlife. Windbreaks also enhance the beauty of the rural home and its surroundings.

A minimum of six rows of trees and shrubs planted on the north and west side of the protected area generally is needed for a farmstead or feedlot windbreak. Of these, two rows of evergreens on the windward side of the windbreak and one row of evergreens on the leeward side are desirable. Secondary windbreaks consisting of one or two rows of shrubs planted on the east and south sides of the protected area provide additional protection. The inside row of the windbreak should not be closer than 100 feet nor farther than 300 feet from the area to be protected.

The purpose of field windbreaks is to help control soil blowing, conserve moisture, and to lessen crop injury by hot summer winds. They can be one row or multirow plantings. Multirow plantings generally do not need to exceed 5 rows in order to be effective.

Site preparation is important in establishing a windbreak. Many of the upland sites can benefit from summer fallowing for a year before planting. This is especially true if the site is in grass or alfalfa. Plantings on the contour help to conserve moisture and control erosion.

To help the plantings survive, cultivation of the windbreak is essential to control grasses and weeds. Supplemental watering during the first growing season and fencing to exclude livestock also help to insure survival. Controlling rodents, insects, and disease are necessary management measures throughout the life of a windbreak.

Table 3 can be used as a guide in planning a windbreak. It lists the main tree and shrub species that are suitable for windbreaks in the county. The heights given are based on measurements and observations made on wind-

[6] By DAVID L. HINTZ, forester, Soil Conservation Service.

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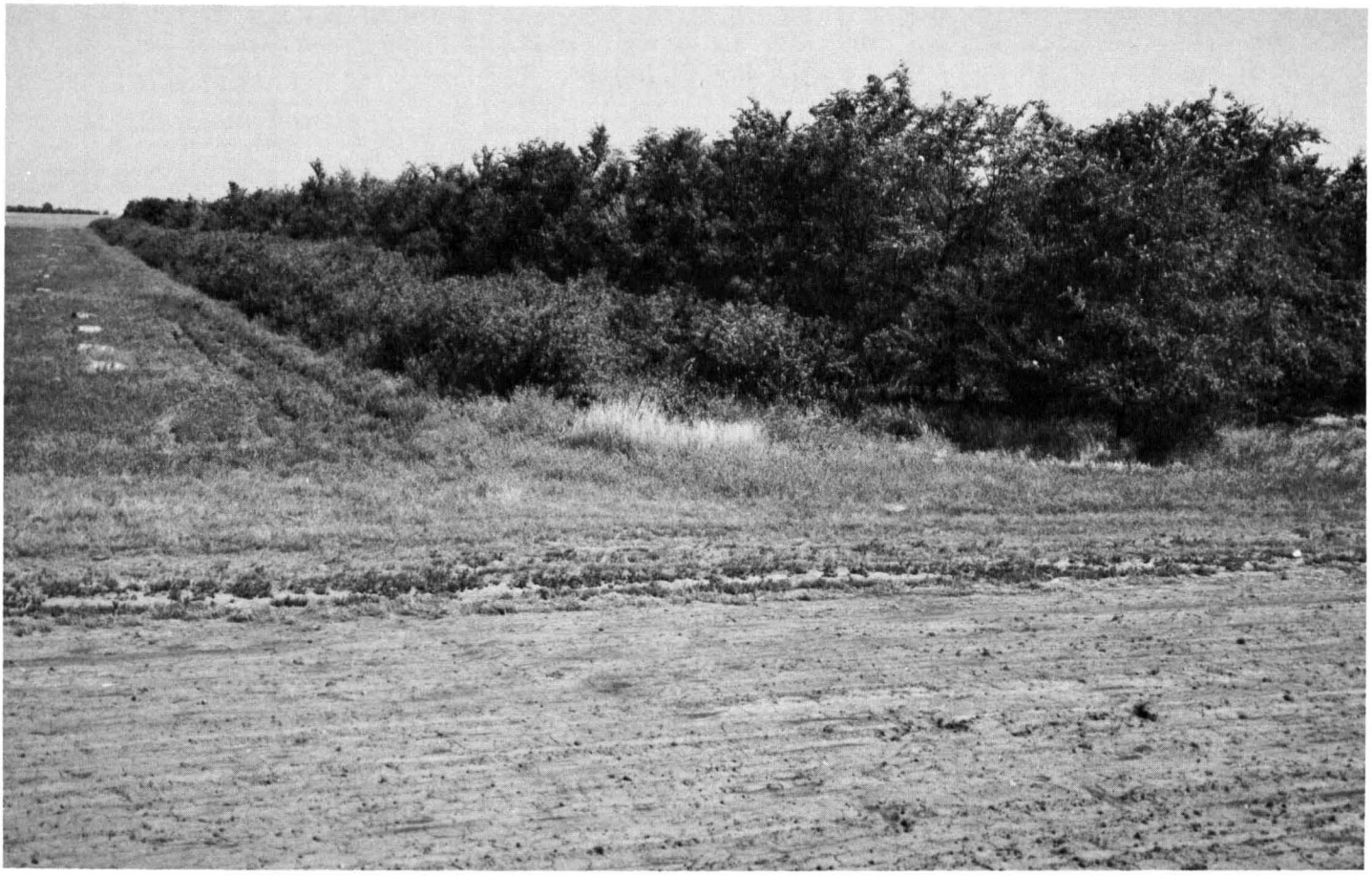

Figure 16.—**Windbreak planting designed for livestock protection and wildlife habitat. Highmore-Eakin silt loams, 0 to 2 percent slopes.**

breaks 20 years of age and adequately managed. The vigor ratings refer to density of foliage, freedom from insect or disease damage, and general appearance of the tree or shrub. Criteria for the vigor ratings are as follows:

Good.—One or more of the following is present: Leaves or needles are normal in color and growth; small amount of dead wood (tops, branches, twigs) in the live crowns; little or no evidence of disease, insect or climatic damage; no more than slight evidence of stagnation or suppression.

Fair.—One or more of the following is present: Leaves or needles obviously are abnormal in color and growth; substantial amount of dead wood (tops, branches, twigs) within the live crowns, evidence of moderate disease, insect or climatic damage; evidence of definite suppression or stagnation; current year's growth obviously is less than normal.

Poor.—One or more of the following is present: Leaves or needles are very abnormal in color and growth; very large amount of dead wood (tops, branches, twigs) within the live crowns; evidence of extensive disease, insect or climatic damage; plants show effects of severe stagnation, suppression, or decadence; current year's growth is negligible. Plants with this rating are poorly suited to windbreak plantings. They may be satisfactory for some wildlife, recreational, and beautification plantings.

The following paragraphs describe the windbreak suitability groups to which the soils of Hughes County are assigned. The groups are not numbered consecutively because not all of the groups in the statewide system are in the county. The names of the soil series represented are mentioned in each group, but this does not mean that all the soils of a given series are in the group. Only those soils suited to windbreak plantings are mentioned. To find the windbreak suitability group of a given soil, turn to the "Guide to Mapping Units."

WINDBREAK GROUP 1

This group consists of deep, well drained and moderately well drained, nearly level loamy and silty soils of the Bon and Onita series. The surface layer of these soils is loam or silt loam, and the subsoil ranges from loam to silty clay.

These soils are high in fertility, organic-matter content, and available water capacity. They receive additional moisture from stream overflow or as runoff from adjacent soils. They have the most favorable moisture regime of all the soils in the county for the survival of trees and shrubs.

Soils of this group are well suited to tree and shrub plantings for the protection of fields, farmsteads, and

Figure 17.—**Snowdrifts held by windbreak planting designed as farmstead shelterbelt. Demky-Cavo silt loams, 0 to 2 percent slopes.**

feedlots. They also are well suited to plantings in landscaping and for recreational areas and wildlife habitat.

WINDBREAK GROUP 2

Munjor fine sandy loam is the only soil in this group. It is a deep, well-drained, nearly level soil that formed in sandy alluvium. It is calcareous and is moderately alkaline in reaction.

This soil takes in water readily and has moderate or high available water capacity. The water table, commonly between depths of 5 and 10 feet, affects the selectivity of trees and shrubs. but adapted species grow well because the moisture supply is abundant.

Soils of this group are well suited to windbreak plantings for the protection of fields, farmsteads, and feedlots. They also are suited to plantings for landscaping, recreational areas, and wildlife habitat.

WINDBREAK GROUP 3

This group consists of deep, well-drained, nearly level to sloping or undulating silty and loamy soils of the Agar, Dorna, Eakin, Glenham, Highmore, Lowry, Peno, Raber and Ree series. The surface layer of these soils is silt loam, loam, or clay loam and the subsoil is silt loam, clay loam, or silty clay loam.

These soils are medium in fertility and moderate or high in available water capacity. Permeability is slow in the underlying materials of the Dorna soil, but is moderate or moderately slow in the other soils.

Soils of this group are well suited to all types of tree plantings. Site preparation includes fallowing during the year before planting. Planting on the contour helps to conserve moisture on the sloping soils of this group.

WINDBREAK GROUP 4

This group consists of deep and moderately deep, well drained and moderately well drained, nearly level to sloping silty, loamy, and clayey soils of the Demky, Dorna, Millboro, Oko, Opal, Promise, and Walke series. The subsoil of these soils is compact clay loam, silty clay loam, clay, or silty clay.

Available water capacity ranges from low or very low in the Opal soil to moderate or high in Demky and Walke soils. Permeability is slow or very slow and the compact subsoil somewhat restricts growth of tree roots.

Soils of this group are moderately suited to windbreaks for fields, farmsteads, and feedlots. They also are moderately suited to other types of plantings where height of growth is not a critical requirement. Fallow is a

TABLE 3.—*Estimated vigor and height of trees and shrubs at 20 years of age by windbreak groups*

[For definitions of vigor classes, see text. Estimate of height is not given for species rated poor]

Species	Group 1		Group 2		Group 3		Group 4		Group 6		Group 8		Group 9	
	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height	Vigor	Height
		Ft.		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Black Hills and Colorado blue spruce.	Good	24–30	Good	20–24	Good	24–28	Poor		Poor		Poor		Poor	
Boxelder	Fair	20–22	Fair	18–20	Fair	20–22	Poor		Poor		Poor		Poor	
Buffaloberry	Good	8–10	Fair	6–8	Good	7–9	Good	7–9	Fair	5–6	Fair	4–5	Fair	3–4
Caragana	Good	9–11	Fair	7–9	Good	9–10	Fair	6–8	Fair	5–7	Fair	7–8	Fair	5–6
Chokecherry	Good	12–14	Fair	9–11	Good	9–12	Good	10–12	Poor		Poor		Poor	
Cotoneaster	Good	6–7	Fair	5–6	Good	6–7	Good	5–7	Fair	4–5	Fair	5–6	Poor	
Cottonwood	Fair or good.	35–40	Poor to good.	32–36	Poor		Poor		Poor		Poor		Poor	
Crabapple	Good	18–20	Good	16–18	Good	15–17	Fair	12–15	Fair	12–14	Poor		Poor	
Eastern redcedar	Good	15–18	Good	14–16	Good	13–15	Good	15–17	Fair	9–11	Fair	9–11	Fair	6–8
Golden and white willow.	Good	32–35	Good	30–34	Poor		Poor		Poor		Poor		Poor	
Green ash	Good	23–27	Good	20–24	Good	20–24	Fair	17–26	Fair	12–14	Fair	14–16	Fair	10–12
Hackberry	Good	23–27	Good	22–26	Good	20–24	Good	15–24	Fair	10–12	Fair	14–16	Poor	
Harbin pear	Good	16–18	Good	14–16	Good	15–17	Fair	12–15	Fair	11–12	Fair	7–9	Fair	5–7
Honey locust	Good	30–34	Good	30–34	Fair	26–30	Fair	24–26	Fair	15–17	Fair	17–20	Poor	
Honeysuckle	Good	8–10	Good	6–8	Good	7–9	Fair	6–8	Fair	5–7	Fair	6–8	Poor	
Lilac	Good	7–8	Good	6–7	Good	6–7	Fair	4–5	Fair	4–5	Fair	5–6	Fair	3–4
Nanking cherry	Good	5–7	Fair	4–5	Fair	5–6	Fair	4–5	Poor		Poor		Poor	
Plum	Good	8–9	Good	5–6	Good	8–9	Fair	5–7	Poor		Fair	5–6	Poor	
Ponderosa pine	Good	24–30	Good	20–22	Good	22–26	Good	17–23	Fair	13–15	Fair	14–16	Fair	10–12
Rocky Mountain juniper.	Good	15–18	Good	14–16	Good	13–15	Good	15–17	Fair	9–11	Fair	9–11	Fair	6–8
Russian-olive	Fair	16–20	Fair	14–16	Fair	15–18	Fair	15–22	Fair	9–12	Fair	14–16	Fair	8–10
Siberian elm	Good	31–36	Good	24–28	Good	30–32	Good	26–30	Fair	16–20	Fair	18–22	Fair	12–14

necessary part of site preparation. Contour planting helps to conserve moisture on sloping sites.

WINDBREAK GROUP 6

In this group are well-drained, nearly level to undulating loamy soils of the Canning, Oahe, and Orton series. These soils have a subsoil that ranges from fine sandy loam to clay loam and is underlain by sand and gravel at a moderate depth.

These soils are medium in fertility, moderate or low in available water capacity, and droughty. Permeability is moderate or moderately rapid in the surface layer and subsoil and rapid in the underlying sand and gravel. Root systems of trees and shrubs are shallow because available water capacity of the underlying sand and gravel is very low.

Soils of this group are poorly suited to windbreak plantings. They can be used for all types of plantings if optimum growth needs are not critical or if supplementary moisture is available. Fallow is a necessary part of site preparation, except on Orton soils. Cover crops are desirable on the Orton soil in order to control soil blowing. Planting on the contour helps to conserve needed moisture.

WINDBREAK GROUP 8

In this group are deep, well-drained, nearly level to sloping silty and loamy soils of the Java and Sully series. The surface layer of these soils is silt loam or loam, and the underlying material is silt loam, loam, or clay loam. The soil is calcareous at or within 10 inches of the surface.

These soils are high in available water capacity, but low in fertility and organic-matter content. Permeability is moderate or moderately slow. The Sully soil blows easily and in sloping areas is highly susceptible to water erosion.

Soils of this group are moderately suited to tree plantings of all kinds if optimum growth requirements are not a critical need. Fallow generally is a part of site preparation. Liberal use of crop residue is necessary to control soil blowing. Planting on the contour helps to conserve moisture and control erosion.

WINDBREAK GROUP 9

This group consists of deep, moderately well drained, nearly level to gently sloping claypan soils of the Cavo, DeGrey, and Mosher series. The surface layer of these soils is silt loam, and the claypan subsoil is clay loam or silty clay. The subsoil and the underlying material are moderately alkaline or strongly alkaline. The soils also contain moderate amounts of salts that affect the growth of trees.

These soils have slow or very slow permeability. Available water capacity is moderate, but the claypan subsoil releases moisture slowly to plants and restricts the growth of roots.

Soils of this group are poorly suited to windbreak plantings. They can be used for other types of plantings if vigor and growth response are not critical.

WINDBREAK GROUP 10

This group consists of a number of soils and miscellaneous land types that are too shallow, too stony, too steep, too wet, or for some other reason are not suited to tree plantings that are normally planted with machinery.

Soils of this group can be used for plantings for recreational areas, wildlife habitat, and landscaping if vigor and growth response are not critical. Trees and shrubs selected should be tolerant of the conditions at the planting site. On most sites special planting methods are needed or the trees should be hand planted. Special care and maintenance generally are needed to insure survival of trees and shrubs.

Wildlife [7]

Wildlife is a product of the soil, and like other crops, responds to good management. The level of production of adapted wildlife usually is in balance with essential habitat containing food and cover. The nature and adequacy of habitat plants, both introduced and native, depend on the suitability of the soil for growing the plants. The complete habitat elements needed by a specific species of wildlife generally require several kinds of soil and commonly a combination of land uses. For this reason, interpretations of the soils of the county can best be related to the soil associations described in the section, General Soil Map.

In the following paragraphs the soil associations of Hughes County are described as wildlife areas that differ in potential, species, mainly game species, and environmental factors.

WILDLIFE AREA 1

This wildlife area is on the Betts-Java-Durrstein, Gettys-Betts, and Sansarc association. The soils are mainly rolling to steep and loamy and clayey. Except for a small acreage of crops on some of the minor soils, almost all areas are in native grass and are used primarily as range. Brushy draws and stringers of trees along some of the drainageways provide habitat cover for many species of wildlife. Most of these wildlife areas are near wildlife areas 3 and 4, which have extensive areas of crops that provide winter feed. Ponds constructed for livestock water are the major source of water.

Wildlife species in this area are badger, bobcat, coyote, fox, mule and whitetail deer, prairie chicken, sharp-tailed grouse, and a limited number of pheasants. Proper range use helps in maintaining or improving habitat for these species.

Some of the larger ponds in the area are stocked with large-mouth bass, bluegill, and rainbow trout. Advantageous sites for pass shooting of geese are in areas near Lake Oahe and Lake Sharpe.

WILDLIFE AREA 2

This wildlife area is on the Cavo-Raber-Demky and Raber-Peno associations. The soils are mainly nearly level to rolling and loamy and silty. Much of this area is in native grass and is used for grazing. Most cultivated crops provide feed and forage for livestock. Small amounts of brush are in some of the draws, and stringers of trees are along some of the creeks and drainageways. Much of the winter cover for wildlife is provided by windbreaks around farmsteads and feedlots.

[7] By JOHN B. FARLEY, biologist, Soil Conservation Service.

The main wildlife species in the area are coyote, sharp-tailed grouse, pheasant, fox, raccoon, and whitetail deer. Ponds for livestock water and some areas of Hoven and Macken soils in closed depressions provide courting and breeding areas for ducks. No wildlife species occurs in numbers to which special significance can be attached.

Proper range use helps maintain or improve the existing habitat elements. Additional windbreaks around farmsteads and feedlots could help improve winter cover.

WILDLIFE AREA 3

This wildlife area is on the Ree-Canning, Highmore-Eakin, and Highmore-DeGrey associations. The soils are nearly level to undulating and loamy and silty. Much of this area is cultivated. Corn, wheat, oats, and alfalfa are the main crops. Small, scattered acreages of native grass are throughout this area. Winter cover is provided mainly by windbreaks planted around farmsteads and feedlots.

This wildlife area has a high potential for such farm game as pheasant, gray partridge, and cottontail. Whitetail deer migrate from wildlife area 1 and use the nearby parts of this area as a source of food. Areas of Hoven and Macken soils in closed depressions or potholes provide courting and breeding areas for ducks. There is some field feeding of migrating ducks and geese during fall and winter, especially in areas nearest to Lake Oahe and Lake Sharpe.

The potential of this wildlife area for farm game species can be enhanced by planting windbreaks of all kinds, planting grasses and legumes on field borders, stubble mulching, and properly managing range and pastures.

WILDLIFE AREA 4

This wildlife area is on the Lowry-Agar association. The soils are nearly level to gently sloping and silty. Except in the southeastern part of the country, most of this area is cultivated and some of it is irrigated. Native trees and shrubs are sparse, and field, farmstead, and feedlot windbreaks are few.

The fields attract ducks and geese from their resting places on Lake Oahe and Lake Sharpe. Sharp-tailed grouse and prairie chicken migrate into the area for winter feeding. The area also has a small population of pheasant.

The greatest potential in this area is suited to providing field feeding for ducks, geese, sharp-tailed grouse, and prairie chicken. The intensity of cropping is not likely to provide the nesting habitat needed to increase the pheasant population.

WILDLIFE AREA 5

This wildlife area is on the Munjor association. The nearly level loamy alluvial soils are on bottom lands and islands of the Missouri River not flooded by Lake Oahe and Lake Sharpe. That part of the area within and near the city of Pierre is used primarily for outdoor recreation. Laframboise Island is the largest remaining tract not flooded by Lake Sharpe. It is now in public ownership and the formerly cropped areas are being restored to grasses and woody plants.

Many wildlife species still occupy Laframboise Island. These include all the common furbearers, cottontail, ducks, eagles, geese, jackrabbit, prairie chicken, sharp-tailed grouse, and whitetail deer. The coyote is the principal predator species on the island. Wild turkeys have been planted, and hunting is managed for turkey and deer. The island has many birds and is an excellent area where ornithologists can expand their bird lists. Laframboise Island has excellent potential to serve as a relict area to document the natural biota of the Missouri River bottom lands.

This wildlife area, along with areas 1 and 4, borders Lake Oahe, the tailwaters of Lake Oahe, and Lake Sharpe. These waters currently provide an excellent sport fishery. Species of the greatest sport value include walleye and northern pike, sauger, white bass, catfish, crappie, and yellow perch. The waters also have potential for a commercial fishery based on small and large-mouthed buffalo.

Recreation

Lake Oahe, the tailwaters of Oahe dam, and Lake Sharpe provide recreation in the form of boating, fishing, water-skiing, and swimming. The proximity of these waters also influences the use of nearby soils for camp areas, picnic areas, playgrounds, paths and trails, and various service facilities.

Knowledge of soils is necessary in planning, developing, and maintaining recreational areas. Table 4 shows the limitations that affect the suitability of the soils of Hughes County for camp areas, playgrounds, picnic areas, and paths and trails.

In table 4 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of 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 favorable and limitations are so minor that they easily can be 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.

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, no flooding during periods of heavy use, and a surface that is firm after rains, but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The best soils have a surface that is firm when wet, but not dusty when dry; no flooding during the season of use; and no slopes or stones that greatly increase the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use have to withstand intensive foot traffic. The best soils have a nearly level surface free of

TABLE 4.—*Degree and kind of limitation of soils for recreational uses*

Soil	Camping areas	Picnic areas	Playgrounds	Paths and trails
Agar silt loam, 0 to 2 percent slopes	None to slight	None to slight	None to slight	None to slight.
Agar silt loam, 2 to 5 percent slopes	None to slight	None to slight	Moderate: slope	None to slight.
Agar-Eakin silt loams, 2 to 5 percent slopes.	None to slight	None to slight	Moderate: slope	None to slight.
Alluvial land, sandy	Moderate: texture	Moderate: texture	Moderate: texture	Moderate: texture.
Alluvial land, undifferentiated	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
Alluvial land, wet	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Betts loam, 15 to 40 percent slopes	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
Bon loam	Severe: flooding	Moderate: flooding	Moderate: flooding	None to slight.
Canning loam, 0 to 2 percent slopes	None to slight	None to slight	None to slight	None to slight.
Canning loam, 2 to 5 percent slopes	None to slight	None to slight	Moderate: slope	None to slight.
Cavo-Demky silt loams, 0 to 2 percent slopes.	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability.	None to slight.
Chantier clay, 2 to 9 percent slopes	Severe: very slow permeability.	Severe: texture	Severe: very slow permeability.	Severe: texture.
Cut and fill land	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
DeGrey-Walke silt loams, 0 to 2 percent slopes.	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability.	None to slight. None to slight.
Demky-Cavo silt loams, 0 to 2 percent slopes.	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability.	None to slight.
Dorna silt loam	None to slight	None to slight	Moderate: texture	None to slight.
Dorna silt loam, thin solum	None to slight	None to slight	Moderate: texture	None to slight.
Durrstein-Egas complex	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: flooding	Severe: wetness, flooding.
Eakin-Raber silt loams, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Eakin-Raber silt loams, 2 to 5 percent slopes.	None to slight	None to slight	Moderate: slope	None to slight.
Eakin-Raber silt loams, 5 to 9 percent slopes.	None to slight	None to slight	Severe: slope	None to slight.
Fill land. No interpretations; properties too variable.				
Gettys clay loam, 15 to 40 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
Glenham-Highmore silt loams, 5 to 9 percent slopes.	None to slight	None to slight	Severe: slope	None to slight.
Highmore silt loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Highmore-DeGrey silt loams, 0 to 2 percent slopes:				
Highmore soil	None to slight	None to slight	None to slight	None to slight.
DeGrey soil	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability.	None to slight.
Highmore-DeGrey silt loams, 2 to 5 percent slopes:				
Highmore soil	None to slight	None to slight	Moderate: slope	None to slight.
DeGrey soil	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability, slope.	None to slight.
Highmore-Eakin silt loams, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Highmore-Eakin silt loams, 2 to 5 percent slopes.	None to slight	None to slight	Moderate: slope	None to slight.
Highmore-Glenham silt loams, 2 to 5 percent slopes.	None to slight	None to slight	Moderate: slope	None to slight.
Highmore-Walke silt loams, 0 to 2 percent slopes:				
Highmore soil	None to slight	None to slight	None to slight	None to slight.
Walke soil	Moderate: slow permeability.	None to slight	Moderate: slow permeability.	None to slight.
Hoven silt loam	Severe: ponding	Severe: ponding	Severe: ponding	Severe: ponding.
Hoven-Onita silt loams:				
Hoven soil	Severe: ponding, very slow permeability.	Severe: ponding	Severe: ponding	Severe: ponding.
Onita soil	Severe: flooding	Moderate: flooding	Severe: flooding	Moderate: flooding.

TABLE 4.—*Degree and kind of limitation of soils for recreational uses*—Continued

Soil	Camping areas	Picnic areas	Playgrounds	Paths and trails
Hurley silt loam, 0 to 6 percent slopes.	Severe: very slow permeability.	Severe: texture	Severe: very slow permeability.	Severe: texture.
Java-Betts loams, 9 to 15 percent slopes.	Moderate: slope	Moderate: slope	Severe: slope	None to slight.
Java-Glenham loams, 2 to 9 percent slopes.	None to slight	None to slight	Moderate to severe: slope.	None to slight.
Jerauld silt loam, 0 to 2 percent slopes.	Severe: very slow permeability.	Severe: texture	Severe: very slow permeability.	Severe: texture.
Lowry silt loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Lowry silt loam, 2 to 5 percent slopes.	None to slight	None to slight	Moderate: slope	None to slight.
Lowry silt loam, 5 to 9 percent slopes.	None to slight	None to slight	Severe: slope	None to slight.
Lowry-Urban land complex, 2 to 5 percent slopes. No interpretations; properties too variable.				
Lowry-Urban land complex, 5 to 9 percent slopes. No interpretations; properties too variable.				
Macken silty clay	Severe: ponding	Severe: ponding	Severe: ponding	Severe: ponding.
Millboro silty clay loam, 0 to 2 percent slopes.	Moderate: slow permeability, texture.	Moderate: texture	Moderate: slow permeability, texture.	Moderate: texture.
Mosher silt loam, 0 to 2 percent slopes.	Moderate to severe: very slow permeability.	None to slight	Moderate to severe: very slow permeability.	None to slight.
Munjor fine sandy loam	None to slight	None to slight	None to slight	None to slight.
Oahe-Orton loams, 2 to 9 percent slopes.	None to slight	None to slight	Moderate to severe: slope.	None to slight.
Oko clay loam, 2 to 5 percent slopes.	Moderate: slow permeability, texture.	Moderate: texture	Moderate: slow permeability, slope.	Moderate: texture.
Oko clay loam, 5 to 9 percent slopes.	Moderate: slow permeability, texture.	Moderate: texture	Severe: slow permeability, slope.	Moderate: texture.
Oko-Jerauld complex, 2 to 9 percent slopes:				
Oko soil	Moderate: slow permeability, texture.	Moderate: texture	Moderate to severe: slow permeability, slope.	Moderate: texture.
Jerauld soil	Severe: very slow permeability.	Severe: texture	Severe: very slow permeability, slope.	Severe: texture.
Onita silt loam, 0 to 2 percent slopes.	Severe: flooding	Moderate: flooding	Severe: flooding	Moderate: flooding.
Onita-Hoven silt loams, 0 to 1 percent slopes:				
Onita soil	Severe: flooding	Moderate: flooding	Severe: flooding.	Moderate: flooding.
Hoven soil	Severe: ponding	Severe: ponding	Severe: ponding	Severe: ponding.
Opal clay, 2 to 5 percent slopes	Severe: texture	Severe: texture	Severe: texture	Severe: texture.
Opal clay, 5 to 9 percent slopes	Severe: texture	Severe: texture	Severe: texture, slope	Severe: texture.
Opal-Lakoma clays, 9 to 15 percent slopes.	Severe: texture	Severe: texture	Severe: texture, slope	Severe: texture.
Peno-Gettys clay loams, 9 to 15 percent slopes.	Moderate: moderately slow permeability, slope, texture.	Moderate: slope, texture.	Severe: slope	Moderate: texture.
Peno-Swanboy complex, 3 to 15 percent slopes:				
Peno soil	Moderate: moderately slow permeability, texture.	Moderate: texture, slope.	Moderate to severe: texture, slope.	Moderate: texture.
Swanboy soil	Severe: texture, very slow permeability.	Severe: texture	Severe: texture, very slow permeability.	Severe: texture.
Promise clay, 0 to 2 percent slopes	Severe: texture	Severe: texture	Severe: texture	Severe: texture.
Promise clay, 2 to 5 percent slopes	Severe: texture	Severe: texture	Severe: texture	Severe: texture.
Promise-Mosher complex, 0 to 2 percent slopes.	Severe: texture	Severe: texture	Severe: texture	Severe: texture.
Raber-Cavo loams, 0 to 2 percent slopes:				
Raber soil	None to slight	None to slight	None to slight	None to slight.
Cavo soil	Moderate: slow and very slow permeability.	None to slight	Moderate: slow and very slow permeability.	None to slight.

TABLE 4.—*Degree and kind of limitation of soils for recreational uses*—Continued

Soil	Camping areas	Picnic areas	Playgrounds	Paths and trails
Raber-Cavo loams, 2 to 5 percent slopes:				
Raber soil	None to slight	None to slight	Moderate: slope	None to slight.
Cavo soil	Moderate: slow and very slow permeability.	None to slight	Moderate: slope, slow and very slow permeability.	None to slight.
Raber-Peno clay loams, 2 to 9 percent slopes.	Moderate: texture	Moderate: texture	Moderate to severe: texture, slope.	Moderate: texture.
Raber and Oko stony soils, 3 to 15 percent slopes.	Severe: stoniness	Severe: stoniness	Severe: stoniness	Severe: stoniness.
Ree loam, 0 to 2 percent slopes	None to slight	None to slight	None to slight	None to slight.
Ree loam, 2 to 5 percent slopes	None to slight	None to slight	Moderate: slope	None to slight.
Ree-Mosher complex, 0 to 2 percent slopes:				
Ree soil	None to slight	None to slight	None to slight	None to slight.
Mosher soil	Moderate to severe: very slow permeability.	None to slight	Moderate to severe: very slow permeability.	None to slight.
Rough broken land	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
Sansarc-Gettys complex, 9 to 34 percent slopes:				
Sansarc soil	Severe: texture	Severe: texture	Severe: slope, texture	Severe: texture.
Gettys soil	Moderate to severe: slope, texture.	Moderate to severe: slope, texture.	Severe: slope	Moderate to severe: slope.
Sansarc-Lakoma clays, 9 to 40 percent slopes.	Severe: texture	Severe: texture	Severe: texture	Severe: texture.
Sansarc-Shale outcrop complex	Severe: texture, slope	Severe: texture, slope	Severe: slope, texture	Severe: texture.
Schamber-Orton complex	Moderate to severe: slope.	Moderate to severe: slope.	Severe: slope	Moderate to severe: slope.
Shale land	Severe: slope, texture	Severe: slope, texture	Severe: slope, texture	Severe: slope, texture.
Sully silt loam, 0 to 2 percent slopes.	None to slight	None to slight	None to slight	None to slight.
Sully silt loam, 2 to 9 percent slopes.	None to slight	None to slight	Moderate to severe: slope.	None to slight.
Sully silt loam, 9 to 15 percent slopes.	Moderate: slope	Moderate: slope	Severe: slope	None to slight.
Sully silt loam, 15 to 35 percent slopes.	Severe: slope	Severe: slope	Severe: slope	Moderate to severe: slope.
Swanboy clay, 0 to 6 percent slopes.	Severe: texture, very slow permeability.	Severe: texture	Severe: texture, very slow permeability.	Severe: texture.
Swanboy-Slickspots complex	Severe: texture, very slow permeability.	Severe: texture	Severe: texture, very slow permeability.	Severe: texture.

coarse fragments and rock outcrops, good drainage, no flooding during periods of heavy use, and a surface that is firm after rains, but not dusty when dry. If grading and leveling are required, depth to rock is important.

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.

For information on the suitability of a soil for cottage sites, waste disposal systems, and roads and streets, the recreation planner can refer to the section "Engineering Uses of the Soils."

Engineering Uses of the Soils [8]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. Information contained in this section is valuable to planning commissions, town and country planners, town and city managers, sanitarians, land developers, and architects and realtors who are concerned with soils and their limitations in land use planning and development. In this section are those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related soil properties is furnished in tables 5, 6, 7, and 8. The estimates and interpretations of soil properties in these tables can be used in—

1. Evaluating potential areas for residential, industrial, commercial, and recreational uses. Among the factors to be considered are depth to bedrock,

[8] GORDON W. STROUP, assistant state conservation engineer, Soil Conservation Service.

TABLE 5.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
*Agar: AgA, AgB, AkB	>5	>10	0–7	Silt loam	ML–CL	A–6
			7–17	Silty clay loam	ML–CL or CL	A–6 or A–7
For Eakin part of AkB, see Eakin series.			17–60	Silt loam	ML–CL or CL	A–6 or A–7
Alluvial land: As, Au, Aw. No valid estimates can be made.						
Betts: BeE	>5	>10	0–3	Loam	ML or ML–CL	A–6
			3–41	Clay loam	ML or ML–CL	A–6
			41–60	Clay loam	CL or ML–CL	A–6 or A–7
Bon: Bo	>5	4–10	0–27	Loam	ML or ML–CL	A–6 or A–4
			27–60	Silty clay loam	ML–CL or CL	A–6
Canning: CaA, CaB	>5	>10	0–5	Loam	ML or ML–CL	A–6 or A–4
			5–12	Clay loam	CL or ML–CL	A–6
			12–30	Clay loam	CL or ML–CL	A–6
			30–60	Sand and gravel	GM, GC, or SM	A–2 or A–1
*Cavo: CdA [1]	>5	>10	0–7	Silt loam	CL or ML	A–6 or A–4
			7–14	Clay loam	CL or CH	A–7
For Demky part of CdA, see Demky series.			14–60	Clay loam	CL or CH	A–6 or A–7
Chantier: ChC	<2	>10	0–18	Clay	MH or CH	A–7
			18–60	Shale.		
Cut and fill land: Cu. No valid estimates can be made.						
*DeGrey: DeA [1]	>5	>10	0–7	Silt loam	ML or CL	A–6
			7–17	Silty clay	CH	A–7
For Walke part of DeA, see Walke series.			17–30	Silty clay loam	CL or CH	A–7 or A–6
			30–60	Clay loam	CL or CH	A–7 or A–6
*Demky: DkA [1]	>5	>10	0–8	Silt loam	ML–CL	A–6
			8–15	Clay loam	CH or CL	A–7 or A–6
For Cavo part of DkA, see Cavo series.			15–60	Clay loam	CL or CH	A–6 or A–7
Dorna: Do, Dr	>5	>10	0–15	Silt loam	ML or ML–CL	A–4 or A–6
			15–24	Silt loam	ML–CL	A–4 or A–6
			24–60	Silty clay	CL or MH	A–7
*Durrstein: Du	>5	3–10	0–2	Silt loam	ML or CL	A–6
			2–14	Silty clay	CL or MH	A–7
For Egas part of Du, see Egas series.			14–60	Silty clay	MH or MH–CH	A–7
*Eakin: ErA, ErB, ErC	>5	>10	0–7	Silt loam	ML or ML–CL	A–6
			7–13	Silty clay loam	CL	A–6 or A–7
For Raber part of ErA, ErB, and ErC, see Raber series.			13–33	Silty clay loam	CL or ML–CL	A–6 or A–7
			33–60	Clay loam	CL or CH	A–7 or A–6
Egas [1]	>5	2–5	0–15	Silty clay loam	CL	A–7
			15–60	Silty clay	CH	A–7
Mapped only with Durrstein soils.						
Fill land: Fd. No valid estimates can be made.						

significant in engineering

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

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	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
				In./hr.	*In./in. of soil*	*pH*	*Mmho/cm.*			
100	100	95–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Low	Low.
100	95–100	90–100	85–95	0. 6–2. 0	0. 17–0. 20	7. 4–7. 8		Moderate	Moderate	Low.
100	95–100	90–100	85–95	0. 6–2. 0	0. 17–0. 20	7. 9–8. 4		Moderate	Moderate	Low.
95–100	85–100	85–95	60–80	0. 6–2. 0	0. 18–0. 20	7. 4–7. 8		Low	Low	Low.
95–100	85–100	85–95	60–80	0. 6–2. 0	0. 17–0. 20	7. 4–7. 8		Moderate	Moderate	Moderate.
100	90–100	85–95	60–80	0. 2–0. 6	0. 17–0. 20	7. 4–8. 4		Moderate	Moderate	Moderate.
100	95–100	85–95	70–90	0. 6–2. 0	0. 18–0. 20	6. 6–8. 4		Low	Low	Low.
100	95–100	85–95	70–90	0. 6–2. 0	0. 14–0. 17	7. 9–8. 4		Moderate	Moderate	Low.
95–100	85–100	70–85	60–75	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3		Low	Low	Low.
90–100	80–100	75–95	60–80	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Moderate	Moderate	Low.
90–100	80–100	75–95	60–80	0. 6–2. 0	0. 17–0. 20	7. 4–8. 4		Moderate	Moderate	Low.
30–100	20–80	10–40	5–35	6. 0–20. 0	0. 03–0. 06	7. 4–7. 8		Low	Moderate	Low.
95–100	90–100	85–95	70–80	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Low.
95–100	90–100	80–95	70–90	<0. 06–0. 2	0. 13–0. 16	7. 4–8. 4		High	High	Moderate.
95–100	90–100	80–95	65–85	0. 06–0. 2	0. 11–0. 14	7. 9–8. 4	4–8	Moderate or high.	High	High.
100	100	95–100	85–100	<0. 06	0. 08–0. 12	7. 9–8. 4	4–12	High	High	High.
100	100	95–100	85–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 8		Low	Moderate	Low.
100	100	95–100	85–100	<0. 6–0. 2	0. 10–0. 15	7. 9–8. 4		High	High	Low.
100	100	95–100	85–95	0. 06–0. 2	0. 11–0. 14	7. 9–8. 4	4–8	Moderate or high.	High	Moderate.
100	90–100	90–100	85–95	0. 2–0. 6	0. 11–0. 14	7. 9–8. 4	4–8	Moderate or high.	High	High.
100	95–100	90–100	70–90	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Low.
100	95–100	85–100	75–95	0. 06–0. 2	0. 16–0. 19	6. 6–7. 8		High	High	Moderate.
100	95–100	85–100	75–95	0. 2–0. 6	0. 11–0. 14	7. 4–8. 4	2–4	Moderate or high.	High	Moderate.
100	100	95–100	90–100	0. 6–2. 0	0. 19–0. 22	7. 4–7. 8		Low	Low	Low.
100	100	95–100	90–100	0. 6–2. 0	0. 17–0. 20	7. 4–7. 8		Low	Low	Low.
100	95–100	90–100	90–95	0. 06–0. 2	0. 11–0. 16	7. 9–8. 4		High	High	Moderate.
100	100	90–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 1–7. 3		Low	High	Low.
100	100	95–100	85–95	0. 02–0. 2	0. 10–0. 15	7. 4–7. 8	2–4	High	High	High.
100	100	95–100	75–95	0. 06–0. 2	0. 08–0. 13	8. 5–9. 0	4–16	High	High	High.
100	100	95–100	70–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Low	Low.
100	100	95–100	85–95	0. 6–2. 0	0. 19–0. 22	7. 4–7. 8		Moderate	Moderate	Low.
100	100	95–100	85–95	0. 6–2. 0	0. 17–0. 20	7. 4–8. 4		Moderate	Moderate	Low.
100	95–100	90–100	70–85	0. 2–0. 6	0. 17–0. 20	7. 9–8. 4	2–4	Moderate or high.	Moderate	Moderate.
100	100	95–100	90–100	0. 06–0. 2	0. 14–0. 17	7. 4–7. 8	>16	Moderate	High	High.
100	100	85–100	85–95	0. 06–0. 2	0. 08–0. 13	7. 4–9. 0	>16	High	High	High.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Gettys: GeE	>3½	>10	0–3	Clay loam	CL or ML–CL	A–7 or A–6
			3–60	Clay loam	ML–CL, CL, or CH	A–7
*Glenham: GhC	>5	>10	0–6	Silt loam	ML or CL	A–6
			6–9	Clay loam	CL	A–6 or A–7
			9–34	Clay loam	CL	A–6 or A–7
			34–60	Clay loam	CL	A–6 or A–7
For Highmore part of GhC, see Highmore series.						
*Highmore: HeA, HgA, HgB, HkA, HkB, HlB, HmA.	>5	>10	0–7	Silt loam	ML–CL	A–6
			7–15	Silty clay loam	CL or ML–CL	A–6 or A–7
			15–30	Silty clay loam	CL or ML–CL	A–6 or A–7
			30–42	Silt loam	ML or CL	A–6 or A–7
			42–60	Loam	ML or CL	A–6 or A–7
For DeGrey part of HgA and HgB, see DeGrey series; for Eakin part of HkA and HkB, see Eakin series; for Glenham part of HlB, see Glenham series; for Walke part of HmA, see Walke series.						
*Hoven: Hn, Ho [1]	>5	>5	0–6	Silt loam	ML or ML–CL	A–4 or A–6
			6–28	Clay	CH or MH	A–7
			28–60	Silty clay loam	CL or MH	A–7 or A–6
For Onita part of Ho, see Onita series.						
Hurley: HuB [1]	1½–3½	>10	0–2	Silt loam	ML	A–4 or A–6
			2–7	Clay	CH	A–7
			7–34	Clay	CH	A–7
			34–60	Shale.		
*Java: JbD, JgC	>5	>10	0–3	Loam	ML or ML–CL	A–6 or A–4
			3–8	Clay loam	CL or ML–CL	A–6 or A–7
			8–34	Clay loam	CL or ML–CL	A–6 or A–7
			34–60	Loam	ML or ML–CL	A–6 or A–7
For Betts part of JbD, see Betts series; for Glenham part of JgC, see Glenham series.						
Jerauld: JlA [1]	>5	>5	0–3	Silt loam	ML or CL	A–4 or A–6
			3–10	Clay	CH or MH	A–7
			10–60	Clay	CH or MH	A–7
Lakoma	1½–3½	>10	0–6	Clay	CH	A–7
			6–28	Clay	CH	A–7
			28–60	Shale.		
Mapped only with Opal and Sansarc soils.						
Lowry: LoA, LoB, LoC, LuB, LuC	>3½	>10	0–14	Silt loam	ML or ML–CL	A–4 or A–6
			14–51	Silt loam	ML or ML–CL	A–4 or A–6
			51–60	Loam	ML or ML–CL	A–4 or A–6
No valid estimates can be made for Urban land part of LuB and LuC.						
Macken: Ma	>5	>5	0–24	Silty clay	CL or CH	A–7
			24–60	Silty clay	CL or CH	A–7
Millboro: MbA	>5	>10	0–7	Silty clay loam	CL	A–7
			7–15	Silty clay	CH	A–7
			15–60	Clay	CH	A–7
Mosher: MoA [1]	>5	>5	0–8	Silt loam	ML or ML–CL	A–4 or A–6
			8–11	Silty clay	CH	A–7
			11–60	Stratified silty clay loam, clay loam, and silty clay.	CL or CH	A–7
Munjor: Mu	>5	5–10	0–37	Fine sandy loam	SC or SM	A–4 or A–2
			37–60	Stratified silty clay loam and loam.	ML or CL	A–4 or A–6

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	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
				In./hr.	*In./in. of soil*	*pH*	*Mmho/cm.*			
95–100	90–100	75–95	70–85	0. 6–2. 0	0. 19–0. 22	7. 4–7. 8		Moderate	Moderate	Low.
95–100	90–100	75–95	60–95	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4		Moderate or high.	Moderate	Moderate.
100	95–100	90–100	70–90	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Low	Low.
100	95–100	85–100	70–85	0. 6–2. 0	0. 19–0. 22	7. 4–7. 8		Moderate	Moderate	Low.
100	90–100	85–100	70–85	0. 6–2. 0	0. 17–0. 20	7. 4–9. 0		Moderate	Moderate	Moderate.
100	90–100	80–100	70–85	0. 2–0. 6	0. 17–0. 20	7. 4–9. 0		Moderate	Moderate	Moderate.
100	100	95–100	85–95	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Low	Low.
100	100	95–100	85–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 8		Moderate	Moderate	Low.
100	95–100	95–100	85–100	0. 6–2. 0	0. 17–0. 20	7. 4–8. 4		Moderate	Moderate	Low.
100	95–100	85–100	75–95	0. 6–2. 0	0. 17–0. 20	7. 9–8. 4		Moderate	Moderate	Low.
100	90–100	85–95	60–85	0. 6–2. 0	0. 16–0. 18	7. 9–8. 4		Low or moderate.	Moderate	Low.
100	95–100	85–100	75–100	0. 6–2. 0	0. 19–0. 22	6. 1–7. 3		Moderate	High	Low.
100	95–100	90–100	90–100	<0. 06	0. 10–0. 15	7. 9–9. 0		High	High	High.
100	95–100	90–100	85–95	0. 06–0. 2	0. 14–0. 17	8. 5–9. 0	2–4	Moderate or high.	High	High.
100	100	95–100	85–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Low.
100	100	95–100	85–95	<0. 06	0. 07–0. 11	6. 6–8. 4	4–8	High	High	High.
100	100	95–100	85–95	<0. 06	0. 05–0. 09	7. 9–9. 0	4–8	High	High	High.
100	95–100	85–95	60–90	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3		Low	Low	Low.
100	95–100	85–95	70–90	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Moderate	Moderate	Low.
100	95–100	85–95	70–90	0. 6–2. 0	0. 17–0. 20	7. 9–8. 4		Moderate	Moderate	Moderate.
100	95–100	85–95	60–90	0. 2–0. 6	0. 16–0. 18	7. 9–9. 0		Low or moderate.	Low or moderate.	Moderate.
95–100	85–100	85–95	70–90	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Moderate.
100	90–100	90–100	85–95	<0. 06	0. 07–0. 11	7. 9–8. 4		High	High	High.
100	90–100	90–100	85–95	<0. 06	0. 05–0. 09	7. 9–9. 0	4–8	High	High	High.
100	100	95–100	90–100	0. 2–0. 6	0. 10–0. 14	7. 4–8. 4		High	High	Moderate.
100	100	95–100	90–100	0. 06–0. 2	0. 08–0. 12	7. 4–8. 4		High	High	Moderate.
100	100	95–100	70–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 8		Low	Low	Low.
100	100	95–100	70–100	0. 6–2. 0	0. 17–0. 20	7. 9–8. 4		Low	Moderate	Low.
100	90–100	85–100	60–100	0. 6–2. 0	0. 16–0. 18	7. 9–8. 4		Low	Moderate	Low.
100	95–100	95–100	85–95	0. 06–0. 2	0. 10–0. 14	6. 1–7. 3		High	High	Moderate.
100	95–100	95–100	85–95	0. 06–0. 2	0. 08–0. 12	7. 4–8. 4		High	High	Moderate.
100	100	95–100	90–100	0. 2–0. 6	0. 19–0. 22	6. 6–7. 3		Moderate	Moderate	Low.
100	100	90–100	85–95	0. 06–0. 2	0. 10–0. 14	6. 6–7. 8		High	High	Low.
100	100	90–100	85–95	0. 06–0. 2	0. 08–0. 12	7. 4–8. 4		High	High	Moderate.
100	100	95–100	70–90	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3		Low	Low	Low.
100	100	90–100	75–90	<0. 06	0. 07–0. 11	7. 9–8. 4		High	High	Moderate.
100	100	90–100	75–90	0. 06–0. 2	0. 11–0. 14	7. 9–9. 0	4–8	High	High	Moderate.
100	95–100	65–85	30–50	2. 0–6. 0	0. 12–0. 15	7. 9–8. 4		Low	Low	Low.
90–100	90–100	85–100	50–70	0. 6–2. 0	0. 16–0. 18	7. 9–8. 4		Moderate	Moderate	Low.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal water table		Dominant USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
*Oahe: OaC	>5	>10	0–11	Loam	ML or ML–CL	A–4
			11–17	Loam	ML or ML–CL	A–4
			17–24	Gravelly loam	SM or ML	A–4
			24–60	Sand and gravel	SM or GM	A–2
For Orton part of OaC, see Orton series.						
*Oko: OcB, OcC, OdC	>5	>10	0–5	Clay loam	CL	A–6
			5–60	Clay	CH	A–7
For Jerauld part of OdC, see Jerauld series.						
*Onita: OnA, OoA	>5	>10	0–15	Silt loam	ML or CL	A–6
			15–29	Silty clay loam	CL or CH	A–7
			29–54	Silty clay loam	CL or CH	A–6 or A–7
			54–60	Clay loam	CL or CH	A–6 or A–7
For Hoven part of OoA, see Hoven series.						
*Opal: OpB, OpC, OrD	1½–3½	>10	0–10	Clay	CH	A–7
			10–28	Clay	CH	A–7
			28–60	Shale.		
For Lakoma part of OrD, see Lakoma series.						
Orton	>5	>10	0–3	Loam	ML–CL	A–4
			3–24	Fine sandy loam	ML–CL or SM	A–4
			24–60	Sand and gravel	GW, GC, or SM	A–2 or A–1
Mapped only with Oahe and Schamber soils.						
*Peno: PeD, PnD	>5	>10	0–3	Clay loam	ML or ML–CL	A–6 or A–7
			3–8	Clay loam	ML, CL, or CH	A–7 or A–6
			8–60	Clay loam	CL, MH, or CH	A–7 or A–6
For Gettys part of PeD, see Gettys series; for Swanboy part of PnD, see Swanboy series.						
*Promise: PrA, PrB, PsA	>3½	>10	0–14	Clay	MH or CH	A–7
			14–60	Clay	MH or CH	A–7
For Mosher part of PsA, see Mosher series.						
*Raber: RaA, RaB, RbC, RdC	>5	>10	0–4	Loam	ML or ML–CL	A–6 or A–7
			4–7	Clay loam	CL or CH	A–7 or A–6
			7–60	Clay loam	CL or CH	A–6 or A–7
For Cavo part of RaA and RaB, see Cavo series; for Peno part of RbC, see Peno series; for Oko part of RdC, see Oko series.						
*Ree: ReA, ReB, RmA	>5	>10	0–6	Loam	ML or ML–CL	A–4 or A–6
			6–13	Clay loam	CL	A–6
			13–36	Clay loam	CL	A–6
			36–50	Loam	ML or ML–CL	A–6 or A–4
			50–60	Sand and gravel	SC or GC	A–2 or A–4
For Mosher part of RmA, see Mosher series.						
Rough broken land: Ro.						
No valid estimates can be made.						
*Sansarc: SaE, ScE, Sd	<1½	>10	0–16	Clay	CH or MH–CH	A–7
			16–60	Shale.		
For Gettys part of SaE, see Gettys series; for Lakoma part of ScE, see Lakoma series. No valid estimates can be made for Shale outcrop part of Sd.						

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Salinity	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
				In./hr.	*In./in. of soil*	*pH*	*Mmho/cm.*			
85–100	75–95	65–85	50–70	0. 6–2. 0	0. 18–0. 20	6. 6–7. 8		Low	Low	Low.
85–100	75–95	65–85	50–70	0. 6–2. 0	0. 16–0. 18	7. 9–8. 4		Low	Low	Low.
70–90	70–90	70–85	35–60	2. 0–6. 0	0. 08–0. 10	7. 9–8. 4		Low	Moderate	Low.
30–50	20–45	15–40	5–30	6. 0–20. 0	0. 03–0. 06	7. 9–8. 4		Low	Moderate	Low.
95–100	90–100	80–95	70–85	0. 2–0. 6	0. 16–0. 19	7. 4–7. 8		Moderate	Moderate	Low.
95–100	90–100	80–95	70–85	0. 06–0. 2	0. 08–0. 12	7. 9–8. 4		High	High	Moderate.
100	95–100	95–100	90–100	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Low.
100	95–100	95–100	85–100	0. 2–0. 6	0. 16–0. 19	7. 4–7. 8		Moderate or high.	High	Low.
100	95–100	95–100	90–95	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4		Moderate or high.	High	Low.
100	100	95–100	75–95	0. 2–0. 6	0. 14–0. 17	7. 9–9. 0		Moderate or high.	High	Low.
100	100	95–100	90–100	<0. 06	0. 10–0. 14	6. 6–7. 3		High	High	Low.
100	100	95–100	90–100	<0. 06	0. 08–0. 12	7. 4–8. 4		High	High	Moderate.
95–100	85–95	60–80	50–70	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3		Low	Low	Low.
95–100	85–95	60–80	50–70	2. 0–6. 0	0. 12–0. 15	7. 4–8. 4		Low	Low	Low.
30–50	20–40	10–30	0–5	6. 0–20. 0	0. 03–0. 06	7. 9–8. 4		Low	Low	Low.
95–100	90–100	80–90	70–80	0. 6–2. 0	0. 19–0. 22	6. 6–7. 3		Moderate	Moderate	Low.
95–100	95–100	85–95	70–85	0. 2–0. 6	0. 16–0. 19	7. 4–8. 4		High	Moderate	Low.
95–100	95–100	85–95	65–75	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4		High	High	Moderate.
100	100	90–100	85–100	0. 06–0. 2	0. 10–0. 14	7. 4–8. 4		High	High	Low.
100	100	90–100	90–100	0. 02–0. 2	0. 08–0. 12	7. 9–8. 4		High	High	Moderate.
95–100	90–100	85–95	65–85	1. 2–2. 0	0. 18–0. 20	6. 6–7. 3		Low or moderate.	Low	Low.
95–100	90–100	90–100	70–80	0. 2–0. 6	0. 16–0. 19	7. 4–7. 8		High	Moderate	Low.
95–100	90–100	90–100	70–80	0. 2–0. 6	0. 14–0. 17	7. 9–8. 4		High	Moderate	Moderate.
100	90–100	90–100	60–100	1. 2–2. 0	0. 18–0. 20	6. 6–7. 3		Low	Low	Low.
100	90–100	85–95	70–90	0. 6–1. 2	0. 19–0. 22	6. 6–7. 3		Moderate	Moderate	Low.
100	90–100	85–95	70–90	0. 6–1. 2	0. 17–0. 20	7. 4–8. 4		Moderate	Moderate	Low.
100	90–100	80–90	60–75	0. 6–1. 2	0. 16–0. 18	7. 9–8. 4		Low	Moderate	Low.
40–60	30–50	25–50	20–40	6. 0–20. 0	0. 03–0. 06	7. 9–8. 4		Low	Moderate	Low.
100	95–100	90–100	85–100	0. 06–0. 2	0. 08–0. 12	7. 4–8. 4		High	High	Moderate.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	Classification		
	Befrock	Seasonal water table		Dominant USDA texture	Unified	AASHO
	ft.	ft.	in.			
*Schamber: Sf	>5	>10	0–7	Gravelly sandy loam.	SM	A–2 or A–4
			7–60	Sand and gravel	GM or GP	A–1 or A–2
For Orton part of Sf, see Orton series.						
Shale land: Sh. No valid estimates can be made.						
Sully: SuA, SuC, SuD, SuE	>5	>10	0–3	Silt loam	ML	A–4
			3–60	Silt loam	ML or ML–CL	A–4 or A–6
Swanboy: SwB, Sx	>3½	>10	0–60	Clay	CH or MH–CH	A–7
No valid estimates can be made for Slickspots part of Sx.						
Walke [1]	>5	>10	0–7	Silt loam	ML	A–6 or A–7
			7–15	Silty clay loam	CL or CH	A–7
			15–36	Silty clay loam	CL or CH	A–7
			36–60	Clay loam	CL	A–7
Mapped only with DeGrey and Highmore soils.						

[1] Exchangeable sodium >15 percent in subsoil or substrata.

TABLE 6.—*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 in such mapping units may have different

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets
*Agar: AgA, AgB, AkB	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: low or moderate shrink-swell potential; moderate potential frost action.	Slight	Severe: AASHO group index more than 8.
For Eakin part of AkB, see Eakin series.						
Alluvial land: As, Au, Aw. No interpretations. Material too variable.						
Betts: BeE	Severe: moderately slow permeability in underlying material.	Severe: slope more than 6 percent.	Moderate if slopes are 9 to 15 percent, severe if more than 15 percent.	Moderate if slopes are 9 to 15 percent, severe if more than 15 percent.	Slight if slopes are less than 15 percent, moderate if 15 to 25 percent, severe if more than 25 percent.	Severe: AASHO group index more than 8.
Bon: Bo	Severe: water table at a depth of 4 to 10 feet; subject to flooding.	Severe: subject to occasional flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to occasional flooding.
Canning: CaA, CaB	Slight [2]	Severe: rapid permeability in substratum.	Severe: 20 to 40 inches deep over sand and gravel.	Slight	Severe: [2] rapid permeability at a depth of 20 to 40 inches.	Slight

See footnotes at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Available Permeability	water capacity	Reaction	Salinity	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
				in./hr.	*in./in. of soil*	*pH*	*Mmho/cm.*			
60–85	50–70	30–50	25–40	2. 0–6. 0	0. 08–0. 10	7. 4–7. 8		Low	Low	Low.
40–60	25–40	20–40	0–30	6. 0–20. 0	0. 03–0. 06	7. 9–8. 4		Low	Low	Low.
100	100	90–100	90–95	1. 2–2. 0	0. 19–0. 22	7. 4–7. 8		Low	Low	Low.
100	100	90–100	85–100	0. 6–2. 0	0. 17–0. 20	7. 4–8. 4		Low	Moderate	Low.
100	95–100	90–100	90–100	<0. 06	0. 05–0. 09	7. 9–9. 0		High	High	Moderate.
100	95–100	90–100	85–95	1. 2–2. 0	0. 19–0. 22	6. 6–7. 3		Low	Moderate	Low.
100	95–100	90–100	85–95	0. 06–0. 2	0. 16–0. 19	6. 6–7. 8		High	High	Low.
100	95–100	90–100	85–95	0. 2–0. 6	0. 11–0. 14	7. 4–8. 4		High	High	Low.
100	90–100	85–100	70–90	0. 2–0. 6	0. 11–0. 14	7. 9–8. 4	2–4	High	High	Moderate.

interpretations

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

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: CL material; plasticity index more than 15.	Unsuitable	Good	Moderate permeability.	Medium or low shear strength; fair compaction characteristics.	Moderate permeability.	High available water capacity.	Uniform slope; moderate permeability.
Poor: AASHO group index more than 8.	Unsuitable	Poor: thin surface soil.	Steepness limits reservoir capacity; moderately slow permeability in underlying material.	Medium or low shear strength; fair or poor compaction characteristics.	Steep	Unsuitable: steep	Steep; numerous stones in some areas.
Fair: low or moderate shrink-swell potential.	Unsuitable	Good	Moderate permeability; water table at a depth of 4 to 10 feet.	Medium or low shear strength; fair or good compaction characteristics.	Subject to stream overflow; water table at a depth of 4 to 10 feet.	Subject to occasional flooding; nearly level; deep root zone.	Nearly level; structures generally not needed.
Fair in surface layer and subsoil, good in underlying material	Good below a depth of 2 to 4 inches.	Good	Rapid permeability in substratum.	Good or fair compaction characteristics; medium shear strength.	Rapid permeability at a depth of 2 to 4 inches.	Depth to gravel limits amount of leveling; low or moderate available water capacity.	Rapid permeability in substratum.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets
*Cavo: CdA For Demky part of CdA, see Demky series.	Severe: slow or very slow permeability.	Slight if slopes are less than 2 percent, moderate if 2 to 5 percent.	Moderate: clay loam texture.	Severe: high shrink-swell potential.	Moderate: clay loam texture.	Severe: AASHO group index more than 8; CL material with plasticity index more than 15.
Chantier: ChC	Severe: very slow permeability; bedded shale at a depth of 12 to 20 inches.	Severe: shale at a depth of 12 to 20 inches; possible seepage.	Severe: shale at a depth of 12 to 20 inches.	Severe: high shrink-swell potential; shale at a depth of 12 to 20 inches.	Severe: clay; shale at a depth of 12 to 20 inches.	Severe: shale at a depth of 12 to 20 inches; high shrink-swell potential.
Cut and fill land: Cu. No interpretations. Material too variable.						
*DeGrey: DeA For Walke part of DeA, see Walke series.	Severe: slow or very slow permeability.	Slight if slopes are less than 2 percent, moderate if 2 to 5 percent.	Moderate: clay loam subsoil and substratum.	Severe: high shrink-swell potential.	Moderate: clay loam substratum.	Severe: AASHO group index more than 8.
*Demky: DkA For Cavo part of DkA, see Cavo series.	Severe: slow permeability.	Slight	Moderate: clay loam.	Moderate or severe: moderate or high shrink-swell potential.	Moderate: clay loam.	Severe: AASHO group index more than 8.
Dorna: Do, Dr	Severe: slow permeability below a depth of 24 inches.	Slight	Severe below a depth of 2 feet; silty clay.	Severe: high shrink-swell potential in substratum.	Severe: silty clay below a depth of 2 feet.	Severe: high shrink-swell potential in substratum.
*Durrstein: Du For Egas part of Du, see Egas series.	Severe: high water table; slow or very slow permeability.	Slight: severe if flood waters are likely to enter or damage lagoon.	Severe: high water table; subject to flooding.	Severe: water table at a depth of 3 to 10 feet; subject to flooding.	Severe: [2] subject to flooding; high water table.	Severe: poorly drained; water table at a depth of 3 to 10 feet; subject to flooding in periods of high runoff; high frost-heave potential.
*Eakin: ErA, ErB, ErC For Raber part of ErA, ErB, and ErC, see Raber series.	Severe: moderately slow permeability in substratum.	Moderate if slopes are less than 6 percent, severe if more than 6 percent.	Moderate: clay loam texture in substratum.	Moderate: CL material with plasticity index more than 15, moderate or high shrink-swell potential.	Moderate: silty clay loam and clay loam texture.	Severe: AASHO group index more than 8; moderate or high shrink-swell potential.
Egas Mapped only with Durrstein soils.	Severe: water table at a depth of 2 to 5 feet; subject to flooding.	Severe: high water table; subject to flooding.	Severe: high water table; subject to flooding.	Severe: water table at a depth of 2 to 5 feet; subject to flooding.	Severe: subject to flooding; silty clay texture.	Severe: poorly drained, subject to flooding, high shrink-swell potential.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index more than 8, moderate or high shrink-swell potential.	Unsuitable	Poor: less than 8 inches thick.	Slow or very slow permeability; good sites for excavated ponds.	Medium or low shear strength; fair to good compaction characteristics.	Slow or very slow permeability; claypan subsoil.	Very slow water intake rate; claypan subsoil; moderate available water capacity; high sodium content.	Slow or very slow permeability; claypan subsoil.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: clay	Very slow permeability; possible seepage in shale fractures; shale at a depth of 12 to 20 inches.	Fair or poor compaction characteristics; medium or low shear strength.	Bedded shale at a depth of 12 to 20 inches.	Not suitable; very slow permeability; shallow to shale; moderately saline.	Shale at a depth of 12 to 20 inches.
Poor: AASHO group index more than 8.	Unsuitable	Poor: less than 8 inches thick.	Slow or very slow permeability; poorly defined drainage makes collection of runoff difficult.	Medium or low shear strength; fair or good compaction characteristics.	Slow or very slow permeability; claypan subsoil.	Not suitable; slow or very slow permeability; high sodium content in subsoil or substrata.	Slow or very slow permeability; claypan subsoil.
Poor: AASHO group index more than 8; high shrink-swell potential.	Unsuitable	Good in upper 8 inches. Fair below a depth of 8 inches; clay loam.	Slow permeability; topography limits collection of runoff in places.	Fair or poor compaction characteristics; medium or low shear strength.	Slow permeability; compact clayey subsoil.	Slow permeability; claypan subsoil; high sodium content in substratum.	Nearly level topography; slow permeability.
Fair in upper 2 feet. Poor below a depth of 2 feet; high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Good	Slow permeability in substratum; nearly level.	Fair or poor stability and compaction characteristics; high compressibility and shrink-swell potential.	Slow permeability in substratum.	Moderate or high available water capacity; slow water intake rate in underlying material.	Long, uniform slopes; moderate permeability in upper 24 inches.
Poor: high shrink-swell potential; poorly drained.	Unsuitable	Poor: silty clay; poorly drained.	Water table at a depth of 3 to 10 feet; good sites for water table dugouts.	Fair or poor compaction characteristics; high compressibility and shrink-swell potential.	Subject to stream overflow; high water table.	Fine texture; poorly drained; claypan subsoil; water table at a depth of 3 to 10 feet.	Level topography; generally not applicable.
Poor: AASHO group index more than 8; moderate or high shrink-swell potential.	Unsuitable	Good in upper 7 inches, fair below; silty clay loam texture.	Moderate permeability in subsoil; moderately slow permeability in substratum.	Fair or good compaction characteristics; medium or high compressibility; medium or low shear strength.	Moderately slow permeability in substratum; moderately fine texture.	High available water capacity, slow water intake rate, possible salt concentration in substratum.	Moderate permeability in soil; mostly smooth; plane, or convex slopes.
Poor: poorly drained water table at a depth of 2 to 5 feet.	Unsuitable	Poor: high soluble salts.	Good site for dug ponds; water table at a depth of 2 to 5 feet; water has high salt content in places.	Fair or poor stability and compaction characteristics.	High water table; subject to stream overflow.	High salinity, poorly drained.	Level bottom lands, usually not applicable.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets
Gettys: GeE	Severe: moderately slow permeability; slope.	Severe: slopes of more than 6 percent.	Moderate if slopes are 9 to 15 percent, severe if more than 15 percent.	Severe: moderate or high shrink-swell potential; steep.	Moderate if slopes are 15 to 25 percent clay loam texture; severe if slopes are more than 25 percent.	Severe: AASHO group index more than 8.
*Glenham: GhC For Highmore part of GhC, see Highmore series.	Severe: moderately slow peremability in substratum.	Slight if slopes are less than 2 percent; moderate if 2 to 6 percent, severe if more than 6 percent.	Moderate: clay loam texture.	Moderate: CL material with plasticity index more than 15.	Moderate: clay loam texture.	Severe: AASHO group index more than 8.
*Highmore: HeA, HgA, HgB, HkA, HkB, HlB, HmA. For DeGrey part of HgA, and HgB, see DeGrey series for Eakin part of HkA, and HkB, see Eakin seis; for Glenham part of HlB, see Glenham series; for Walker part of HmA, see Walke series.	Moderate: moderate permeability.	Moderate if slopes are less than 5 percent; severe if more than 5 percent.	Slight	Moderate: silty clay loam texture in subsoil.	Slight or moderate: silty clay loam or clay loam texture in some places.	Severe: AASHO group index more than 8.
*Hoven: Hn, Ho For Onita part of Ho, see Onita series.	Severe: very slow permeability; frequent ponding.	Severe: frequent ponding; slight if water not likely to enter or damage lagoon.	Severe: frequent ponding; clay texture.	Severe: high shrink-swell potential; frequent ponding.	Severe: poorly drained; frequent ponding; clay texture.	Severe: poorly drained; frequent ponding; AASHO group index more than 8.
Hurley: HuB	Severe: very slow permeability; shale at a depth of 20 to 40 inches.	Moderate or severe: shale at a depth of 20 to 40 inches; clay texture.	Severe: shale at a depth of 20 to 40 inches; clay texture.	Severe: high shrink-swell potential; shale at a depth of 20 to 40 inches.	Severe: clay texture; shale at a depth of 20 to 40 inches.	Severe: AASHO group index more than 8; high shrink-swell potential.
*Java: JbD, JgC For Betts part of JbD, see Betts series; for Glenham part of JgC, see Glenham series.	Severe: moderately slow permeability in substratum.	Moderate if slopes are 2 to 6 percent, severe if more than 6 percent.	Moderate: clay loam texture.	Moderate: moderate shrink-swell potential.	Moderate: clay loam texture.	Severe: AASHO group index more than 8.
Jerauld: JlA	Severe: very slow permeability.	Slight if slopes are less than 2 percent; moderate if 2 to 6 percent; severe if more than 6 percent.	Severe: clay texture	Severe: high shrink-swell potential.	Severe: clay texture	Severe: high shrink-swell potential; AASHO group index more than 8.
Lakoma Mapped only with Opal and Sansarc soils.	Severe: slow permeability; shale at a depth of 20 to 40 inches.	Severe: slopes of more than 9 percent, shale at a depth of 20 to 40 inches.	Severe: clay texture; shale at a depth of 20 to 40 inches.	Severe: high shrink-swell potential.	Severe: clay texture; shale at a depth of 20 to 40 inches.	Severe: high shrink-swell potential; AASHO group index more than 8.
Lowry: LoA, LoB, LoC, LuB, LuC. No interpretations for Urban land part of LuB and LuC.	Slight	Moderate if slopes are less than 5 percent; severe if more than 5 percent; moderate permeability.	Slight	Slight	Slight	Moderate: AASHO group index of 4 to 8.
Macken: Ma	Severe: slow permeability; frequent ponding.	Severe: frequent ponding.	Severe: frequent ponding.	Severe: high shrink-swell potential; frequent ponding.	Severe: poorly drained; frequent ponding.	Severe: frequent ponding; high shrink-swell potential; AASHO group index more than 8.
Millboro: MbA	Severe: slow permeability.	Slight	Severe: silty clay and clay texture in subsoil and substratum.	Severe: high shrink-swell potential.	Severe: silty clay and clay texture.	Severe: high shrink-swell potential; AASHO group index of 8.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index more than 8.	Unsuitable	Poor: less than 8 inches thick; slopes more than 15 percent.	Moderately slow permeability, steepness affects storage capacity.	Fair to poor compaction characteristics; medium or low shear strength.	Steep convex slopes	Steepness; severe erosion hazard.	Steep.
Poor: AASHO group index more than 8.	Unsuitable	Good in upper 6 inches; fair below; clay loam texture.	Moderate permeability in subsoil; moderately slow permeability in substratum.	Fair or good compaction characterisitcs; medium or low shear strength.	Moderately slow permeability in substratum.	High available water capacity; slow water intake rate; deep root zone.	Plane to convex slopes; moderate permeability in subsoil.
Poor: AASHO group index more than 8, mostly CL materials with plasticity index more than 15.	Unsuitable	Good in upper 7 inches, fair below; silty clay loam texture.	Moderate permeability; may require sealing.	Fair or good stability and compaction characteristics.	Moderate permeability.	High available water capacity; moderately slow water intake rate.	Uniform slopes; moderate permeability.
Poor: poorly drained; AASHO group index more than 8.	Unsuitable	Poor: less than 8 inches thick; poorly drained.	Verys low permeability; good sites for dugouts.	Fair or poor compaction characteristics; medium or low shear strength.	Frequent ponding; generally lower than available outlets.	Poorly drained; claypan subsoil; frequent ponding.	Flat; poorly drained depressions; generally not applicable.
Poor: AASHO group index more than 8; high shrink-swell potential.	Unsuitable	Poor: less than 8 inches thick.	Bedded shale at a depth of 20 to 40 inches; shale fractures induce piping.	Fair or poor stability and compaction characteristics; medium or low shear strength.	Very slow permeability; claypan subsoil.	Very slow permeability; claypan with shale at a depth of 20 to 40 inches.	Very slow permeability; claypan subsoil; shale at a depth of 20 to 40 inches.
Poor: AASHO group index more than 8.	Unsuitable	Fair: mainly clay loam texture in upper 16 inches.	Moderate permeability in subsoil, moderately slow permeability in substratum.	Fair or good compaction characteristics.	Moderately slow permeability in substratum.	Short convex slopes; high available water capacity.	Mostly short convex slopes.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: clay texture.	Very slow permeability; generally nearly level slopes.	Fair or poor stability and compaction characteristics.	Very slow permeability in subsoil.	Claypan subsoil; very slow permeability.	Mostly nearly level slopes; very slow permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: clay texture.	Slow permeability; shale at a depth of 20 to 40 inches; possible seepage in shale fractures.	Fair or poor compaction characteristics.	Slow permeability; shale at a depth of 20 to 40 inches.	Low or very low available water capacity; very slow water intake rate; erosive.	Slopes of more than 9 percent; shale at a depth of 20 to 40 inches.
Fair: AASHO group index of 4 to 8.	Unsuitable [3]	Good	Moderate permeability; generally require sealing.	Fair or poor stability and compaction characteristics; subject to piping.	Moderate permeability.	High available water capacity; moderate permeability; deep root zone.	Uniform slopes; moderate permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: silty clay texture, poorly drained.	Closed depressions; good sites for dug ponds; slow permeability.	Fair or poor stability and compaction characteristics.	Slow permeability; frequent ponding.	Poorly drained depressions; frequent ponding.	Not applicable.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Fair in upper 7 inches, poor below; silty clay texture.	Slow permeability; nearly level terrain slightly limits storage capacity.	Fair or poor stability and compaction characteristics; high compressiblity.	Slow permeability in subsoil and substratum; nearly level.	Very slow water intake rate; low or moderate available water capacity.	Long uniform slopes; slow permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets
Mosher: MoA	Severe: very slow permeability in upper part of subsoil; slow permeability in substratum.	Slight	Severe: silty clay and clay texture.	Severe: high shrink-swell potential.	Severe: silty clay and clay texture.	Severe: high shrink-swell potential; AASHO group index more than 8.
Munjor: Mu	Slight [2] through severe, depending on depth to water table.	Severe: moderately rapid permeability.	Slight	Moderate: low or moderate shrink-swell potential in underlying material; high water table in some places.	Severe: [2] moderately rapid permeability.	Moderate: moderate potential frost action.
*Oahe: OaC For Orton part of OaC, see Orton series.	Slight [2]	Severe: rapid permeability below a depth of 20 inches.	Severe: loose sand and gravel at a depth of 20 to 40 inches.	Slight	Severe: [2] sand and gravel at a depth of 20 to 40 inches; rapid permeability.	Moderate: AASHO group index of 4 to 8.
*Oko: OcB, OcC, OdC For Jerauld part of OdC, see Jerauld series.	Severe: slow permeability.	Moderate if slopes are 2 to 5 percent, severe if more than 5 percent.	Severe: clay texture	Severe: high shrink-swell potential.	Severe: clay texture	Severe: AASHO group index more than 8; high shrink-swell potential.
*Onita: OnA, OoA For Hoven part of of OoA, see Hoven series.	Severe: moderately slow permeability.	Slight: run-in water not likely to enter lagoon or damage lagoons.	Moderate: periodically wet.	Severe: subject to run-in water from adjacent slopes.	Moderate: subject to run-in water from adjacent slopes.	Severe: AASHO group index more than 8; moderate or high shrink-swell potential.
*Opal: OpB, OpC, OrD For Lakoma part of OrD, see Lakoma series.	Severe: very slow permeability; shale at a depth of 20 to 40 inches.	Moderate if slopes are 2 to 5 percent, severe if more than 5 percent.	Severe: clay texture	Severe: high shrink-swell potential.	Severe: clay texture	Severe: AASHO group index more than 8; high shrink-swell potential.
Orton Mapped only with Oahe and Schamber soils.	Slight [2] if slopes are less than 9 percent, moderate if 9 to 15 percent, severe if more than 15 percent.	Severe: moderately rapid or rapid permeability in substratum.	Severe: loose sands and gravel at a depth of 20 to 40 inches.	Slight if slopes are less than 9 percent, moderate if 9 to 15 percent, severe if more than 15 percent.	Severe: [2] rapid permeability at a depth of 20 to 40 inches.	Moderate if slopes are less than 9 percent, severe if more than 9 percent.
*Peno: PeD, PnD For Gettys part of PeD, see Gettys series; for Swanboy part of PnD, see Swanboy series.	Severe: moderately slow permeability.	Moderate if slopes are less than 5 percent, severe if more than 5 percent.	Moderate: clay loam texture.	Severe: high shrink-swell potential.	Moderate: clay loam texture.	Severe: AASHO group index more than 8; high shrink-swell potential.
*Promise: PrA, PrB, PsA For Mosher part of PsA, see Mosher series.	Severe: slow or very slow permeability.	Slight if slopes are less than 2 percent, moderate if 2 to 5 percent.	Severe: clay texture	Severe: high shrink-swell potential.	Severe: clay texture	Severe: high shrink-swell potential; AASHO group index more than 8.
*Raber: RaA, RaB, RbC, RdC. For Cavo part of RaA, and RaB, see Cavo series; for Peno part of RbC, see Peno series; for Oko part of RdC, see Oko series.	Severe: moderately slow permeability.	Slight if slopes are less than 2 percent, moderate if 2 to 5 percent, severe if more than 5 percent.	Moderate: clay loam texture.	Severe: high shrink-swell potential.	Moderate: clay loam texture.	Severe: AASHO group index more than 8; high shrink-swell potential.

See footnotes at end of table.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: high shrink-swell potential.	Unsuitable	Poor: less than 8 inches over clayey texture.	Very slow permeability; nearly level slopes.	Fair or poor compaction characteristics; high compressibility.	Very slow permeability; claypan subsoil.	Very slow water intake rate; claypan subsoil; high sodium content.	Nearly level slopes; very slow permeability.
Fair; moderate potential frost action.	Unsuitable	Good	Moderately rapid permeability.	Good or fair compaction characteristics; slow permeability of compacted soil; subject to piping.	Moderately rapid permeability; high water table in some places.	Moderately rapid permeability; moderate or high available water capacity.	Nearly level; moderately rapid permeability.
Fair in upper 20 inches, good below.	Fair to good below a depth of 20 inches, depending on fines.	Good	Gravel and sand below a depth of 20 inches; rapid permeability.	Fair or good compaction characteristics of material in upper 20 inches.	Rapid permeability in substratum.	Low available water capacity; rapid permeability in substratum.	Sand and gravel at a depth of 20 to 40 inches limits cuts in places.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: clayey texture.	Slow permeability	Fair or poor compaction characteristics; high compressibility.	Slow permeability in subsoil and substratum.	Low or moderate available water capacity; very slow water intake rate.	Long, smooth convex slopes; slow permeability.
Poor: moderate or high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Good	Moderately slow permeability; good site for dugout.	Fair or good compaction characteristics; medium or high compressibility.	Moderately slow permeability in subsoil.	Nearly level; moderately slow permeability; high available water capacity.	Nearly level swales and drainageways.
Poor: AASHO group index more than 8; high shrink-swell potential.	Unsuitable	Poor: clay texture.	Shale at a depth of 20 to 40 inches; possible seepage.	Fair or poor compaction characteristics; high compressibility.	Very slow permeability; shale at a depth of 20 to 40 inches.	Very slow permeability; shale at a depth of 20 to 40 inches; low or very low available water capacity.	Very slow permeability; long smooth slopes; shale at a depth of 20 to 40 inches.
Good if slopes are less than 15 percent, fair if 15 to 25 percent, poor if more than 25 percent.	Good through poor, depending on percent of fines.	Fair: 8 to 16 inches thick.	Rapid permeability in substratum.	Fair or good compaction characteristics; medium shear strength; subject to piping.	Rapid permeability at a depth of 20 to 40 inches.	Moderately rapid permeability in soil, rapid permeability in substratum; low available water capacity.	Sand and gravel at a depth of 20 to 40 inches; moderately rapid permeability in soil.
Poor: AASHO group index more than 8; high shrink-swell potential.	Unsuitable	Fair: clay loam texture.	Moderately slow permeability; dug ponds have limited storage on steeper slopes.	Fair or good compaction characteristics; medium or low shear strength.	Moderately slow permeability; most slopes more than 5 percent.	Moderately slow permeability; most slopes more than 5 percent.	Smooth convex slopes; moderately slow permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Poor: clay texture.	Slow or very slow permeability; low seepage.	Fair to poor stability and compaction characteristics; high compressibility.	Slow or very slow permeability; clay texture.	Slow or very slow permeability; long uniform slopes.	Gentle, uniform slopes; slow or very slow permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable	Fair: clay loam texture below a depth of 4 inches.	Moderately slow permeability; nearly level to moderate slopes.	Fair or good stability and compaction; good resistance to piping.	Moderately slow permeability; clay loam texture.	Moderately slow permeability; most slopes are more than 2 per cent; moderate or high available water capacity.	Short irregular slopes in some areas; moderately slow permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary land fill [1]	Local roads and streets
*Ree: ReA, ReB, RmA. For Mosher part of RmA, see Mosher series.	Moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: clay loam texture.	Moderate: moderate shrink-swell potential in subsoil.	Moderate: clay loam texture in subsoil.	Severe: AASHO group index more than 8 in subsoil.
Rough broken land: Ro. No interpretations.						
*Sansarc: SaE, ScE, Sd. For Gettys part of SaE, see Gettys series; for Lakoma part of ScE, see Lakoma series. No interpretations for Shale outcrop part of Sd.	Severe: slow permeability; shale at a depth of 8 to 20 inches.	Severe: shallow to shale; most slopes are more than 6 percent.	Severe: clay texture.	Severe: high shrink-swell potential; shale at a depth of 8 to 20 inches.	Severe: clay texture.	Severe: high shrink-swell potential; shale at a depth of 8 to 20 inches.
*Schamber: Sf. For Orton part of Sf, see Orton series.	Moderate [2] if slopes are 9 to 15 percent, severe if more than 15 percent.	Severe: rapid permeability.	Severe: loose sand and gravel at a depth of less than 10 inches.	Moderate if slopes are 9 to 15 percent, severe if more than 15 percent.	Severe: rapid permeability; less than 10 inches to gravel.	Moderate if slopes are 9 to 15 percent, severe if slopes are more than 25 qercent.
Shale land: Sh. No interpretations.						
Sully: SuA, SuC, SuD, SuE.	Slight if slopes are less than 9 percent, moderate if 9 to 15 percent, severe if more than 15 percent.	Moderate if slopes are less than 6 percent, severe if more than 6 percent.	Slight.	Moderate: ML material; moderate if slopes are less than 15 percent, severe if more than 15 percent.	Slight if slopes are less than 15 percent, moderate if 15 to 25 percent, severe if more than 25 percent.	Slight if slopes are less than 9 percent, moderate if 9 to 15 percent, severe if more than 15 percent slopes.
Swanboy: SwB, Sx. No interpretations for Slickspots part of Sx.	Severe: very slow permeability.	Slight if slopes are less than 2 percent, moderate if slopes are 2 to 6 percent.	Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay texture.	Severe: high shrink-swell potential; AASHO, group index more than 8.
Walke. Mapped only with DeGrey and Highmore soils.	Severe: moderately slow permeability in substratum.	Slight.	Slight through subsoil; moderate in underlying glacial till.	Severe: high shrink-swell potential.	Moderate: silty clay loam or clay loam texture.	Severe: high shrink-swell potential; AASHO group index more than 8.

[1] Onsite study is needed of the underlying stratum, the water table, and the hazards of aquifer pollution and drain age into ground water in landfill deeper than 5 or 6 feet.

interpretations—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: AASHO group index more than 8 in subsoil material.	Unsuitable[2]---	Good to 6 inches, fair to 19 inches; clay loam texture.	Moderate permeability; some areas underlain by sand and gravel below a depth of 40 inches.	Fair or good stability and compaction characteristics.	Moderate permeability; nearly level to gently sloping.	Moderate permeability; nearly level to gently sloping; high available water capacity.	Uniform slopes; moderate permeability.
Poor: shale at a depth of 8 to 20 inches; high shrink-swell potential.	Unsuitable----	Poor: clay texture.	Shale at a depth of 8 to 20 inches; possible seepage in shale fractures.	High compressibility; fair or poor compaction characteristics.	Slow permeability; steep; shale at a depth of 8 to 20 inches.	Steep; slow permeability; very low available water capacity.	Steep; shale at a depth of 8 to 20 inches; slow permeability.
Slight if slopes are less than 15 percent, moderate if 15 to 25 percent, severe if more than 25 percent.	Poor through good, depending on percent fines.	Poor: thin surface.	Rapid permeability; high seepage.	Fair or good compaction characteristics; medium or high permeability of compacted soil material.	Rapid permeability---	Shallow over gravel; rapid permeability; very low or low available water capacity.	Gravel and sand at a depth less than 10 inches; slopes are more than 9 percent; rapid permeability.
Fair if slopes are less than 25 percent, severe if more than 25 percent; ML material plasticity index less than 15.	Unsuitable----	Good if slopes are less than 9 percent, fair if 9 to 15 percent, poor if more than 15 percent.	Moderate permeability; sealing generally needed.	Fair or poor stability and compaction characteristics; poor resistance to piping.	Moderate permeability; most slopes are more than 6 percent.	Nearly level to steep; moderate permeability; moderate water intake rate.	Erodible; nearly level to steep; moderate permeability.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable----	Poor: clay texture.	Very slow permeability.	Fair or poor stability and compaction characteristics; medium or low shear strength.	Very slow permeability.	Very slow permeability, salt accumulations in subsoil and substrata.	Very slow permeability; clay texture.
Poor: high shrink-swell potential; AASHO group index more than 8.	Unsuitable----	Good in upper 7 inches.	Moderately slow permeability in lower parts of subsoil and substratum; nearly level slopes make water collection difficult.	Fair or poor stability and compaction; medium or high compressibility.	Moderately slow permeability in lower parts of subsoil and substratum; nearly level.	Moderate or high available water capacity; slow permeability in upper part of subsoil; salt accumulations in underlying glacial till.	Long smooth slopes; nearly level.

[2] Possible pollution of underground water supplies.
[3] Possible source of sand and gravel at depths below 40 inches in the southeastern part of the county.

TABLE 7.—*Engineering*

[Tests performed by the South Dakota Department of Highways in cooperation with the U.S. Bureau of Public

Soil name and location	Parent material	Depth	Moisture density [1]	
			Maximum dry density	Optimum moisture
		Inches	*Percent*	*Percent*
Canning loam:				
2,520 feet north and 66 feet east of fence from southwest corner of sec. 28, T. 110 N., R. 75 W.	Old alluvium.	5–18	106	19
		30–60	117	13
Cavo silt loam:				
1,320 feet north and 60 feet east of fence from center of sec. 11, T. 111 N., R. 75 W.	Glacial till.	7–14	96	24
		31–60	104	20
Gettys clay loam:				
2,640 feet east and 686 feet south of northwest corner of sec. 20, T. 110 N., R. 75 W.	Clayey glacial till.	9–37	98	22
Highmore silt loam:				
1,220 feet northeast and 130 feet north perpendicular to fence along U.S. Highways 14 and 83 from north to south center fence line of sec. 2, T. 111 N., R. 78 W.	Silty glacial drift.	7–15	102	19
		20–30	107	16
		45–52	107	16
Java loam:				
1,584 feet north and 75 feet west of center of road from southeast corner of sec. 36, T. 111 N., R. 78 W.	Glacial till.	3–15	100	17
		15–60	107	17
Lowry silt loam:				
2,390 feet east and 30 feet north of road ditch from southwest corner of sec. 24, T. 112 N., R. 81 W.	Loess, mostly silts.	8–14	104	19
		21–34	104	18
Peno clay loam:				
218 feet south and 50 feet west of fence from northeast corner of sec. 20, T. 112 N., R. 74 W.	Clayey glacial till.	3–16	94	23
		16–32	99	22
		32–60	97	23

[1] Based on AASHO Designation: T 99–70, Method C (*1*).

[2] Mechanical analysis according to the AASHO Designation: T 88–70 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser

test data

Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than 0.005 mm.			AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)					
99	98	85	72	22	38	14	A–6(8)	ML–CL
100	80	35	14	4	22	2	A–1–b(0)	SM
100	97	94	85	40	50	25	A–7–6(16)	CL
98	96	87	67	33	48	25	A–7–6(13)	CL
96	95	87	72	41	49	21	A–7–6(12)	ML–CL
----------	100	98	93	35	43	18	A–7–6(12)	ML–CL
----------	----------	100	97	34	36	13	A–6(9)	ML–CL
100	99	95	79	28	36	13	A–6(9)	ML–CL
100	98	88	74	30	41	13	A–7–6(9)	ML
99	96	87	75	31	38	14	A–6(10)	ML–CL
----------	----------	100	97	23	34	11	A–6(8)	ML–CL
----------	----------	100	96	33	37	13	A–6(9)	ML–CL
98	96	89	73	42	48	17	A–7–5(12)	ML
99	97	92	76	45	52	25	A–7–6(16)	MH–CH
99	97	87	71	39	48	22	A–7–6(13)	ML–CL

than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are no suitable for naming textural classes for soils.

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given a borderline lassification. An example of borderline classification obtained by this use is ML–CL.

TABLE 8.—*Engineering test data for soil samples*

[Tests made by the South Dakota Department of Highways in cooperation with the U.S. Bureau of Public Roads, in accordance with for that

Soil series	Horizon	Number of samples tested	Mechanical analysis[1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Agar.	A	26	98–100	100	94–100	98	75–100	90
	B	59	97–100	99	93–100	98	81–100	91
	C	90	95–100	99	90–100	97	75–100	90
	IIC	8	76–100	93	56–100	83	23–95	59
	C[8]	4	95–100	99	86–100	94	79–100	91
Betts.	A	7	84–100	94	75–98	87	41–87	64
	B	5	88–100	96	79–100	91	49–98	74
	C	105	85–100	95	75–100	89	50–90	70
	IIC	2	75–100	91	0–100	60	0–80	26
	C[8]	3	98–100	99	93–98	95	74–95	85
Bon.	A	4	94–100	99	67–100	92	41–100	77
	B	4	----------	96	97–100	99	73–92	82
	C	9	98–100	99	91–100	97	23–100	68
Chantier.	A	2	98–100	100	94–100	98	90–97	94
	B	1	----------	100	----------	98	----------	96
	C	6	99–100	100	95–100	98	87–100	94
	C[8]	19	97–100	99	94–100	98	89–100	95
DeGrey.	A	3	98–100	99	95–99	97	86–93	90
	B	22	96–100	99	91–100	97	80–100	92
	C	11	96–100	99	92–100	97	75–100	90
Eakin.	A	15	98–100	99	92–100	96	73–99	86
	B	37	95–100	99	86–100	95	71–100	88
	C	13	92–100	97	82–100	92	62–99	80
	IIC	65	87–100	96	77–100	90	55–97	76
Egas.	C	2	87–100	96	60–100	87	44–100	81
Gettys.	A	2	69–100	90	64–100	83	67–70	69
	B	1	----------	100	----------	97	----------	88
	C	22	67–100	91	45–100	80	30–100	69
	IIC	1	----------	40	----------	33	----------	30
	C[8]	3	94–99	97	87–94	91	64–98	81
Glenham.	A	10	90–100	96	71–100	90	57–100	79
	B	5	95–100	99	85–100	93	64–93	78
	C	18	85–100	95	77–100	89	51–99	75
	IIC	1	----------	100	----------	100	----------	95
Highmore.	A	95	97–100	99	93–100	97	80–99	90
	B	257	95–100	99	90–100	96	74–100	88
	C	169	94–100	98	87–100	95	69–100	86
	IIC	8	95–99	97	86–98	92	67–86	77
Hoven.	A	1	----------	96	----------	92	----------	85
	B	10	98–100	100	94–100	98	81–99	90
	C	7	90–100	97	73–100	92	56–100	82
Hurley.	A	4	----------	100	93–99	96	74–99	87
	B	10	99–100	100	95–100	99	87–100	96
	C	29	97–100	99	94–100	98	74–100	91
	C[8]	18	96–100	99	86–100	98	79–100	94
Java.	A	1	----------	97	----------	87	----------	67
	B	3	94–100	98	88–99	94	70–95	83
	C	6	61–100	88	41–100	76	19–87	53

See footnotes at end of table.

taken along proposed highway routes in Hughes County and surrounding counties

standard procedures of the American Association of State Highway Officials (AASHO) (*1*). Dashed lines indicate that soils were not tested property]

Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [4]
Range	Average	Range	Average	AASHO [5] (old index)	AASHO [6] (new index)	Unified [7]	
34–47	41	12–19	15	A–7–6(10)	A–7–6(15)	ML-CL	5
35–46	41	12–27	19	A–7–6(12)	A–7–6(19)	CL	5
32–48	40	9–28	18	A–6(12)	A–6(17)	CL	5
20–83	52	3–50	26	A–7–6(13)	A–7–6(14)	CH	3
72–99	86	42–64	53	A–7–5(20)	A–7–5(57)	CH	1
31–47	39	7–21	14	A–6(7)	A–6(8)	ML–CL	5
33–47	40	6–26	16	A–6(10)	A–6(11)	ML–CL	5
27–54	40	9–34	21	A–6(11)	A–6(13)	CL	5
0–38	12	0–12	3	A–2–4(0)	A–2–4(0)	SM–SC	----
41–103	72	19–78	48	A–7–6(20)	A–7–6(45)	CH	1
23–63	43	8–32	20	A–7–6(13)	A–7–6(15)	CL	4
38–50	44	17–24	20	A–7–6(13)	A–7–6(17)	ML–CL	4
20–53	37	3–35	19	A–6(10)	A–6(11)	CL	6
66–69	68	36–53	44	A–7–6(20)	A–7–6(47)	CH	1
----	83	----	49	A–7–5(20)	A–7–5(57)	MH–CH	1
70–93	82	41–62	51	A–7–5(20)	A–7–5(57)	CH	1
74–117	96	47–82	64	A–7–5(20)	A–7–5(72)	CH	1
41–49	45	14–19	16	A–7–6(11)	A–7–6(17)	ML–CL	4
48–64	56	24–43	33	A–7–6(19)	A–7–6(34)	CH	3
31–65	48	12–43	27	A–7–6(17)	A–7–6(26)	CL	4
35–50	43	11–24	17	A–7–6(11)	A–7–6(16)	ML–CL	4
39–50	44	13–30	21	A–7–6(13)	A–7–6(20)	CL	4
40–59	49	21–37	28	A–7–6(17)	A–7–6(23)	CL	3
35–60	47	16–39	27	A–7–6(17)	A–7–6(20)	CL	4
44–117	81	25–81	53	A–7–6(20)	A–7–6(47)	CH	1
28–84	56	8–40	24	A–7–6(15)	A–7–6(17)	MH	3
----	59	----	27	A–7–5(19)	A–7–5(28)	MH	2
35–80	57	14–51	32	A–7–6(18)	A–7–6(22)	CH	3
----	63	----	39	A–2–7(3)	A–2–7(4)	GC	----
41–113	77	21–74	47	A–7–6(20)	A–7–6(43)	CH	1
31–51	41	6–30	18	A–7–6(11)	A–7–6(14)	CL	5
26–50	38	9–27	18	A–6(11)	A–6(13)	CL	6
35–51	43	15–30	22	A–7–6(14)	A–7–6(16)	CL	4
----	39	----	20	A–6(12)	A–6(20)	CL	5
36–48	42	9–25	17	A–7–6(11)	A–7–6(17)	ML–CL	5
37–52	44	16–32	23	A–7–6(14)	A–7–6(22)	CL	4
36–55	45	16–35	25	A–7–6(15)	A–7–6(22)	CL	4
35–60	48	18–38	27	A–7–6(17)	A–7–6(21)	CL	4
----	49	----	22	A–7–6(15)	A–7–6(21)	ML–CL	3
50–80	65	22–59	40	A–7–6(20)	A–7–6(41)	CH	2
36–75	55	17–43	30	A–7–6(19)	A–7–6(26)	CH	3
48–57	53	20–32	26	A–7–6(17)	A–7–6(25)	MH–CH	3
52–92	72	22–63	42	A–7–6(20)	A–7–6(49)	CH	1
40–81	61	20–54	36	A–7–6(20)	A–7–6(37)	CH	2
61–100	80	33–67	50	A–7–5(20)	A–7–5(55)	CH	1
----	41	----	16	A–7–6(9)	A–7–6(10)	ML–CL	5
37–55	46	11–26	18	A–7–6(13)	A–7–6(17)	ML–CL	4
29–45	37	12–25	18	A–6(7)	A–6(7)	CL	6

TABLE 8.—*Engineering test data for soil samples*

Soil series	Horizon	Number of samples tested	Mechanical analysis[1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Jerauld.	B	3	96–100	98	91–100	96	77–87	82
	C	8	98–100	99	92–100	97	80–100	91
Lakoma.	A	12	98–100	100	90–100	97	69–100	86
	B	23	99–100	100	95–100	98	86–100	94
	C	45	95–100	99	93–100	98	83–100	94
	C[8]	101	99–100	100	93–100	99	85–100	95
Lowry.	A	6	82–100	96	74–100	94	63–100	89
	B	29	99–100	100	93–100	98	63–100	87
	C	31	91–100	99	73–100	95	51–100	85
	IIC	9	38–100	83	0–100	59	0–96	40
	C[8]	4	96–100	99	89–100	96	60–100	84
Macken.	B	1	----------	100	----------	97	----------	94
	C	3	99–100	100	95–100	98	86–100	94
Millboro.	A	34	99–100	100	91–100	97	71–100	89
	B	94	99–100	100	93–100	98	82–100	92
	C	132	99–100	100	92–100	97	80–100	92
	IIC	9	----------	100	93–100	97	82–100	91
	C[8]	15	98–100	100	97–100	99	91–99	95
Mosher.	A	5	----------	100	98–100	99	66–100	83
	B	18	99–100	100	98–100	99	70–100	87
	C	8	99–100	100	99–100	100	75–100	89
	IIC	1	----------	55	----------	54	----------	47
Munjor.	C	1	----------	100	----------	100	----------	97
Oahe.	A	18	80–100	95	62–100	84	37–85	61
	B	33	74–100	93	55–100	82	28–91	60
	C	7	91–100	97	83–100	93	18–100	60
	IIC	61	36–99	68	12–82	47	0–55	25
Oko.	A	3	91–100	97	80–100	92	63–97	80
	B	3	99–100	100	94–100	97	86–96	91
	C	9	93–100	99	68–100	90	52–100	81
	IIC	2	98–100	100	82–100	94	70–100	86
Onita.	A	29	95–100	99	90–100	97	81–100	91
	B	76	96–100	99	91–100	97	75–100	89
	C	45	94–100	98	85–100	94	65–100	85
	IIC	1	----------	12	----------	8	----------	7
Opal.	A	51	95–100	100	94–100	98	84–100	93
	B	87	96–100	99	91–100	98	83–100	94
	C	131	99–100	100	96–100	99	89–100	96
	C[8]	263	97–100	100	93–100	99	86–100	96
Orton.	B	5	77–100	93	59–95	77	37–75	56
	C	4	39–100	73	10–78	44	75–31	19
	IIC	2	76–100	90	72–75	74	23–58	41
Peno.	A	12	96–100	99	86–100	93	57–91	74
	B	19	96–100	99	90–98	94	66–89	78
	C	18	74–100	94	62–100	88	46–100	74
Promise.	A	37	96–100	99	93–100	98	84–100	93
	B	110	97–100	99	92–100	98	85–100	95
	C	237	99–100	100	93–100	98	86–100	95
	C[8]	46	98–100	100	96–100	99	91–100	96

See footnotes at end of table.

taken along proposed highway routes in Hughes County and surrounding counties—Continued

Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [4]
Range	Average	Range	Average	AASHO [5] (old index)	AASHO [6] (new index)	Unified [7]	
49–74	61	31–50	40	A–7–6(20)	A–7–6(34)	CH	2
47–87	67	30–62	45	A–7–6(20)	A–7–6(46)	CH	2
38–89	63	11–57	33	A–7–6(20)	A–7–6(33)	MH–CH	2
46–85	65	21–54	37	A–7–6(20)	A–7–6(41)	CH	2
47–86	66	21–55	38	A–7–6(20)	A–7–6(42)	CH	2
51–101	76	28–67	47	A–7–6(20)	A–7–6(53)	CH	1
31–43	37	5–16	10	A–4(8)	A–4(10)	ML–CL	6
26–39	33	5–14	9	A–4(8)	A–4(8)	ML–CL	7
20–48	34	3–23	12	A–6(9)	A–6(10)	CL	7
4–55	30	0–23	9	A–4(1)	A–4(1)	SC	8
23–113	68	9–82	45	A–7–6(20)	A–7–6(41)	CH	1
----------	58	----------	32	A–7–6(20)	A–7–6(34)	CH	2
41–85	63	22–55	38	A–7–6(20)	A–7–6(41)	CH	2
39–61	50	13–34	23	A–7–6(16)	A–7–6(24)	ML–CL	3
44–75	59	18–52	34	A–7–6(20)	A–7–6(36)	CH	2
44–77	60	21–50	35	A–7–6(20)	A–7–6(30)	CH	2
59–81	70	30–53	41	A–7–6(20)	A–7–6(44)	CH	1
45–98	72	19–71	45	A–7–6(20)	A–7–6(50)	CH	1
27–58	42	3–34	18	A–7–6(12)	A–7–6(16)	CL	5
30–67	48	9–45	27	A–7–6(16)	A–7–6(25)	CL	4
22–59	41	1–40	20	A–7–6(13)	A–7–6(19)	CL	5
----------	41	----------	25	A–7–6(7)	A–7–6(7)	GC	4
----------	30	----------	3	A–4(8)	A–4(4)	ML	8
25–54	40	6–18	12	A–6(6)	A–6(6)	ML	5
22–49	36	4–24	14	A–6(7)	A–6(6)	ML–CL	6
0–72	36	0–40	17	A–6(8)	A–6(8)	CL	6
7–47	27	0–23	9	A–2–4(0)	A–2–4(0)	SC	----------
37–56	46	11–28	19	A–7–6(13)	A–7–6(17)	ML–CL	4
38–67	53	17–39	28	A–7–6(18)	A–7–6(29)	CH	3
41–65	53	27–37	32	A–7–6(19)	A–7–6(27)	CH	3
69–73	71	45–48	46	A–7–6(20)	A–7–6(44)	CH	1
34–50	42	11–24	17	A–7–6(11)	A–7–6(18)	ML–CL	5
37–60	48	14–40	26	A–7–6(16)	A–7–6(25)	CL	4
31–65	48	10–42	25	A–7–6(16)	A–7–6(23)	CL	4
----------	50	----------	26	A–2–7(0)	A–2–7(0)	GC	----------
45–79	62	18–46	32	A–7–5(20)	A–7–5(35)	MH–CH	2
53–88	71	29–58	43	A–7–6(20)	A–7–6(47)	CH	1
55–93	74	29–61	44	A–7–6(20)	A–7–6(51)	CH	1
56–98	77	30–65	47	A–7–6(20)	A–7–6(54)	CH	1
34–42	38	7–17	11	A–6(5)	A–6(5)	ML–CL	6
22–31	27	6–11	8	A–2–4(0)	A–2–4(0)	SC	----------
25–35	30	6–20	13	A–6(2)	A–6(2)	SC	8
32–55	44	9–25	17	A–7–6(11)	A–7–6(13)	ML–CL	4
44–56	50	23–33	28	A–7–6(17)	A–7–6(22)	CL	3
40–60	50	20–38	28	A–7–6(17)	A–7–6(21)	CL	3
45–71	58	18–39	28	A–7–5(19)	A–7–5(31)	MH–CH	2
49–87	68	26–56	41	A–7–6(20)	A–7–6(45)	CH	1
52–85	69	29–54	40	A–7–6(20)	A–7–6(45)	CH	1
56–103	80	32–66	48	A–7–5(20)	A–7–5(56)	CH	1

TABLE 8.—*Engineering test data for soil samples taken along proposed*

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)	
			Range	Average	Range	Average	Range	Average
Raber.	A	14	93–100	98	85–100	93	60–96	78
	B	50	96–100	99	90–100	96	71–99	85
	C	43	93–100	98	86–100	93	63–98	81
Ree.	A	5	97–100	99	82–100	92	71–95	83
	B	15	92–100	98	79–100	90	51–92	71
	C	15	86–100	95	72–100	89	47–88	68
	IIC	2	51–100	78	29–47	38	5–43	24
	C [8]	3	84–100	96	84–100	95	82–96	89
Sansarc.	A	7	99–100	100	80–100	94	57–100	80
	C	28	97–100	99	93–100	98	80–100	92
	C [8]	105	98–100	100	94–100	98	85–100	94
Schamber.	A	3	46–100	82	22–100	69	6–78	42
	C	45	30–100	69	10–100	55	0–59	29
	IIC	20	9–100	63	0–100	55	0–74	32
	C [8]	20	87–100	96	77–100	93	51–100	81
Sully.	A	2	93–100	98	68–100	91	49–100	82
	B	1	----------	100	----------	98	----------	95
	C	9	66–100	91	55–100	85	40–100	76
	IIC	3	11–100	59	0–63	29	0–51	19
	C [8]	2	----------	99	81–100	94	67–100	87
Swanboy.	A	28	99–100	100	95–100	98	85–100	93
	B	11	97–100	99	83–100	96	70–100	90
	C	98	93–100	99	85–100	96	75–100	90
	C [8]	8	99–100	100	94–100	99	91–100	97
Walke.	A	27	98–100	100	94–100	98	83–100	91
	B	47	95–100	99	90–100	96	77–100	89
	C	14	93–100	98	85–100	94	66–100	84

[1] Mechanical analyses according to the AASHO Designation T 88–70. Results by this procedure may differ somewhat from the results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes of soils.

[2] Based on AASHO Designation T 89–68.

[3] Based on AASHO Designation T 90–70.

highway routes in Hughes County and surrounding counties—Continued

Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [4]
Range	Average	Range	Average	AASHO [5] (old index)	AASHO [6] (new index)	Unified [7]	
35–50	42	13–22	17	A–7–6(12)	A–7–6(14)	ML–CL	5
32–62	47	11–39	25	A–7–6(15)	A–7–6(22)	CL	4
32–66	49	13–42	27	A–7–6(17)	A–7–6(23)	CL	3
30–46	38	11–15	12	A–6(9)	A–6(11)	ML–CL	6
31–45	38	13–25	18	A–6(11)	A–6(12)	CL	6
23–49	36	9–29	18	A–6(10)	A–6(11)	CL	6
18–43	31	3–24	13	A–2–6(0)	A–2–6(0)	SC	----------
36–82	59	23–53	37	A–7–6(20)	A–7–6(37)	CH	2
52–92	74	21–62	41	A–7–5(20)	A–7–5(37)	MH–CH	1
50–101	76	25–64	44	A–7–5(20)	A–7–5(48)	MH–CH	1
53–125	89	31–88	59	A–7–5(20)	A–7–6(65)	CH	1
9–68	39	0–25	12	A–6(2)	A–6(2)	SM–SC	5
7–54	30	0–29	12	A–2–6(0)	A–2–6(0)	SC	----------
13–51	32	0–30	12	A–2–6(0)	A–2–6(0)	SC	----------
36–95	66	16–62	39	A–7–6(20)	A–7–6(34)	CH	2
38–42	40	11–14	12	A–6(9)	A–6(11)	ML–CL	5
----------	31	----------	4	A–4(8)	A–4(5)	ML	8
19–58	39	0–37	17	A–6(11)	A–6(13)	CL	5
0–52	21	0–22	8	A–2–4(0)	A–2–4(0)	SC	----------
86–111	99	52–63	57	A–7–5(20)	A–7–5(59)	MH–CH	1
46–75	60	21–42	31	A–7–6(20)	A–7–6(34)	MH–CH	2
31–134	82	2–103	52	A–7–5(20)	A–7–5(54)	CH	1
49–105	77	24–76	50	A–7–6(20)	A–7–6(52)	CH	1
49–158	104	22–128	75	A–7–6(20)	A–7–6(85)	CH	1
34–53	44	6–30	18	A–7–6(12)	A–7–6(19)	ML–CL	4
40–66	53	18–47	32	A–7–6(19)	A–7–6(31)	CH	3
33–65	50	15–44	29	A–7–6(18)	A–7–6(26)	CL	3

[4] Estimated values based on relationships between California Bearing Ratio and liquid limit.
[5] Based on AASHO Designation M 145–49.
[6] Based on AASHO Designation M 145–661.
[7] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given borderline classification. Examples of borderline classifications obtained by this use are ML–CL and SM–SC.
[8] Soft bedded shale of Pierre Formation.

seasonal water table, flood hazard, and soil permeability.

2. Evaluating potential locations for roads, highways, airports, pipelines, and underground cables. Among the factors to be considered are depth to bedrock, depth to water table, corrosivity, soil permeability, flooding frequency, and susceptibility to sliding.
3. Locating areas that are probable sources of sand, gravel, or road fill suitable for use as construction material. To be considered are depth to water table, presence of stones and boulders, thickness of the deposits, shrink-swell potential, susceptibility to frost action, and moisture content.
4. Planning drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil. Important considerations are permeability and seepage rate, depth to water table, slope, available water capacity, and depth to a layer, such as a claypan, bedrock, and sand or gravel, that influence the rate of water movement and flooding or stream overflow.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works. The soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used by soil scientists have a special meaning in soil science that may not be familiar to engineers. These and other terms are defined in the Glossary at the back of this soil survey.

Engineering classification systems

The two systems most commonly used in classifying samples of soil horizons for engineering are the AASHO system, adopted by the American Association of State Highway Officials, and the Unified system, used by SCS engineers, Department of Defense, and others.

The AASHO system (*1*) is used to classify soils according to those properties that affect use in highway construction. In this system a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basic 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. At the other extreme, in group A-7 are clay soils that have low strength when wet. The best soils for subgrade are, therefore, classified as A-1, the next best A-2, and so on to class A-7, which 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. If soil material is near a classification boundary it is given a symbol showing both classes; for example, A–2 or A–4. Within each group, the relative engineering value of a soil material is indicated by a group index number. Group indexes range from 0 for the best material to 20 for the poorest.

In the Unified system (*10*) soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped into 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. GP and GW are clean gravels, and GM and GC are gravels that include, respectively, an appreciable amount of nonplastic and plastic fines. SP and SW are clean sands. SM and SC are sands that include fines of silt and clay. ML and CL are silts and clays that have a low liquid limit. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML-CL.

Soil scientists use the USDA textural classification. In this, the texture of the soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay. Textural modifiers, such as gravelly, stony, shaly, and cobbly, are used as needed.

Tables 7 and 8 show the AASHO and Unified classification of specified soils in the county as determined by laboratory tests. Table 5 shows the estimated classification of all the soils in the county according to all three systems of classification.

Estimated engineering properties

Table 5 provides estimates of soil properties important to engineering. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adajcent areas, and from detailed experience in working with the individual kind of soil in the survey area. Some of the terms for which data are shown are explained in the following paragraphs.

Permeability, as used in table 5, relates only to movement of water downward through undisturbed and uncompacted soil in a saturated condition. It does not include lateral seepage. The estimates are based on soil characteristics that influence porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of these soils are not considered.

Permeability classes	*Numerical range (inches per hour)*
Very slow	Less than 0.06
Slow	0.06-0.2
Moderately slow	0.2-0.6
Moderate	0.6-2.0
Moderately rapid	2.0-6.0
Rapid	6.0-20
Very rapid	More than 20

Available water capacity is the capacity of soils to store water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH test is made of a water solution of the soil. This value and relative terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to other materials. Salinity in millimhos per centimeter at 25° C. and the

terms used to describe salinity ratings of the soil are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of a structure constructed in, on, or with such materials.

Corrosivity, as used here, indicates the potential danger to uncoated steel or concrete structures through chemical action that dissolves or weakens the structural material. Structural materials can corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Engineering interpretations

Table 6 contains selected information useful to engineers and others who plan to use soil material in construction of local roads and streets, farm facilities, buildings, and sewage disposal systems. Detrimental or undesirable features are emphasized, but important desirable features also may be listed. The ratings and other interpretations in this table are based on estimated engineering properties of the soil in table 5; on available test data, including those in tables 7 and 8; and on field experience. While, strictly, the information applies only to soil depths indicated in table 5, it is reasonably reliable to depths of about 5 to 6 feet.

Soil limitations are indicated by the ratings *slight*, *moderate*, and *severe*. *Slight* means soil properties generally favorable for the rated use, or in other words, limitations that 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 so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance. A severe limitation does not mean that the soil is excluded from a specific land use. The principal reasons for assigning moderate or severe limitations are given.

Septic tank absorption fields are affected mainly by permeability, location of water table, susceptibility to flooding, and soil slope.

Sewage lagoons are influenced chiefly by soil features such as permeability, location of water table, and slope.

Shallow excavations are less than 6 feet deep and pertain to those made for a variety of purposes, such as basements, ditches, graves, and underground cables, pipelines, and sewers.

Ratings for dwellings with basements are based chiefly on soil characteristics affecting foundations, but soil slope, susceptibility to flooding, seasonal wetness, depth to bedrock, and other conditions are considered.

Sanitary landfill is an engineering method of disposing of solid wastes on or in the soil by spreading the wastes in thin layers, compacting it to the smallest practical volume, and covering the wastes with soil each day in a manner that provides maximum protection of the environment.

Ratings for local roads and streets pertain to construction and maintenance of improved roads and streets having some kind of all-weather surfacing, commonly asphalt or concrete; they are expected to carry automobile traffic all year, but not fast-moving, heavy trucks.

The suitability of the soil as a source of road fill, sand and gravel, and topsoil is expressed as *good*, *fair*, or *poor*. The principal reasons for fair or poor ratings are given for each soil.

Road fill is the material used as an embankment to support the subbase and base course or surface course. The ratings indicate performance on soil material moved from borrow areas for these purposes.

Sand and gravel ratings are based on the probability that delineated areas of the soil contain deposits of sand and gravel or sand alone and provide guidance about where to look for it. The ratings do not indicate size of deposit.

Topsoil is soil material usable for spreading over barren surfaces, lawns, and gardens so as to improve soil conditions for establishing or maintaining adapted vegetation.

Pond reservoir areas are affected mainly by seepage loss of water, and the soil features are those that influence such seepage.

The factors considered for embankments, dikes, and levees are those features and qualities of disturbed soils that affect their suitability for constructing earth fills. The soil features of both subsoil and substratum are evaluated where they have significant thickness for use as borrow.

The factors considered for drainage are those features and qualities of the soil that affect the installation and performance of surface and subsurface drains.

Irrigation is influenced chiefly by soil features, such as water intake rate, permeability, available water capacity, depth to rooting zone, susceptibility to stream overflow, salinity, stoniness, slope, hazard of wind and water erosion, and presence of a layer limiting water movement.

The factors considered for terraces and diversions are those features and qualities of the soil that affect their stability or hinder layout and construction and also hazards of sedimentation in channels and difficulty of establishment and maintenance of cover on diversions.

Engineering test data

Tables 7 and 8 contain results of engineering tests performed by the South Dakota Department of Highways in cooperation with the U. S. Bureau of Public Roads (BPR). Table 7 contains the results of tests on selected soils at specific sites in Hughes County. Table 8 is a summary of tests performed along highway routes in this and surrounding counties. In table 8, the horizon column indicates the major horizons from which samples were taken. The samples were taken at depths that reflect distinct changes in color and texture. Therefore, in some instances the sample may contain material from more than one major horizon of the given soil. The number of samples tested also are given. Because the methods of sampling differ, the particle-size data given in table 8 do not necessarily coincide with the range of data given in table 6. Some of the terms used in tables 7 and 8 not

previously explained are defined in the following paragraphs.

Maximum dry density is the maximum unit dry weight of the soil when it is compacted with optimum moisture content by the prescribed method of compaction. It is expressed in pounds per cubic foot. The moisture content which gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

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 passes from semisolid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Formation and Classification of the Soils

This section tells how the factors of soil formation have affected the soils in Hughes County. It also explains the current system of soil classification and classifies all the soil series represented in the county according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineral composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms 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 formation 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 formation are unknown.

Parent material

Many soils in the county formed in glacial material derived from preglacial formations of granite, gneiss, limestone, sandstone, and shale. The glacier picked up materials from these formations, ground and mixed them as it transported them, and redeposited them as the glacier melted. Some deposits consist of unsorted material, or glacial till. Other deposits are material sorted either by water as it was deposited or by wind and water after it was deposited. These deposits are referred to as glacial drift.

The glacial till ranges from loam to clay in texture and from friable to firm in consistence. Betts, Glenham, Raber, and Oko soils are examples of soils that formed in glacial till.

Glacial drift that is high in silt content is the most extensive of the surface materials of glacial origin. This material was deposited during the Wisconsin Stage of the Pleistocene Epoch (*2*, *3*). Eakin and Highmore soils are examples of soils that formed in silty glacial drift. Canning and Orton soils are examples of soils that formed in loamy materials over outwash sand and gravel deposited by glacial melt waters.

The Pierre Formation is the only bedrock exposed in Hughes County. It is a marine shale of Cretaceous age. The exposures are mainly along the Missouri River and in many places have been covered with thin glacial deposits which subsequently eroded away leaving only scattered boulders on the surface. Lakoma, Opal, Promise, and Sansarc soils are examples of soils that formed in materials weathered from Pierre Shale.

Loess mantles the uplands in the western part of the county within a few miles of the Missouri River, the source of the wind-deposited material. Agar soils formed in the older loess deposits. Lowry and Sully soils formed in loess of more recent deposition.

Bon and Munjor soils are examples of soils that formed in alluvium of Recent age.

Climate

Hughes County has a subhumid climate of cold winters and hot summers. This climatic condition promotes moderately slow weathering of bedrock and soil formation. It is assumed that the climate is relatively uniform throughout the county. Therefore, climate alone does not account for differences in the soils of Hughes County, but rather it is the effects of climate as modified by the other factors of soil formation. Climatic data for the county are given in the section "General Nature of the County."

Plant and animal life

Plants, animals, insects, earthworms, bacteria, and fungi are important in the formation of soils. Plants, although influenced by climate and relief, cause changes in the amounts of organic matter and soil nutrients. Most nearly level to sloping soils have similar kinds and amounts of vegetation varying with the kind of soil. Therefore, amounts of organic matter are similar. Steeper soils, such as Betts and Gettys, have different composition of grasses and lose much of the rainfall through runoff and erosion, and thus have thinner A horizons and less organic matter content. Animals, especially burrowing

ones, such as gophers and prairie dogs, have mixed horizons in some soils. Earthworm activity has had some effect on soils that have a more favorable moisture regime, such as Bon and Onita soils.

Relief

Relief affects soil formation through steepness of slope. The steep Betts, Gettys, and Sansarc soils lose much of the rainfall through runoff. Less sloping soils, depending on texture and structural development, absorb more moisture, which in turn influences the kinds and amounts of vegetation.

Time

The length of time that soil material has been exposed to other soil-forming factors determines the kind of soils that form. Older landscapes have well-defined soil horizons, as for example, in Highmore, Eakin, and Raber soils. Some of the more youthful are Sully soils, which formed in loess, and Munjor soils, which formed in recent alluvium.

Classification of the Soils

The purpose of soil classification is to help us remember the significant characteristics of soils, assemble our knowledge about the soils, see their relationships to one another and to the whole environment, and develop principles relating to their behavior and their response to manipulation. First through classification and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The current system of soil classification (*5*, *8*) was adopted by the Cooperative Soil Survey in 1965. It is a comprehensive system, designed to accommodate all soils. In this system classes of soils are defined in terms of observable or measurable properties. The properties chosen are primarily those that result in the grouping of soils of similar genesis, or mode of origin. Genesis does not, however, appear in the definitions of the classes.

The current system of classification has six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great group, the subgroup, the family, and the series. Table 9 shows the classification of the soils of Hughes County according to this system. Brief descriptions of the six categories follow.

Order.—Ten soil orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate orders are those that tend to give broad climatic groupings of soils. Two exceptions to this generalization are the Entisols and the Histosols, both of

TABLE 9.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Agar	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Betts	Fine-loamy, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Bon	Fine-loamy, mixed, mesic	Cumulic Haplustolls	Mollisols.
Canning	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Argiustolls	Mollisols.
Cavo	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
Chantier	Clayey, montmorillonitic (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
DeGrey	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
Demky	Fine, mixed, mesic	Glossic Natrustolls	Mollisols.
Dorna	Coarse-silty over clayey, mixed, mesic	Fluventic Haplustolls	Mollisols.
Durrstein	Fine, mixed, mesic	Typic Natraquolls	Mollisols.
Eakin	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Egas	Fine, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Gettys	Fine, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Glenham	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Highmore	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Hoven	Fine, montmorillonitic, mesic	Typic Natraquolls	Mollisols.
Hurley	Very fine, montmorillonitic, mesic	Leptic Natrustolls	Mollisols.
Java	Fine-loamy, mixed, mesic	Entic Haplustolls	Mollisols.
Jerauld	Fine, montmorillonitic, mesic	Leptic Natrustolls	Mollisols.
Lakoma	Fine, montmorillonitic, mesic	Typic Ustochrepts	Inceptisols.
Lowry	Coarse-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Macken	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Millboro	Fine, montmorillonitic, mesic	Vertic Argiustolls	Mollisols.
Mosher	Fine, montmorillonitic, mesic	Typic Natrustolls	Mollisols.
Munjor	Coarse-loamy, mixed (calcareous), mesic	Typic Ustifluvents	Entisols.
Oahe	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplustolls	Mollisols.
Oko	Fine, montmorillonitic, mesic	Vertic Argiustolls	Mollisols.
Onita	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Opal	Very fine, montmorillonitic, mesic	Vertic Haplustolls	Mollisols.
Orton	Coarse-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Peno	Fine, mixed, mesic	Typic Haplustolls	Mollisols.
Promise	Very fine, montmorillonitic, mesic	Vertic Haplustolls	Mollisols.
Raber	Fine, mixed, mesic	Typic Argiustolls	Mollisols.
Ree	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Sansarc	Clayey, montmorillonitic (calcareous), mesic, shallow	Typic Ustorthents	Entisols.
Schamber	Sandy-skeletal, mixed, mesic	Ustic Torriorthents	Entisols.
Sully	Coarse-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Swanboy	Very fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Walke	Fine, mixed, mesic	Glossic Natrustolls	Mollisols.

which occur in many different climates. Four of the ten orders are represented in Hughes County: Aridisols, Entisols, Inceptisols, and Mollisols.

Aridisols are light-colored mineral soils that are high in bases and have well-expressed mineral genetic horizons.

Entisols are light-colored soils that do not have natural genetic horizons or that have only weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Inceptisols are light-colored mineral soils that are high in bases and have weakly expressed mineral genetic horizons.

Mollisols formed under grass and have a thick, dark-colored surface horizon that contains colloids dominated by bivalent cations. These soils have not been mixed by shrinking and swelling.

Suborder.—Each order is divided into suborders, mainly on the basis of soil characteristics that result in grouping soils according to genetic similarity. The climatic range is narrower than that of the order. The properties used are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, cracking of soils when dry, fine stratification, and the accumulation of clay, iron, or organic carbon in the upper solum.

Great group.—Each suborder is divided into great groups on the basis of similarity in the kind and sequence of the major horizons and in major soil properties. The horizons considered are those in which clay, iron, or humus have accumulated and those in which pans that interfere with the growth of roots and the movement of water have formed. The properties are soil temperature, chemical composition (mainly content of calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 9 because it is the last word in the name of the subgroup.

Subgroup.—Each great group is divided into subgroups, one that represents the central (typic) concept of the group, and others, called intergrades, that have one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

Family.—Families are established within each subgroup, primarily on the basis of properties important to the growth of plants or properties significant in engineering. Texture, mineral content, reaction, soil temperature, permeability, thickness of horizons, and consistence are among the properties considered.

Series.—The series is a group of soils that have horizons similar in all important characteristics, except for texture of the surface layer, and similar in arrangement in the profile.

General Nature of the County

Hughes County was created in 1873 by an act of the legislature of Dakota Territory. Railway transportation to Pierre began in 1880 and is still the only rail service in the county. Pierre became the capital of the State of South Dakota in 1904.

By 1890, the county had a population of 5,044. Growth was gradual during the next few decades, but rapid during the construction of Oahe Dam. The population had increased to 12,275 in 1960. In 1970 (*9*) the population was 11,632 of which 9,699 were in Pierre.

U.S. Highways 14 and 83 and State Highway 34 traverse the county and provide travel routes into Pierre from all directions. A network of secondary roads, either oiled or graveled, provide access to most of the farms and ranches.

Much of the livestock produced in the county is sold at public sales barns in Fort Pierre and Highmore in adjacent counties. Part is shipped by truck to central markets at Sioux Falls and Sioux City. Grain crops are marketed mainly at elevators in Blunt, Harrold, and Pierre in the county and also in Fort Pierre in neighboring Stanley County.

Hunting and fishing provide most of the recreation. Both Lake Oahe and Lake Sharpe provide excellent fishing and camping.

There are no mineral resources in the county. Ground water is scarce except for shallow wells on terraces east of Chapelle Creek and along some of the other creeks. Lake Oahe and Lake Sharpe supply water of good quality for irrigation. Artesian wells and many ponds of surface water created by dams and dugouts provide most of the water for livestock.

Climate [9]

Hughes County has a continental type climate characterized by cold winters and hot summers and little precipitation in winter. Rainfall during the growing season is marginal for crops. The recently formed Oahe Reservoir extends along the northwestern border and the recently formed Lake Sharpe extends along the southwestern and southern borders of the county. These bodies of water have some small effect on the climate in the immediate vicinity. Elsewhere, however, the climate is not affected by bodies of water or other physical features.

The climatic summary for this county is based on 73 years (1893-1965) of weather observations at Pierre, which is in the west central part of the county at an elevation of 1,734 feet. Climatic conditions at Pierre are representative of those throughout the county. The mean annual precipitation can vary as much as 0.5 inch from north to south and 1.5 inches from west to east, but the mean annual temperature is expected to be within 1 degree of that at Pierre.

The county experiences large seasonal variations in temperature and occasionally a large variation from day to day. Readings have gone above 100° F. in summer and dropped to lower than −30° in winter. Readings reach 100° or higher on the average of 9 times each year. The temperature can drop to 30° below zero or lower on the average of once in 8 years and to 20° or lower on an average of 2 to 3 times each year. Minimum temperatures of zero or lower can be expected on an average of about

[9] By WALTER SPUHLER, State climatologist, National Oceanic and Atmospheric Administration.

25 times each year. On an average of about 4 days each year, the temperature is below zero.

Table 10 shows the chance of certain low temperatures occurring after specified dates in spring or before indicated dates in fall. For example, the upper half of the table shows a 50 percent chance that temperature of 30 will occur after May 5, or in about 5 years in 10 a temperature of 32° or lower can be expected after May 5. The 50 percent chance date is also the average date of occurrence.

Similarly, the lower half of table 10 shows a 30 percent chance that a temperature of 32° or lower will occur by September 15, or on the average, in 3 years out of 10, a temperature of 32 degrees or lower at Pierre can be expected on or before this date. These figures refer to air temperature as measured in a standard instrument shelter. Plant temperatures vary somewhat from the temperatures of the free air. Other temperature data are given by month in table 11.

The average annual precipitation at Pierre is 16.49 inches, of which 12.59 inches, or 76 percent, falls during the April to September growing season. During the 73 year period 1893 to 1965, the annual precipitation has ranged from 7.82 inches in 1894 to 23.57 inches in 1915. Thundershowers are the main source of rainfall during the growing season and produce a wide range of intensities and amounts. About once a year 1 inch or more of rain in 1 hour can be expected, and about once in 5 years 1.7 inches or more. A 24-hour rain of 2 inches or more can be expected about once in 2 or 3 years.

Snow cover is important as a winter protection for pastures and fall seeded grains, but can be a hindrance to farm or ranch activities. The seasonal snowfall at Pierre averages 31 inches. It has ranged from 13 inches in 1910–11 to 82 inches in 1951–52. Strong winds often accompany snowfall and cause large drifts in or near sheltered areas, while open fields remain nearly bare. Days with a snow cover of 1 inch or more average about 53 per year.

Sunshine, wind, and relative humidity information is estimated for the county from data obtained at Rapid City, Huron, and Valentine, Nebraska, and Bismarck, North Dakota. The percentage of possible sunshine received averages about 66 percent. It ranges from 75 percent in July to 50 percent in December.

The relative humidity usually varies widely from early morning to afternoon and occasionally from day to day. The average ranges from about 66 percent in the afternoon to about 80 percent during early morning in winter and from about 45 percent in the afternoon to about 84 percent during early morning in summer. The passage of a cold front occasionally accompanies the replacement of a warm and humid air mass with a much colder and drier air mass.

Windspeed averages about 10 to 11 miles per hour the year around. The prevailing direction is from the south in summer and from the northwest in winter. Strong winds of 50 miles per hour or more can occur during any month, but are most likely during summertime thunderstorms.

Thunderstorms occur an average of about 7 days per month in May, 11 days in June, 11 days in July, and 9 days in August. They are fewer in other months, and the annual average is about 44 thunderstorm days. Hail occasionally accompanies thunderstorms and may be expected at any one location on the average of about 2 times per year. Hail may occur as early as March and as late as October, but the months of most frequent occurrence are June, July, and August.

The potential water loss from soil and crops is indicated by the loss from an evaporation pan. Average annual evaporation from the Weather Service Class A pan is about 51 inches. Evaporation is about 41 inches during the period May through October. Evaporation from small lakes is about 36 inches. The actual water loss from soil and crops is even less since it depends on the available soil moisture.

Relief and Drainage

Relief ranges from nearly level and sloping, on much of the uplands, to hilly or steep along the Missouri River and its larger tributaries. Practically all of the county drains into the Missouri River or its reservoirs, Lake Oahe and Lake Sharpe. The exceptions are small drainageways that terminate in closed depressions or potholes. The

TABLE 10.—*Probability of last freezing temperatures in spring and first in fall*

[Prepared by WILLIAM F. LYTLE, South Dakota State University. Based on data recorded at Pierre, S. Dak., 1893–1965. Elevation 1,734 feet]

Probability	Dates for given probability and temperature					
	16°F.	20°F.	24°F.	28°F.	32°F.	36°F.
After a specified date in spring:						
90 percent	March 2	March 10	March 13	March 27	April 10	April 21
70 percent	March 7	March 14	March 19	April 1	April 14	April 25
50 percent	March 26	April 4	April 14	April 22	May 5	May 13
30 percent	April 14	April 23	May 8	May 13	May 24	May 30
10 percent	April 18	April 28	May 14	May 18	May 29	June 4
Before a specified date in fall:						
10 percent	October 14	October 9	September 29	September 20	September 10	September 3
30 percent	October 19	October 13	October 4	September 25	September 15	September 7
50 percent	November 10	November 2	October 25	October 15	October 6	September 26
70 percent	November 30	November 21	November 14	November 4	October 25	October 14
90 percent	December 5	November 25	November 19	November 8	October 30	October 18

TABLE 11.—*Temperature and precipitation*

[Data from Pierre, Hughes County, S. Dak., 1893–1965. Elevation 1,440 feet]

Month	Temperature				Precipitation						Days with snowfall of 1 inch or more	Days with snow cover of 1 inch or more
	Average daily maximum	Average daily minimum	Two years in 10 will have—		Average total	Record		One year in 10 will have—		Average snowfall		
			Average daily maximum equal to or higher than—	Average daily minimum equal to or lower than—		Maximum total	Minimum total	Less than—	More than—			
	°F.	°F.	°F.	°F.	In.	In.	In.	In.	In.	In.	No.	No.
January	27.0	6.7	37.4	−2.4	0.45	1.66	0	0.07	1.00	5.4	2	15
February	30.6	9.8	40.8	1.8	.55	2.66	.04	.10	1.18	6.4	2	14
March	42.3	21.1	52.2	13.7	.98	2.63	.02	.24	1.96	7.3	2	9
April	59.3	35.4	65.6	30.8	1.71	5.93	.00	.46	3.30	2.6	1	1
May	70.4	46.6	76.8	42.2	2.60	6.47	.05	.70	5.06	.1	0	0
June	80.3	57.0	86.3	53.0	2.93	7.25	.32	1.02	5.28	0	0	0
July	88.8	63.0	94.3	59.1	2.16	6.12	.10	.67	4.04	0	0	0
August	87.2	60.8	92.2	57.7	2.00	5.43	.21	.52	3.89	0	0	0
September	76.4	50.1	82.2	45.8	1.19	3.71	.06	.24	2.46	0	0	0
October	63.8	38.0	70.4	33.8	.95	3.58	0	.12	2.22	.8	0	1
November	45.1	23.5	53.0	17.9	.50	3.16	0	.09	1.15	3.5	1	4
December	31.9	12.6	40.1	5.4	.47	2.91	0	.07	1.04	4.9	2	11
Year	58.6	35.4	61.5	33.0	16.49	[1] 23.57	[2] 7.82	11.41	22.10	31.0	10	54

[1] In 1915.
[2] In 1894.

western part of the county is drained primarily by Dry Run Creek and Spring Creek. The central and northeastern parts of the county are drained by Medicine Knoll Creek. The principal drainageways in the southeastern part of the county are Chaney Rush Creek, Chapelle Creek, and Joe Creek.

Ranching and Farming

Ranching and dryland farming are the main agricultural enterprises in Hughes County. The trend since 1930 is toward fewer and larger holdings. According to the 1969 Census of Agriculture, there were 288 farms with an average size of 1,536 acres.

About two-thirds of the income from farm products comes mainly from the sale of cattle, hogs, and sheep, and about one-third from crops, mainly winter and spring wheat, oats, corn, and flax.

Livestock reported in the 1969 census included 39,506 cattle, 5,973 sheep and lambs, and 5,351 hogs and pigs.

The major crops grown in the county are corn, winter wheat, spring wheat, alfalfa, and oats. According to the 1964 census, corn was harvested from 21,666 acres, spring wheat from 20,499 acres, winter wheat from 12,422 acres, oats from 16,157 acres, and alfalfa from 17,761 acres. Since 1964, more winter wheat has been grown on summer fallowed land than all spring wheat under continuous cultivation. Another trend is the production of more sorghum for grain, replacing corn acreages.

Information on past history of cropping and livestock raising can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service (*6*).

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Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

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

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.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

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

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

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

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.*

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Salinity classes	*Numerical ratings Mmho/cm.*
None	Less than 2.0
Low	2.0–4.0
Moderate	4.0–8.0
High	8.0–16.0
Very high	More than 16.0

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.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

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

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

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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.

Wind stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

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