SOIL SURVEY

Shannon County, South Dakota

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
and
UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Indian Affairs
In cooperation with
SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1955–59. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1959. 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 Oglala Sioux Tribe and the Shannon County Soil and Water Conservation District.

Either enlarged or reduced copies of the printed soil map in this publication can be made by commercial photographers, or can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, 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, or other structures; and in judging the suitability of tracts of land for agriculture, industry, or recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by a symbol. 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 in this survey. This guide lists all the soils of the county in alphabetic order by map symbol and gives the range site, the capability unit, and the windbreak group in which the soil has been placed. It also gives the page where each soil and each group is described.

Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. 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 ranchers and those who work with them can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites, capability units, and windbreak groups.

Game managers, sportsmen, and others can find information about the common birds and animals in the section "Wildlife."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that give engineering properties of the soils in the county, information about soil features that affect engineering practices and structures, and engineering test data.

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

Newcomers in Shannon 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 section "General Nature of the County."

COVER PICTURE

Typical scene in the Oglala-Canyon soil association. Photo by Bureau of Indian Affairs.

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SOIL SURVEY OF SHANNON COUNTY, SOUTH DAKOTA

BY ROBERT E. RADEKE, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY REX L. CAREY, EDWARD BOOKLESS, JOHN FOREMAN, RICHARD KRUEGER, ROY LEMBKE, WILLIAM W. NYE, JACK SAFFORD, AND ALBERT THURMAN, BUREAU OF INDIAN AFFAIRS, AND WARREN JOHNSON, SOIL CONSERVATION SERVICE[1]

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

SHANNON COUNTY is in the southwestern part of South Dakota (fig. 1). It covers an area of about 1,344,000 acres. Pine Ridge, in the southern part of the county, is the main town and is the headquarters for the Pine Ridge Indian Reservation. The county is unorganized and is attached to Fall River County for administration.

All of Shannon County is a part of the Pine Ridge Indian Reservation. About 241,000 acres in the northern part of the county is owned by the Federal Government. About 165,000 acres is patented land owned by non-Indians. Most of the federally owned land makes up the Defense Department bombing and gunnery range. The rest of the acreage is tribal and allotted land, administered by the Bureau of Indian Affairs. The patented land and the Indian land are intermingled, especially in the eastern part of the county.

This county is in the Great Plains physiographic province, at the northern extremity of the High Plains. The plains are gently rolling to rolling, but the relief becomes steep and broken along the White River, the Cheyenne River, and the tributaries of these two rivers. Most of the county is in the watershed of the White River, which enters the southwestern part of the county and flows northeast. The extreme northwestern part of the county is in the Cheyenne watershed.

Livestock ranching is the main agricultural enterprise. Only about 6 percent of the county is cropland. Winter wheat, alfalfa, barley, oats, corn, and rye are the main crops. Commercial wheat farming is important in the southeastern part of the county, west and northwest of Batesland. Except for Barren badlands, the rest of the county is used for grazing and hay.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Shannon County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; 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 roots of plants.

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. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, the major horizons of all the soils of one series are similar in thickness, arrangement, and other important characteristics. A soil series is usually named for a town or

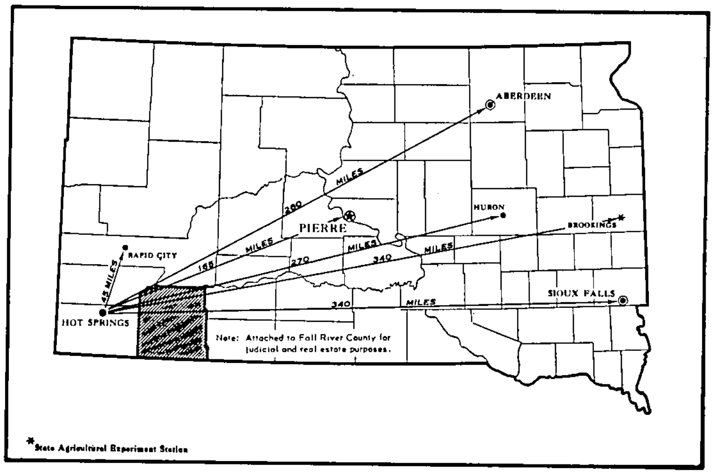

Figure 1.—**Location of Shannon County in South Dakota.**

[1] Others who contributed to the soil survey are J. B. ELLIS and DUANE C. MOXON, Bureau of Indian Affairs.

other geographic feature near the place where a soil of that series was first observed and mapped. Haverson and Keith, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the natural, undisturbed landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in the texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Haverson loam and Haverson silty clay loam are two soil types in the Haverson series. The difference in texture of their surface layers is apparent from their names.

Some soil types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Keith silt loam, 3 to 5 percent slopes, is one phase of Keith silt loam, a soil type that has a slope range of 0 to 18 percent.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. 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 type or phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed or occur in individual areas of such small size that it is not practical to show them separately on the map. They show such a mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Lamo-Elsmere complex.

Another kind of mapping unit is the undifferentiated group, which consists of two or more soils that may occur together without regularity in pattern or relative proportion. The individual tracts of the component soils could be shown separately on the map, but the differences between the soils are so slight that the separation is not important for the objectives of the soil survey. An example is Richfield and Altvan silt loams, 0 to 3 percent slopes.

Some mapping units contain more than one kind of soil in a pattern more open and less intricate than that of a soil complex. Such a mapping unit is called a soil association. A soil association differs from a soil complex in that its component soils could be mapped separately, at ordinary scales such as 4 inches per mile, and would be if practical advantages made the effort worthwhile. A soil association, like a soil complex, is named for the major soils in it, for example, Canyon-Rock outcrop association.

Most surveys include areas where the soil material is so rocky, so shallow, or so frequently worked by wind and water that it cannot be classified by soil series. These areas are shown on the map like other mapping units, but they are given descriptive names, such as Alluvial land or Badlands, and are called land types.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of readers, among them farmers, ranchers, managers of woodland and rangeland, and engineers. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present 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 Shannon 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 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 farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The fourteen soil associations in Shannon County are described briefly in this section. The terms for texture used in the titles for the associations apply to the surface layer. For example, in the title for association 1, the term "loamy" refers to the texture of the surface layer. More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading the section "Descriptions of the Soils."

1. Oglala-Canyon association

Rolling to hilly, well-drained to somewhat excessively drained, loamy soils that are deep to shallow over soft sandstone; on uplands

This association is mainly in the south-central part of the county. The hilly parts are made up of the rough, broken sides of valleys and canyons. The intervening ridges are generally rolling, but in scattered areas they are broad and gently sloping. Deeply entrenched, north-flowing tributaries of the White River form a complete drainage system. The soils formed either in loamy material weathered from sandstone or, in places, in loess.

This association covers a total area of about 410,000 acres, or about 30 percent of the county. About 35 percent is made up of Oglala soils; 35 percent, of Canyon soils; about 15 percent of Keith and Ulysses soils; and the rest, of other soils (fig. 2).

Oglala soils have a surface layer of dark-colored loam over light-colored, weakly prismatic, friable very fine sandy loam. They are on rolling to hilly mid and lower slopes.

Canyon soils are shallow, light-colored, calcareous, loamy soils underlain by fine sand interbedded with limy sandstone. They are on narrow, rolling ridges and on the side slopes of valleys and canyons along streams.

Patches of silty soils, mainly dark-colored Keith and Ulysses soils, are scattered throughout the association but are mostly on the south- and east-facing slopes of the rolling ridges.

Less extensive in this association are Alluvial land, on narrow flood plains along streams; Colby soils, on well-rounded ridges and knolls within areas of Keith and Ulysses soils; Goshen soils, in swales on the broader upland divides; and Rosebud soils, on gently sloping drainage divides.

Most of this association is used for grazing and for hay. Only about 4 percent is cultivated. Some winter wheat is grown, but feed grain and alfalfa are grown on much of the cropland.

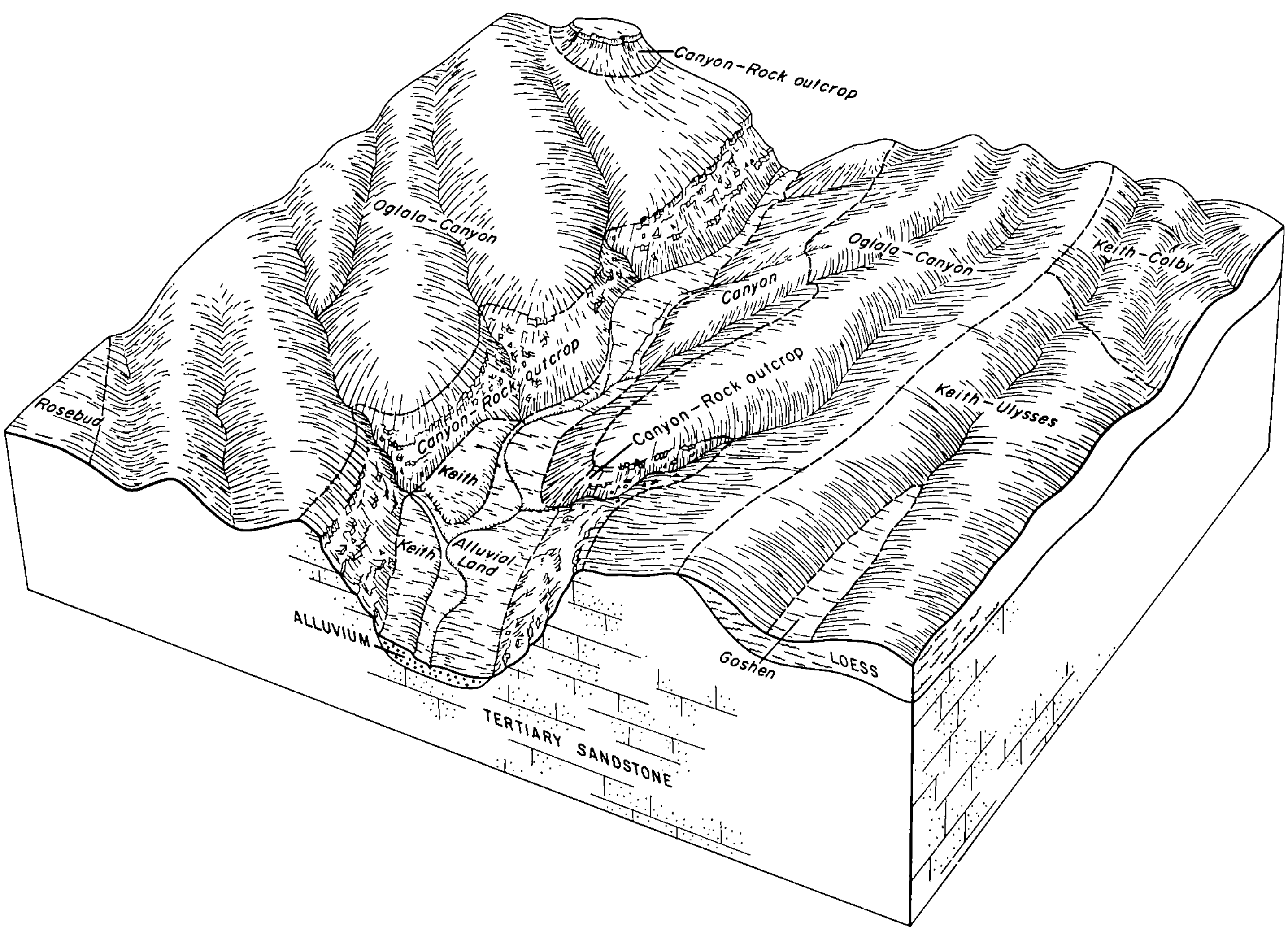

Figure 2.—**Representative pattern of soils in association 1.**

Ranches range from 1,000 to 20,000 acres in size. Raising beef cattle is the main enterprise. The few roads in the association connect the villages of Manderson, Porcupine, Wounded Knee, and Pine Ridge. Between these main roads are winding ranch trails.

Permeable underlying material affects the water-holding capability of most farm ponds and sewage lagoons in this association. The topography and depth to bedrock are limitations on the use of these soils as sewage disposal fields. Road construction necessitates many cuts and fills and measures for control of roadside erosion.

2. *Keith-Rosebud association*

Nearly level to gently sloping, well-drained, silty and loamy soils that are deep to moderately deep over soft sandstone; on uplands

This association is in the southeastern part of the county. It is made up of tablelands at the highest elevation in the county. It constitutes a drainage divide between the White River to the north and the headwaters of the Little White River to the east. The soils formed in windblown material and material weathered from soft sandstone.

This association covers a total area of about 70,000 acres, or about 5 percent of the county. About 45 percent is made up of Keith soils; 45 percent, of Rosebud soils; and about 10 percent, of other soils (fig. 3).

Keith soils have a surface layer of dark-colored silt loam or loam 4 to 10 inches thick and a subsoil of friable to firm, prismatic silty clay loam to loam 12 to 40 inches thick. These soils are on nearly level table-like areas and on the longer gentle slopes facing south and east.

Rosebud soils have a surface layer of dark-colored loam and a subsoil of weakly prismatic, friable loam or clay loam. These soils are moderately deep over bedded loamy material and soft sandstone. They are on the shorter slopes.

Less extensive in this association are Canyon soils, which are on the tops of ridges and knolls in association with Rosebud soils and are conspicuous because of their white appearance in cultivated fields; Colby and Ulysses soils, which are on rounded ridges and knolls, in association with Keith soils; Dawes and Richfield soils, on flats and in upland swales; Goshen soils, in upland swales; Hoven soils, in small upland depressions; and Oglala soils, on the mid and lower slopes in the more rolling areas.

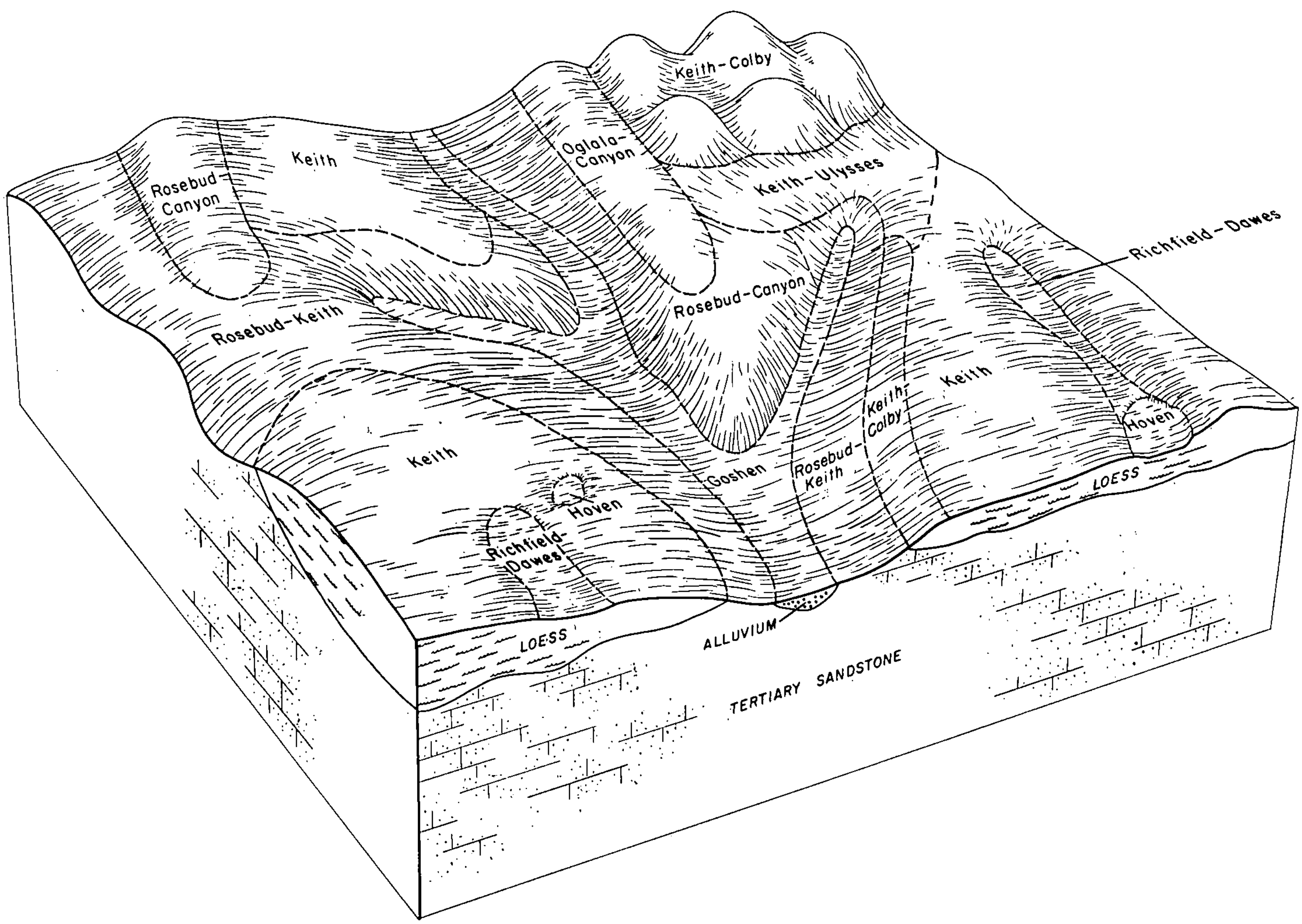

Figure 3.—**Representative pattern of soils in association 2.**

About 80 percent of this association is cultivated. Wheat is the main crop, but other crops also are grown. Some farmers raise beef cattle along with growing wheat, and a few raise dairy cattle, hogs, and chickens.

Farms in this association range from 160 to 3,000 acres in size. They are served by gravel roads, graded dirt roads, or trails on almost all section lines.

Terracing and other erosion control measures are practical in cropped areas, except those on Canyon soils. Permeable underlying material affects the water-holding capability of farm ponds. Road construction necessitates many cuts and fills, as well as measures for control of roadside erosion. Frost heaving is likely to damage highways.

3. *Keith-Colby association*

Gently sloping to rolling, well-drained to somewhat excessively drained, deep, silty soils on uplands

This association is in the west-central part of the county. It is on uplands adjacent to areas of Badlands, east and south of the White River. The topography is more rolling than that of association 2.

This association covers a total area of about 45,000 acres, which is about 3 percent of the county. About 65 percent is made up of Keith soils; 20 percent, of Colby soils; and the rest, of minor soils. Keith soils are on the long side slopes. The light-colored, calcareous Colby soils are on rounded ridges and knolls.

Less extensive in this association are Canyon, Dawes, Goshen, Oglala, Richfield, and Rosebud soils. Dawes, Goshen, and Richfield soils are on nearly level, concave slopes and swales. Canyon, Oglala, and Rosebud soils are along the larger drains and on ridges.

Nearly all of this association is in native grass and is used for grazing and hay. Many areas of these soils are suitable for cultivation, but they are isolated and surrounded by large areas suited only to grazing.

Most of the acreage is Indian land that is leased to livestock operators. Few ranch headquarters are in the area. A gravel road borders the east side of the association. A few winding ranch trails are the only other means of access to the area.

Terraces and grassed waterways are effective means of erosion control in cropped areas. Permeable underlying material affects the water-holding capability of farm ponds. Road construction necessitates many cuts and fills and measures for control of roadside erosion. Frost heaving is likely to damage highways.

4. *Kadoka-Epping association*

Gently sloping to hilly, well-drained to somewhat excessively drained, silty soils that are moderately deep to shallow over bedded silt and siltstone; on uplands

This association is in the northeastern and southwestern parts of the county. It is 100 to 300 feet lower than the Oglala-Canyon association. The topography is mainly sloping to rolling, but hilly areas occur along the larger intermittent tributaries of the White River. Step-and-riser ("catstep") relief is common in the rolling areas.

This association covers a total area of about 97,000 acres, or about 7 percent of the county. About 45 percent is made up of Kadoka soils; 35 percent, of Epping soils; and the rest, of other soils (fig. 4).

Kadoka soils have a surface layer of dark-colored silt loam, 2 to 8 inches thick, and a subsoil of friable to firm silty clay loam that has prismatic and blocky structure. They are underlain by light-colored silt loam that contains fragments of siltstone. They are on slopes ranging to 15 percent.

Epping soils are shallow over bedded siltstone. They are light colored and calcareous within 6 inches of the surface. These soils are on the tops of ridges and knolls and on the steeper slopes.

Less extensive in this association are Alluvial land, along the larger intermittent streams; Colby, Keith, and Ulysses soils, in scattered patches of silty loess; and Goshen, Wanblee, and Wortman soils, on concave foot slopes, on fans, and in upland valleys. Outcrops of siltstone are associated with Epping soils on the upper part of steep valley slopes. Small areas of Badlands occur along some deeply entrenched streams.

Most of this association is in native grass and is used for grazing. Scattered tracts of cropland, mostly on Kadoka and Keith soils, make up about 3 percent of the area. Feed grain and alfalfa are grown to provide a feed base for livestock. Some winter wheat is grown also.

Ranches range from 1,000 to 30,000 acres in size. Ranch trails supplement the few good roads in the area.

Terraces are not practical in fields of Kadoka soils where inclusions of Epping soils are numerous. Farm ponds generally hold water satisfactorily. Roadside erosion is common in rolling areas. Highways are subject to frost heave.

5. *Tuthill-Richfield association*

Nearly level to undulating, well-drained, deep, loamy and silty soils on tablelands and terraces

This association is in the northern part of the county. It is made up of isolated tablelands and terraces higher than those of the adjacent Badlands association. The soils formed in ancient alluvium that had been modified in places by blowing and deposition of sand and silt. They are underlain by stratified sand and gravel.

This association covers a total area of about 41,000 acres, or about 3 percent of the county. About 45 percent of the association is made up of Tuthill soils; 20 percent, of Richfield soils; and the rest, of small areas of other soils.

Tuthill soils have a surface layer of fine sandy loam to loam and a subsoil of sandy clay loam. The underlying material grades with depth to loose sand. These soils are gently undulating.

Richfield soils have a surface layer of thick, dark-colored silt loam and a subsoil of silty clay loam. These soils are nearly level.

Among the minor soils in this association are Altvan, Anselmo, Manter, and Valentine soils. Altvan soils are associated with Richfield soils, and Anselmo, Manter, and Valentine soils are associated with Tuthill soils. Other inextensive soils in this association are Dawes, Hoven, and Keith soils. Dawes and Goshen soils are in slightly depressed areas, in association with Richfield soils. Small spots of Gravelly land occur as low gravelly humps.

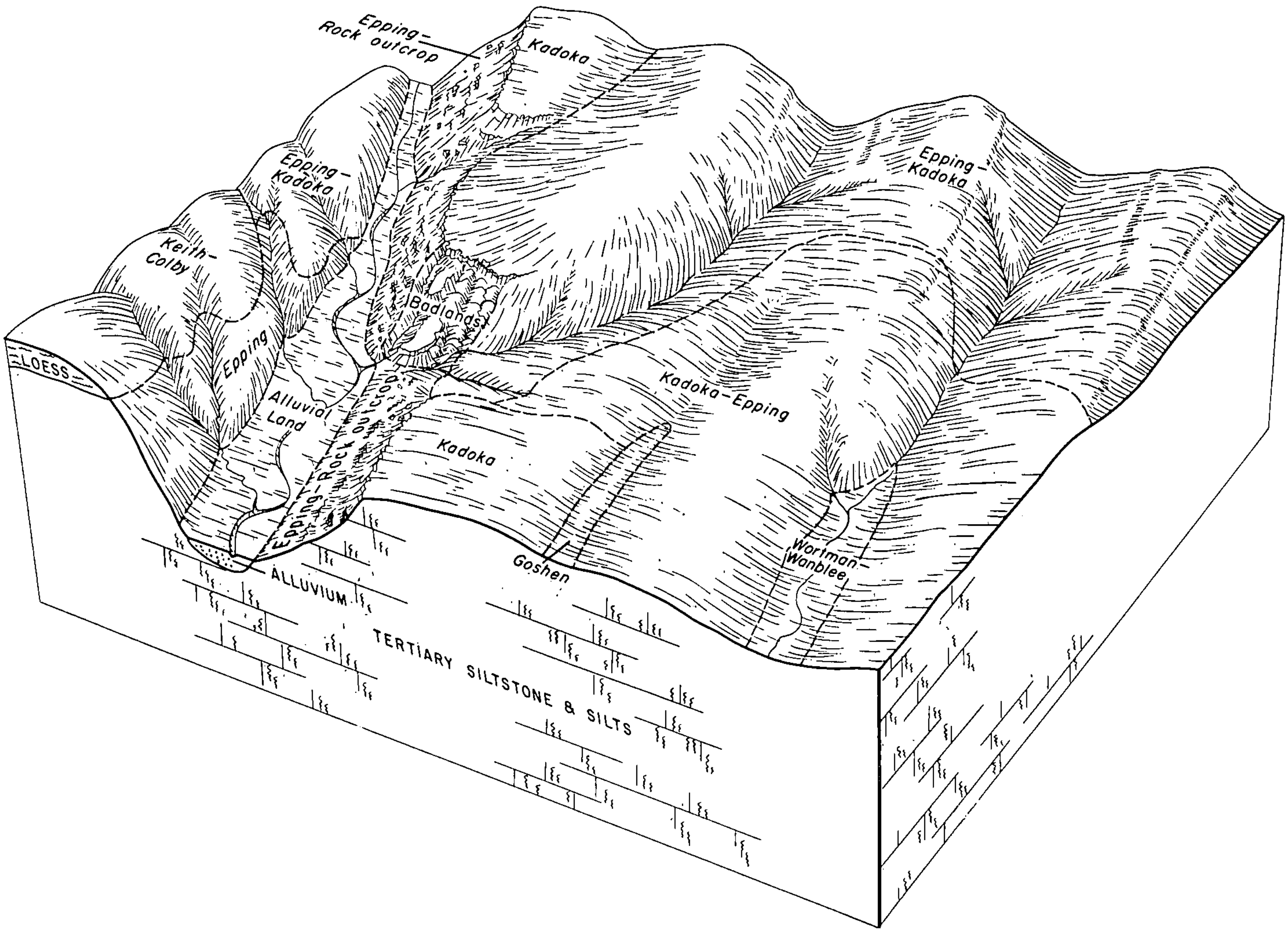

Figure 4.—Representative pattern of soils in association 4.

Most of this association is used for grazing. Extensive areas formerly were cultivated but now are in native grass. Only a few ranch headquarters are now in the association. Most of the tablelands are accessible by road.

Porous underlying material makes these soils unsuitable for farm ponds. Shallow wells are the best sources of water for livestock. Terraces and diversions are practical in most areas but possibly not in areas that have sand and gravel at a depth of less than 40 inches. Stability and bearing capacity for most types of structures are good. Sand and gravel occur at a depth of 2 to 10 feet; tests are necessary to determine the quantity and quality.

6. Pierre-Samsil association

Gently sloping to rolling, well-drained to excessively drained, clayey soils that are moderately deep to shallow over shale; on uplands

This association is in the western part of the county. Most areas are rolling, but gentle slopes occur where the drainage divides broaden and flatten. The soils formed in clay weathered from clay shale.

This association covers a total area of about 125,000 acres, or about 9 percent of the county. About 65 percent is made up of Pierre soils; 20 percent, of Samsil soils; and 15 percent, of small areas of other soils (fig. 5).

Pierre soils have a surface layer of moderately dark colored silty clay or clay, 2 to 6 inches thick, and a subsoil of grayish-brown to olive, very firm, prismatic to blocky clay. The depth to bedded clay shale ranges from 20 to 40 inches. These soils generally have gentle slopes but in places have slopes of as much as 20 percent.

Samsil soils are shallow to shale. They occur on ridgetops, on short-sloped shoulders of drains, and on the steeper slopes.

Less extensive in this association are Hisle soils, which are on plane to concave slopes along upland drains; Kyle soils, on foot slopes, fans, and stream terraces; and Swanboy soils, on foot slopes and alluvial fans. Eroding outcrops of shale are at the heads of some upland drains and on the faces of some ridges.

Almost all of this association is in native grass and is used for grazing and hay. Less than 2 percent is cultivated. Feed crops are the main crops grown.

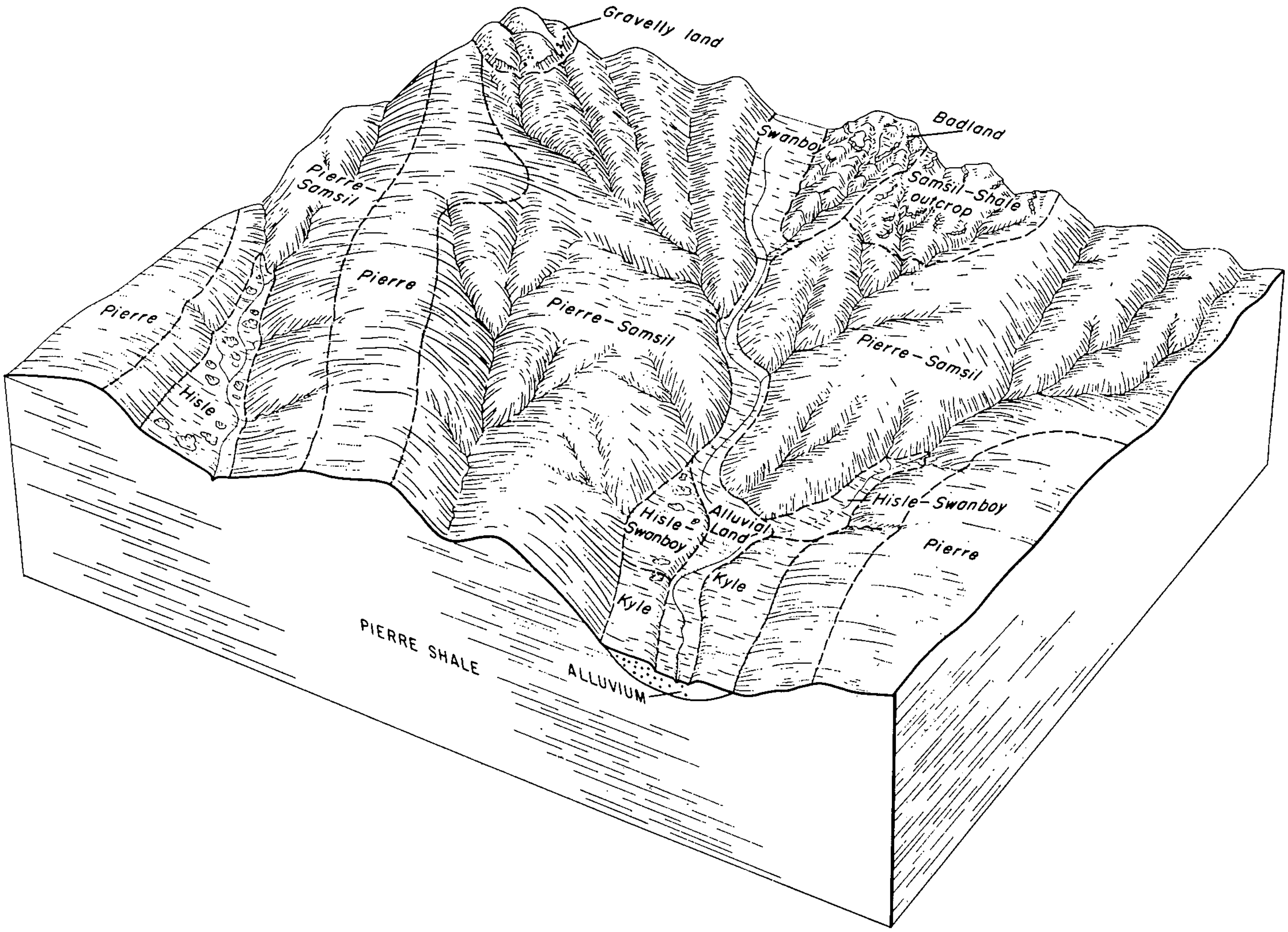

***Figure 5.*—Representative pattern of soils in association 6.**

Ranches range from 2,000 to 40,000 acres in size. Producing feeder calves is the main enterprise. U.S. Highway 18 crosses the association. Most areas are accessible by graded roads and ranch trails.

Earthen structures in this association are affected by high shrink-swell potential, poor shear strength, and instability. Ground water is scarce. Farm ponds generally hold water, but some seepage occurs if the fill is not cored at the line of contact with the underlying shale. Permeability is slow, and only graded terraces are satisfactory in cultivated areas.

7. Samsil-Pierre association

Mainly hilly, excessively drained to well-drained, clayey soils that are shallow to moderately deep over shale; on uplands

This association consists of rough broken areas near the Cheyenne River and its tributaries, in the northwestern part of the county. Drainageways occur at relatively close intervals. Many are gullied. Massive landslides are common near the river.

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This association covers a total area of about 22,000 acres, or about 2 percent of the county. It contains soils similar to those in association 6, but the topography is more hilly and the proportions of the dominant soils are different. About 60 percent is made up of Samsil soils; 25 percent, of Pierre soils; 10 percent, of barren outcrops of shale; and the rest, of minor soils.

Samsil soils are dominant on the river breaks. Pierre soils are on the more gentle and, in places, the longer slopes in the area. Small outcrops of shale are intermingled with the Samsil soils.

Less extensive in this association are Gravelly land, on the upper part of steep slopes where the association is adjacent to tablelands, such as Red Shirt Table; and Hisle and Swanboy soils, on foot slopes and fans along the narrow valleys of intermittent streams.

All of this association is used for grazing. Ranch headquarters are in adjacent associations. Much of the area is inaccessible to vehicles, and trails are few.

Sites suitable for ponds are scarce in this association because of sedimentation, a lack of natural spillways, and instability of the soil material. Earthen structures are affected by high shrink-swell potential. Highway construction is costly because of landslides, the numerous intermittent natural drainageways, and the likelihood of erosion.

8. *Penrose-Minnequa association*

Rolling or sloping, somewhat excessively drained to well-drained, silty soils that are shallow to moderately deep over chalky shale; on uplands

This association is in the southwestern part of the county. The soils formed in material weathered from chalk and chalky shale.

This association covers a total area of about 30,000 acres, or about 2 percent of the county. About 40 percent is made up of Penrose soils; 30 percent, of Minnequa soils; 15 percent, of Manvel soils; and the rest, of minor soils.

Penrose soils are shallow, light-colored, calcareous silty clay loams. They are on ridges, on short-sloped shoulders of drains, and on the steeper slopes.

Minnequa soils are calcareous silty clay loams that are moderately deep to chalk and chalky shale. They are on the more gentle slopes.

Manvel soils are deep, calcareous silty clay loams. They are on the longer slopes that are nearly level and very gently sloping.

Less extensive in this association are Buffington and Kyle soils, on stream terraces along the White River; small, scattered areas of Pierre and Samsil soils, on uplands; Wanblee and Wortman soils, on foot slopes and fans along drainageways on uplands; and outcrops of shale, chalk, and limestone, in complex with Penrose soils, on the eroded sides of buttes and escarpments and along deeply notched drainageways on uplands.

Most of this association is in native grass and is used for grazing. About 3 percent of the area is cultivated. Alfalfa and feed grains are the main crops. The soils contain selenium, and livestock that graze continuously in the area are subject to selenium poisoning.

Ranches range from 2,000 to 40,000 acres in size. A good graded road crosses each of the two areas of this association.

Farm ponds generally hold water satisfactorily. Cut spillways erode readily. Sediment yield is high if the vegetative cover on the watershed is poor. Graded terraces are needed in cultivated areas. Roadsides erode and gully readily.

9. *Valentine association*

Rolling to hilly, excessively drained, deep, sandy soils on uplands

This association, an extension of the Nebraska sandhills, is in the southeastern part of the county. It is made up of a succession of small, rounded, rolling hills and ridges that range from 20 to 75 feet in height. It has no distinct drainage channels, but dry valleys terminate in the subirrigated basins and small lakes.

This association covers a total area of about 43,000 acres, or about 3 percent of the county. It is about 65 percent Valentine soils. Anselmo, Dunday, Elsmere, and Loup soils make up most of the rest (fig. 6).

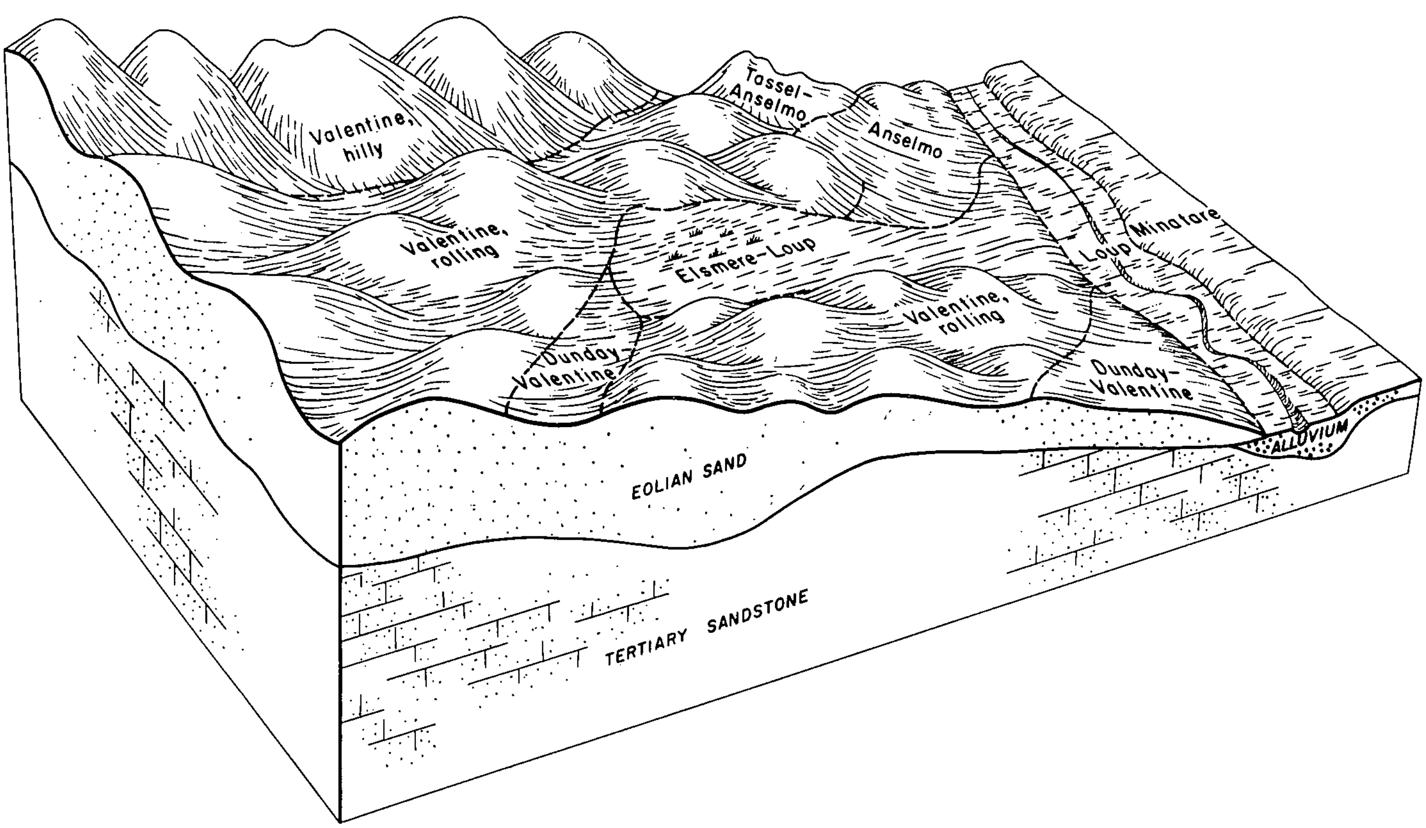

Figure 6.—**Representative pattern of soils in associations 9 and 14.**

Valentine soils are loose, sandy soils that have a thin surface layer only slightly darkened by organic matter.

Anselmo soils are dark-colored sandy loams on the outer edges of the area, in transition to association 2. Dunday soils are deep, dark-colored loamy fine sands in dry valleys and on the outer edges of the area. Elsmere and Loup soils are dark-colored, sandy soils in nearly level basins and valleys. They have a moderate to high water table. On the outer edges of the association are small areas of Canyon, Rosebud, and Tassel soils.

Most areas of this association are in native grass and are used for grazing. Some areas of Dunday, Elsmere, and Loup soils are used as hay meadows. About 2 percent of the area is cropland. Soils in cultivation are mostly the Anselmo, Dunday, and Rosebud.

Ranches range from 1,000 to 15,000 acres in size. One highway crosses the association, and scattered trails reach most of the rest of the area. Some of the hilly areas are accessible only by horseback.

The soils of this association are too sandy to be suitable for terraces or farm ponds. Exposed surfaces blow readily. Road ditches fill with windblown sand. Wells and springs provide water for livestock.

10. Valentine-Anselmo association

Undulating to rolling, excessively drained to well-drained, deep, sandy soils on uplands

This association is in the northern part of the county, on scattered tablelands between the Cheyenne River and the White River. The soils formed in sandy alluvium that has been blown about and redeposited by the wind.

This association covers a total area of about 52,000 acres, or about 4 percent of the county. About 60 percent is made up of Valentine soils; 20 percent, of Anselmo soils; and the rest, mostly of Manter and Tuthill soils.

The Valentine soils in this association are similar to those in association 9, but they contain coarser sand and are generally more yellowish in color. They are on the rolling parts of the association.

The Anselmo soils, which are less sandy than the Valentine soils, are on the undulating parts.

Manter and Tuthill soils are common in the association. They occupy the nearly level areas and the longer gentle slopes. Small areas of Dunday, Goshen, and Richfield soils and Gravelly land occur in places.

Except for one area, all of this association is in the bombing range and is used for grazing. The areas are isolated, and only a few winding ranch trails penetrate them.

Wells and springs are the best source of water for livestock. Terraces and diversions generally are not practical. Exposed surfaces blow readily. Exploration is necessary to determine the quality and quantity of the sand and gravel that is under most of the area.

11. Badlands association

Barren badlands intermingled with clayey and loamy soils on mesas, escarpments, buttes, and tablelands and in basins

This association is mainly in the northern part of the county, where natural geologic erosion has cut into soft, silty to clayey formations. The association consists of small, grass-covered tablelands and mesas, eroded walls and escarpments, and basins in which there are light-colored, calcareous soils and scattered, eroded buttes. The slope ranges from almost vertical to nearly level. The area is cut by numerous drainageways that are gullied and have vertical walls.

This association covers a total area of about 350,000 acres, or about 26 percent of the county. About 50 percent is made up of Badlands and Barren badlands; 30 percent, of Clayey land, Loamy land, and Orella and Swanboy soils; and the rest, of other soils.

Barren badlands occur as broad areas that are more than 75 percent bare. Badlands are about 25 to 75 percent bare. Intermingled with them are mixed soils that are grass covered.

Clayey land and Loamy land are in the basins and in areas below the walls. Clayey land consists of mixed, calcareous, clayey soils. Loamy land consists of mixed, calcareous, loamy and silty soils.

Orella and Swanboy soils are also in the basins. Orella soils are shallow, calcareous clays underlain by bedded clay and soft shale. They are on the level to rolling parts of the basin areas and in most places are intermingled with barren clay and shale outcrops. Swanboy soils are deep, dense, alkaline clays on nearly level fans and flats.

Less extensive soils in this association are the Anselmo, Colby, Epping, Hisle, Kadoka, Keith, Richfield, Ulysses, Valentine, Wanblee, and Wortman soils. They occur as small areas scattered throughout the association.

Almost all of this association is used for grazing. Runoff water carries heavy loads of sediment. Good sites for livestock water developments are scarce.

Ranches and range leases range from 2,000 to 50,000 acres in size. Few ranch headquarters are in the area, and trails are few. Most areas can be reached by jeep and by horseback, but a few are inaccessible.

Runoff water carries so much sediment that farm ponds are rapidly filled. Sediment catchment structures prolong the life of the ponds, but maintenance is costly. Spillways gully readily. All types of earthen structures are affected by poor bearing capacity, instability, moderate to high shrink-swell potential, poor shear strength, and heavy runoff.

12. Bankard association

Nearly level, well-drained to somewhat excessively drained, deep, sandy soils on flood plains

This association is in the northwestern corner of the county. It is on nearly level bottom lands and low terraces along the Cheyenne River.

This association covers a total area of about 4,000 acres, or less than 1 percent of the county. About 65 percent is made up of Bankard soils; 20 percent, of Kyle soils; and the rest, of Haverson, Hisle, and Swanboy soils.

Bankard soils are light-colored, calcareous, sandy soils. They occur close to the river and are slightly hummocky, partly because of old flood channels and partly as a result of wind action.

Of the less extensive soils, Kyle soils occupy the most acreage. They are on low terraces, only 2 to 10 feet higher than Bankard soils. Haverson soils occur as smaller areas and occupy narrow strips in transition between Bankard and Kyle soils. Hisle and Swanboy soils are on foot slopes and fans where tributary drainageways enter the river valley.

Most of this association is used for grazing. Scattered stands of cottonwood trees provide some winter protection for livestock.

Exposed surfaces are subject to soil blowing. Shallow wells and the Cheyenne River are sources of water for livestock. Except in the areas of Kyle soils, farm ponds will not hold water. Sprinkler irrigation is more effective and less costly than gravity irrigation on Bankard soils. Structures close to the river are affected by flooding in some years.

13. Alluvial land-Haverson association

Nearly level, deep soils that are sandy to clayey but mainly loamy; on flood plains

This association is on bottom lands and low terraces along the White River and its tributaries.

The total area of this association is about 48,000 acres, which is less than 4 percent of the county. About 50 percent is made up of Alluvial land; about 40 percent, of Haverson soils; and the rest, of minor soils.

Alluvial land consists of mixed soil material and, as mapped, includes varying amounts of Haverson soils. It is on the lower parts of the flood plains and in areas dissected by channels.

Haverson soils are light-colored, calcareous loams that are stratified with silt and very fine sand.

Less extensive in this association are Colby, Keith, Kyle, and Ulysses soils, which are on terraces on the outer edges of stream valleys.

Most of this association is used for grazing and hay. Scattered thickets of trees and shrubs provide winter protection for livestock and game animals. About 5 percent of this association is in crops, mainly alfalfa.

Many ranches are headquartered in or near this association. The area along White Clay Creek is favored by the Indians because water and fuelwood are available and the soils are good for gardens. Most parts of the association are accessible by roads and trails. Some in the northern part of the county are not, because they are surrounded by the Badlands association.

Farm ponds in these soils generally need a seal blanket. Streams and shallow wells are the sources of water for livestock. Floodwaters laden with silt and debris damage engineering structures in some years. Water for irrigation could be pumped from the White River, but streamflow is not dependable.

14. Minatare-Loup association

Nearly level, poorly drained, deep, loamy soils in stream valleys and basins

This association is along Stinking Water Creek in the southeastern part of the county. It consists of saline-alkali soils and dark-colored, moderately coarse textured soils that have a high water table.

This association covers a total area of about 3,000 acres, or less than 1 percent of the county. About 50 percent is made up of Minatare soils; 40 percent, of Loup soils; and the rest, of other soils.

Minatare soils are light-colored claypan soils. They are strongly alkaline in the subsoil because of the deposition of salts by the fluctuating water table. They are mainly on the north side of the valley, 1 to 5 feet higher than Loup soils (see fig. 6).

Loup soils are dark-colored, moderately coarse textured soils that have a water table at or near the surface early in the growing season.

Less extensive in this association are Dunday, Elsmere, and Mosher soils. The dark-colored, sandy Dunday soils are on dry benches and valley slopes. They have a water table below a depth of 5 feet. Elsmere soils are sandy, and they have a water table at a depth of 50 inches. Mosher soils are dark colored and slowly permeable.

Most of this association is used for hay meadow and range. It serves as a winter feed base. Ranch headquarters are in and near the association.

A high water table affects earthen structures in this association and makes sewage disposal systems impractical. Dug ponds and shallow wells provide water for livestock. Minatare soils are not suitable for cultivation, even if artificially drained. The high water table is a favorable factor in the production of native hay.

Descriptions of the Soils

In this section the soils of Shannon County are described in detail. The procedure is to describe first a soil series and then the mapping units in that series. The description of each soil series includes a description of a profile that is considered representative of all the soils of the series. If the profile of a given mapping unit differs from this typical profile, the differences are stated in the description of the mapping unit, unless they are apparent from the name of the mapping unit. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs.

As explained in the section "How This Survey Was Made," a few of the mapping units, Alluvial land and Gravelly land, for example, are not part of any soil series, but they are listed in alphabetic order along with the soil series.

The approximate acreage and proportionate extent of each mapping unit are shown in table 1. Many terms used in describing soil series and mapping units are defined in the Glossary, and some are defined in the section "How This Survey Was Made." At the back of this survey is the "Guide to Mapping Units," which lists all the mapping units in the county and shows the range site, the capability unit, and the windbreak group in which each has been placed.

Alluvial Land

Alluvial land (Aa) is on bottom lands in all parts of the county except the southeastern. The slope range is 0 to 3 percent. Many of the long, narrow flood plains are broken into small areas by meandering stream channels. This land type is subject to flooding and to deposition of sediments. The soil material ranges from almost white

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Alluvial land	51, 238	3. 8	Loamy land	32, 102	2. 4
Anselmo sandy loam, 0 to 5 percent slopes	3, 337	. 2	Loup soils	4, 304	. 3
Anselmo sandy loam, 5 to 9 percent slopes	3, 334	. 2	Manvel silty clay loam, 0 to 5 percent slopes	3, 535	. 3
Anselmo-Valentine complex, 5 to 20 percent slopes	32, 089	2. 4	Minatare soils	2, 583	. 2
Badlands	81, 582	6. 1	Minnequa silty clay loam, 5 to 12 percent slopes	1, 298	. 1
Bankard loamy sand	2, 341	. 2	Mosher-Minatare complex	11, 356	. 8
Barren badlands	92, 229	6. 9	Oglala-Canyon complex, 9 to 18 percent slopes	148, 372	11. 0
Buffington silty clay loam	1, 936	. 1	Orella clay, 0 to 9 percent slopes	2, 744	. 2
Canyon association, 18 to 40 percent slopes	73, 197	5. 4	Orella-Shale outcrop complex	22, 580	1. 7
Canyon-Rock outcrop association	118, 937	8. 8	Penrose and Minnequa silty clay loams, 5 to 20 percent slopes	9, 385	. 7
Clayey land	32, 175	2. 4	Penrose-Rock outcrop complex	2, 854	. 2
Dunday-Valentine complex, 0 to 5 percent slopes	7, 012	. 5	Pierre clay, 3 to 9 percent slopes	22, 539	1. 7
Elsmere-Loup loamy fine sands	3, 578	. 3	Pierre-Samsil clays, 9 to 25 percent slopes	56, 225	4. 2
Epping complex, 9 to 40 percent slopes	8, 876	. 7	Richfield and Altvan silt loams, 0 to 3 percent slopes	12, 410	. 9
Epping-Kadoka silt loams, 9 to 18 percent slopes	36, 227	2. 7	Richfield and Altvan silt loams, 3 to 5 percent slopes	1, 618	. 1
Epping-Rock outcrop complex	20, 791	1. 5	Richfield-Dawes silt loams, 0 to 3 percent slopes	4, 822	. 4
Goshen silt loam, 0 to 3 percent slopes	5, 710	. 4	Rosebud-Canyon loams, 5 to 9 percent slopes	30, 621	2. 3
Gravelly land	9, 799	. 7	Rosebud-Keith silt loams, 3 to 9 percent slopes	20, 798	1. 5
Haverson loam, high, 0 to 3 percent slopes	4, 084	. 3	Samsil-Shale outcrop complex	14, 748	1. 1
Haverson loam, low, 0 to 3 percent slopes	14, 697	1. 1	Swanboy clay	6, 398	. 5
Haverson silty clay loam, 0 to 3 percent slopes	2, 964	. 2	Tassel-Anselmo complex, 10 to 40 percent slopes	935	. 1
Hisle clay	8, 041	. 6	Terrace escarpments	9, 748	. 7
Hisle-Swanboy clays, saline	7, 462	. 6	Tuthill and Anselmo fine sandy loams, 0 to 3 percent slopes	1, 537	. 1
Hoven silt loam	974	. 1	Tuthill and Anselmo fine sandy loams, 3 to 9 percent slopes	12, 982	1. 0
Kadoka silt loam, 0 to 3 percent slopes	2, 435	. 2	Tuthill and Manter soils, 0 to 3 percent slopes	7, 937	. 6
Kadoka silt loam, 3 to 5 percent slopes	6, 255	. 5	Tuthill and Manter soils, 3 to 5 percent slopes	8, 795	. 7
Kadoka silt loam, 5 to 9 percent slopes	4, 022	. 3	Tuthill and Manter soils, 5 to 9 percent slopes	4, 816	. 4
Kadoka-Epping silt loams, 3 to 9 percent slopes	11, 985	. 9	Ulysses-Colby complex, sand substratum, 3 to 9 percent slopes	1, 323	. 1
Keith silt loam, 0 to 3 percent slopes	25, 947	1. 9	Valentine fine sand, rolling	18, 173	1. 4
Keith silt loam, 3 to 5 percent slopes	12, 608	. 9	Valentine fine sand, hilly	4, 059	. 3
Keith-Colby silt loams, 9 to 12 percent slopes	39, 180	2. 9	Valentine sand	32, 694	2. 4
Keith-Colby silt loams, 12 to 18 percent slopes	32, 359	2. 4	Wortman-Wanblee complex	22, 499	1. 7
Keith-Rosebud silt loams, 0 to 3 percent slopes	6, 920	. 5	Water	3, 616	. 3
Keith and Ulysses silt loams, 5 to 9 percent slopes	14, 296	1. 1			
Kyle clay, alkali, 0 to 3 percent slopes	16, 447	1. 2			
Kyle clay, alkali, 3 to 5 percent slopes	3, 782	. 3			
Kyle silty clay, 0 to 3 percent slopes	4, 279	. 3			
Lamo-Elsmere complex	469	(1)	Total	1, 344, 000	100. 0

[1] Less than 0.05 percent.

very recent alluvium to dark-colored older alluvium. It ranges from loamy sand to clay and generally consists of layers of contrasting texture. Included in the areas mapped are patches of Bankard and Haverson soils and also cut banks and vertical-walled channels that are bare of vegetation.

The native vegetation consists of sparse to good stands of tall and mid grasses. Some areas have clumps of native trees and shrubs, which protect livestock and game animals in winter.

Most areas are used for grazing, but some small ones are used for hay. A few are cultivated. Alfalfa is the main crop. Some areas in the central and southern parts of the county are used as garden plots. Most areas suitable for cultivation are either too small for farming operations or are inaccessible. Occasional flooding, which damages fences and deposits sediment and trash, is the main hazard. Most areas can be planted to trees, and most provide wildlife habitat. (Overflow range site, capability unit VIw-1, windbreak group 4)

Altvan Series

The Altvan series consists of nearly level and very gently sloping, friable, dark-colored, loamy soils that are moderately deep over sand and gravel. These soils formed in stratified, loamy alluvium and are on terraces and tablelands in the northern part of the county.

In a typical profile, the surface layer, about 4 inches thick, is grayish-brown silt loam that has weak platy and granular structure. The subsurface layer, about 5 inches thick, is dark grayish-brown silt loam that has weak prismatic and subangular blocky structure. Both layers are soft when dry and friable when moist.

The subsoil, about 22 inches thick, consists of three layers. The upper 6 inches is dark-brown sandy clay loam that is hard when dry and friable when moist and has weak prismatic and moderate blocky structure. The middle 10 inches is brown sandy clay loam that is hard when dry and firm when moist and has moderate to strong blocky structure. The lower 6 inches is brown sandy clay loam that is hard when dry and friable when moist and has moderate subangular blocky structure.

The underlying material is pale-brown, calcareous sandy clay loam that is slightly hard when dry and friable when moist and has weak subangular blocky structure. Below a depth of 39 inches are stratified calcareous sand and gravel.

Altvan soils are well drained. Surface runoff is slow to medium; permeability is moderately slow in the surface layer, moderate in the subsoil, and rapid in the underlying material; and the water-holding capacity is moderate. The fertility is moderate.

Most areas are in native grass and are used for grazing and hay. The native vegetation consists of mid and short grasses. Areas once cultivated but now part of what formerly was a bombing range are in grass. Only a few scattered tracts are cultivated.

In Shannon County, Altvan soils are mapped only with Richfield soils.

Profile of an Altvan silt loam, located in the NE. corner of sec. 26, T. 42 N., R. 47 W., in an area formerly cultivated and now in grass:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, thick and thin, platy structure breaking to moderate, medium, granular; soft, friable; neutral; abrupt, smooth boundary.

A12—4 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to weak, subangular blocky; soft, friable; neutral; abrupt, wavy boundary.

B21t–9 to 15 inches, dark-brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure breaking to moderate, coarse and medium, blocky; hard, friable; mildly alkaline; gradual, smooth boundary.

B22t—15 to 25 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, coarse, blocky structure breaking to strong, fine, blocky; hard, firm; mildly alkaline; gradual, smooth boundary.

B3—25 to 31 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, coarse and medium, subangular blocky structure; hard, friable; mildly alkaline; gradual boundary.

C1ca—31 to 39 inches, pale-brown (10YR 6/3) sandy clay loam, yellowish brown (10YR 5/4) when moist; weak, coarse, subangular blocky structure; slightly hard, friable; moderately alkaline; calcareous; gradual boundary.

IIC2—39 to 60 inches, stratified sand and gravel; calcareous.

The A horizon ranges from 3 to 10 inches in thickness and from silt loam to loam in texture. The subsoil (B horizon) ranges from 10 to 26 inches in thickness and from silty clay loam to sandy clay loam and loam in the most clayey layer. The lowest layer of the subsoil is calcareous in places. In places a few rounded pebbles occur throughout the soil. The depth to sand and gravel ranges from 20 to 40 inches.

Altvan soils have more silt in the surface layer and more gravel in the underlying material than Tuthill soils. They differ from Keith and Richfield soils in having sand and gravel at a depth of less than 40 inches.

Anselmo Series

This series consists of deep, undulating to rolling, very friable, dark-colored, moderately coarse textured soils on uplands. These soils formed in wind-worked sand that contained enough silt to be slightly coherent. They are in the southeastern and northern parts of the county.

In a typical profile, the surface layer, about 4 inches thick, is grayish-brown sandy loam that has weak, granular structure. The subsurface layer, about 10 inches thick, is dark grayish-brown sandy loam that has very weak subangular blocky structure. Both layers are loose when dry and very friable when moist.

Below these layers is a transitional layer, about 12 inches thick, of brown sandy loam that has very weak subangular blocky structure. It is loose when dry and very friable when moist. Underlying this is brown sandy material that is structureless and loose.

Anselmo soils are well drained and porous. Surface runoff is slow, and permeability is moderately rapid. The fertility is moderate. Soil blowing is a hazard.

Most areas are in native grass and are used for grazing and hay. Scattered areas are cultivated. Spring-sown grain, corn, and alfalfa are the main crops. Some areas that were once cultivated are now seeded to tame grass. Trees planted for windbreaks do well on these soils.

Profile of Anselmo sandy loam, 0 to 5 percent slopes, located in the SE¼SW¼ sec. 1, T. 35 N., R. 42 W., in native pasture:

A11—0 to 4 inches, grayish-brown (10YR 5/2) sandy loam, very dark brown (10YR 2/2) when moist; weak, fine and medium, granular structure; loose, very friable; neutral; clear, smooth boundary.

A12—4 to 14 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; very weak, medium, subangular blocky structure breaking to very weak, medium, platy; loose, very friable; neutral; gradual, smooth boundary.

AC—14 to 26 inches, brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) when moist; very weak, coarse, subangular blocky structure; loose, very friable; neutral; gradual, smooth boundary.

C—26 to 40 inches, brown (10YR 5/3) sand, dark brown (10YR 4/3) when moist; structureless; loose; mildly alkaline.

The A horizon ranges from 4 to 14 inches in thickness. In places the A horizon is loamy sand. The AC horizon ranges from 6 to 14 inches in thickness and from sandy loam to loamy sand in texture. The underlying material ranges from sandy loam to sand. In places in the southeastern part of the county, fragments of calcareous sandstone are in the underlying material at depths below 40 inches. In the northern part of the county, the underlying sand is yellowish brown to light yellowish brown in color and in places has lenses of coarse sand and scattered rounded quartz gravel.

Anselmo soils are darker colored and less sandy than Valentine soils, and they are less sandy than Dunday soils. They are more sandy than Oglala soils. Anselmo soils lack the distinct B horizon of Manter and Tuthill soils.

Anselmo sandy loam, 0 to 5 percent slopes (AsB).—This soil is on uplands in the southeastern part of the county. The areas are mostly less than 500 acres in size. The soil is porous, and there is no runoff. Soil blowing is a hazard. The slope is nearly level to gently undulating.

This soil has the profile described as typical for the series. In many cultivated areas the structure of the surface layer has been destroyed, and sand particles on the surface are winnowed by wind action. In places the surface layer is loamy sand. Included in the areas mapped are small bodies of Dunday and Manter soils.

This soil is used for crops, pasture, and hay. Spring-sown grain, corn, alfalfa, and tame grass are suitable crops. Control of soil blowing and conservation of moisture are the main management problems in cultivated areas. Practices that supply organic matter, maintain fertility, and preserve structure are needed. (Sandy range site, capability unit IIIe-2, windbreak group 1)

Anselmo sandy loam, 5 to 9 percent slopes (AsC).—This undulating soil is on uplands in the southeastern part of the county. The areas are mostly less than 400 acres in size. The soil is porous, and there is little runoff. Soil blowing is a hazard. The dark-colored surface layer is generally thinner than that in the profile described as typical for the series. Cultivation readily destroys the granular structure. Sand particles on the surface are winnowed by wind action, and in places the surface layer is loamy sand.

Included in the areas mapped are small areas of Dunday and Tassel soils. Dunday soils are on foot slopes and in swales. Tassel soils are on ridgetops and knolls. Inclusions make up less than 15 percent of the total area mapped.

Most of this soil is used for grazing and hay. A few scattered tracts are cultivated. Spring-sown grain, corn, alfalfa, and tame grass are the main crops. Conservation of moisture and control of soil blowing and water erosion are the main management problems. Practices that supply organic matter and improve fertility are needed. (Sandy range site, capability unit IVe-3, windbreak group 1)

Anselmo-Valentine complex, 5 to 20 percent slopes (AvE).—Anselmo and Valentine soils each make up 35 to 50 percent of this complex. The complex is on uplands in the northern part of the county. The soils are closely associated, and they change with the relief within short distances. The areas range up to 1,000 acres in size. The slopes are undulating to rolling. Anselmo soils occupy the longer, more stable and uniform slopes, generally those of 5 to 9 percent gradient. Valentine soils are on the shorter and steeper slopes and the upper parts of ridges and knolls.

The surface layer of the Anselmo soils in this complex is thinner than that in the profile described for the series. The substratum is variable. In places it consists of calcareous sand stratified with thin layers of coarse sand and a few rounded pebbles. The Valentine soils in this part of the county formed in coarser sand than those in the southeastern part. In places this sand is stratified by size.

Included in some of the areas mapped are patches, generally less than 20 acres in size, of Manter and Tuthill soils that have very gentle and commonly concave slopes. Inclusions make up less than 15 percent of the total area mapped.

Nearly all of this complex is used for grazing. Scattered tracts that were cultivated before the establishment of the bombing range are now in either native grass or tame grass. These tracts consist mostly of Anselmo soils. Control of soil blowing is the main management problem. (Anselmo: Sandy range site, capability unit VIe-2, windbreak group 1. Valentine: Sands range site, capability unit VIe-2, windbreak group 7)

Badlands

Badlands (Ba) are in the northern part of the county. The slope range is 3 to 50 percent. The areas range up to 2,500 acres in size. This land type consists of barren, broken areas intermingled with grass-covered areas of mixed loamy and clayey soils that have not been defined or named. Part of it is in the form of escarpments that are partly stabilized with vegetation, and part is in the form of basins where gullies cut through gentle slopes at close intervals. The mixed clayey and loamy soils, which are in low areas, make up 25 to 75 percent of the area. Included in the areas mapped are small areas of Colby, Epping, Hisle, Kadoka, Orella, Swanboy, Ulysses, Wanblee, and Wortman soils. These inclusions generally make up less than 20 percent of any given area of this land type.

The small, scattered areas of loamy and clayey soils have value for grazing. Providing water for livestock is a problem in some areas. Proper range use helps to control erosion and prevent the expansion of the barren areas. (Clayey soils: Clayey range site, capability unit VIe-1, windbreak group 3. Loamy soils: Silty range site, capability unit VIe-1, windbreak group 2. Barren broken areas: capability unit VIIIs-1, no range site or windbreak group)

Bankard Series

This series consists of deep, loose, light-colored, coarse-textured soils. These nearly level soils are mainly on bottom lands along the Cheyenne River in the northwestern part of the county.

In a typical profile, the surface layer, about 2 inches thick, is grayish-brown loamy sand that is structureless, loose, and calcareous. Below the surface layer is a transitional layer, about 8 inches thick, consisting of light brownish-gray loamy sand that has weak, subangular blocky structure. It is loose and calcareous. Underlying this is light brownish-gray sand that is loose and calcareous.

Bankard soils are well drained to somewhat excessively drained. They are flooded in some years. Surface runoff is slow; permeability is rapid; and the water-holding capacity is low. The organic-matter content is low, and the fertility is low. Soil blowing is a hazard if the soils are cultivated.

These soils are used for grazing. The native vegetation consists mainly of tall and mid grasses and scattered stands of cottonwood trees. The low natural fertility, the low water-holding capacity, and susceptibility to soil blowing make these soils unsatisfactory for dryland cultivation. Selected areas could be irrigated under intensive management.

Profile of Bankard loamy sand, located in the SW¼NE¼ sec. 25, T. 41 N., R. 44 W., in native pasture:

A1—0 to 2 inches, grayish-brown (10YR 5/2) loamy sand, dark brown (10YR 3/3) when moist; structureless; loose; moderately alkaline; calcareous; clear, smooth boundary.

AC—2 to 10 inches, light brownish-gray (10YR 6/2) loamy sand, dark brown (10YR 4/3) when moist; very weak, medium, subangular blocky structure; loose; moderately alkaline; calcareous; clear, smooth boundary.

C1—10 to 50 inches, light brownish-gray (10YR 6/2) sand, brown (10YR 5/3) when moist; structureless; loose; moderately alkaline; calcareous; abrupt, smooth boundary.

C2—50 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; structureless; soft, friable; moderately alkaline; calcareous.

The A1 horizon ranges from 1 to 6 inches in thickness, but in most places it is thin enough that the plow layer is light colored if the soil is cultivated. The texture ranges from very fine sandy loam to fine sand. The AC horizon is absent in places. The underlying material is ordinarily stratified with thin layers of silt loam and coarse to very fine sand. In places it contains layers of gravel.

Bankard soils contain more sand and less silt than Haverson soils. They resemble Valentine soils but are calcareous and have a stratified substratum.

Bankard loamy sand (0 to 3 percent slopes) (Bk).—This soil occurs as long, narrow areas, few more than 300 feet wide, on bottom lands of the Cheyenne and White Rivers in the northern part of the county. In places the relief is uneven because of overflow channels that run parallel to the river.

This soil has the profile described as typical for the series. In places the surface is covered with 1 to 3 inches of recent sediment that ranges in texture from sand to clay. Included in some of the areas mapped are small areas of Haverson soils.

Most of this soil is used for grazing. It is good for wintering livestock because of its valley location and the stands of cottonwood trees. A few areas are used for native hay. Control of soil blowing is the chief problem if the surface layer is disturbed. Management that maintains an adequate vegetative cover is needed. (Overflow range site, capability unit VIe-2, windbreak group 1)

Barren Badlands

Barren badlands (Br) occurs in the northern part of the county. It consists of buttes, walls, gullies, and eroded floors. Bare, eroding exposures of geologic material make up at least 75 percent of the total area mapped. Included in the areas mapped are areas of vegetated soils similar to those included in Badlands.

The vegetated areas are so small and so scattered that using them for grazing is impractical. (Capability unit VIIIs-1, no range site or windbreak group)

Buffington Series

The Buffington series consists of deep, friable, dark-colored, moderately fine textured soils that are high in lime content. These soils are on terraces along the White River in the southwestern part of the county. They formed in alluvium derived partly from the chalk and chalky shale on the surrounding uplands.

In a typical profile, the surface layer, about 6 inches thick, is calcareous silty clay loam that has moderate granular structure and is soft when dry and friable when moist. This layer is gray in the upper part and grayish brown in the lower part. Below the surface layer is a transitional layer, about 13 inches thick, of pale-brown, calcareous silty clay loam that has moderate, medium, prismatic structure and is slightly hard when dry and friable when moist. The underlying material, to a depth of 36 inches, is very pale brown, blocky silty clay loam that is hard when dry and friable when moist. Below this is pale-brown, calcareous, structureless silt loam that is soft when dry and friable when moist. Spots and streaks of gypsum become common at a depth of about 50 inches.

Buffington soils are well drained. Surface runoff is medium to slow, permeability is moderately slow, and the water-holding capacity is high. The fertility is low. The lime content is high. Soil blowing is a hazard.

Most areas of these soils are used for grazing and hay. The native vegetation consists of mid and short grasses. A few small, scattered tracts are cultivated.

Profile of Buffington silty clay loam, located 200 feet south and 75 feet west of the NE. corner of sec. 15, T. 35 N., R. 47 W., in native pasture:

A11—0 to 3 inches, gray (10YR 5/1) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

A12—3 to 6 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, friable; moderately alkaline; calcareous, abrupt, smooth boundary.

AC—6 to 19 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure breaking to moderate, fine, blocky; slightly hard, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

C1—19 to 36 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; weak, fine and medium, blocky structure; hard, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

C2—36 to 65 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; structureless; soft, friable; moderately alkaline; calcareous; common small fragments of chalk; common, fine, distinct, segregated gypsum below a depth of 50 inches.

The A1 horizon ranges from 3 to 7 inches in thickness and in places is silt loam. In places the underlying material is stratified with sandy to clayey layers. Buried surface layers occur in places at depths of 20 to 40 inches.

Buffington soils have a thicker dark-colored surface layer than Manvel soils.

Buffington silty clay loam (0 to 5 percent slopes) (Bu).—This soil is on terraces along the White River in the southwestern part of the county. Most areas have slopes of less than 3 percent, though the range is from 0 to 5 percent. The areas range from 20 to 400 acres in size. This soil has the profile described as typical for the series.

Included in some of the areas mapped are small areas of Kyle and Manvel soils. Inclusions make up less than 15 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. Some fields that formerly were cultivated have been seeded to tame grass. Control of soil blowing and conservation of moisture are the main management needs in cultivated areas. (Clayey range site, capability unit IIIc-2, windbreak group 2)

Canyon Series

This series consists of shallow, gently sloping to steep, friable, light-colored, medium-textured, calcareous soils. These soils are in the eastern and southern parts of the county, on ridges and on the tops of knolls on rolling uplands and on rough, broken side slopes of stream valleys.

In a typical profile, the surface layer, about 2 inches thick, is light brownish-gray loam that is soft when dry and friable when moist. The transitional layer, about 2 inches thick, is brown, calcareous loam that is soft when dry and friable when moist and has weak subangular blocky structure. This layer contains fine bits of calcareous sandstone. The underlying material is pale-brown, calcareous, structureless loam that is soft when dry and very friable when moist. It contains fragments of sandstone up to 3 inches in diameter. This layer overlies bedded geologic materials consisting of very pale brown silt, very fine sand, and very fine grained sandstone.

Canyon soils are somewhat excessively drained. Surface runoff is medium to rapid, permeability is moderate to moderately rapid, and the water-holding capacity is low. The fertility is low. Water erosion and soil blowing are hazards if the vegetation is disturbed.

Most areas of these soils are used for grazing. The native vegetation consists of mid and short grasses and scattered, thin stands of ponderosa pine. Small spots that occur within larger areas of other soils are cropped along with those soils.

Profile of a Canyon loam, located in the NE¼NW¼ sec. 20, T. 37 N., R. 45 W., in native pasture:

A1—0 to 2 inches, light brownish-gray (10YR 6/2) loam, brown (10YR 5/3) when moist; weak, fine, granular structure; soft, friable; mildly alkaline; abrupt, smooth boundary.

AC—2 to 4 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, medium, subangular blocky structure; soft, friable; moderately alkaline; calcareous; common fine bits of sandstone; abrupt, smooth boundary.

C—4 to 10 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; structureless; moderately alkaline; calcareous; fragments of sandstone up to 3 inches in diameter; abrupt, smooth boundary.

R—10 to 20 inches, very pale brown (10YR 7/3), weakly cemented, fine-grained sandstone, pale brown (10YR 6/3) when moist; interbedded with very fine sand and silt; calcareous.

The A1 horizon ranges from 1 to 4 inches in thickness and is loam, very fine sandy loam, or silt loam in texture. It is calcareous in places. It ranges from light brownish gray to dark grayish brown in color. The AC horizon ranges from 2 to 10 inches in thickness and from light gray to brown in color. The depth to the bedded material ranges from 6 to 20 inches. This material is white to very pale brown in color.

Canyon soils are lighter colored than Rosebud soils, and they have less distinct layers and are more shallow. They contain more sand and less silt than Epping soils. They contain less sand than Tassel soils.

Canyon association, 18 to 40 percent slopes (CaF).—Canyon soils make up 60 to 85 percent of this association, and Oglala and Rosebud soils make up 15 to 40 percent. These are loamy soils on the sides of the valleys of deeply entrenched intermittent streams and tributary side draws. The areas of this association range up to 1,000 acres in size and are irregular in shape. Canyon soils are on the ridgetops and the upper part of steep slopes. They have a profile like the one described for the series. Oglala soils are on the mid and lower slopes in many areas, and Rosebud soils are on small flattened drainage divides and some mid slopes. In many places soils of both of these series have a slope of less than 20 percent. The areas range up to 20 acres in size.

Included in some of the areas mapped are Colby, Goshen, and Ulysses soils and Rock outcrop. Patches of Colby and Ulysses soils, few more than 10 acres in size, are on some ridgetops and on the upper part of some slopes, mostly south-facing and east-facing ones. Goshen soils occur as narrow strips along drainageways. Outcrops of sandstone, few more than 1 acre in size, are on the upper part of some slopes. Inclusions make up less than 10 percent of the total area mapped.

All of this association is used for grazing. The native vegetation consists of mid and short grasses and, on some north-facing slopes, scattered thin stands of stunted pines. Cultivation of these steep and dominantly shallow soils is impractical. Gullies form readily if the vegetation is disturbed. Seeding and other mechanical measures are impractical on the dominant Canyon soil. Management that maintains the native cover is needed. (Canyon: Shallow range site, capability unit VIIs–2, no windbreak group. Oglala and Rosebud: Silty range site, capability unit VIe–1, windbreak group 2)

Canyon-Rock outcrop association (18 to 40 percent slopes) (Cc).—Canyon soils make up 40 to 70 percent of this association; Rock outcrop, 10 to 25 percent; Oglala soils, 10 to 25 percent; and other soils, about 10 percent. This association occurs as rough, broken areas along the deeply entrenched, intermittent streams in the central and east-central parts of the county. The topography is more broken and irregular than that of Canyon association, 18 to 40 percent slopes. The areas are irregular in shape and range up to 1,500 acres in size. Canyon soils are on ridges and steep side slopes. They have a profile like the one described for the series. The outcrops are closely intermingled with Canyon soils. Few are more than 10 acres in size. Many are almost vertical exposures of nearly white sandstone. Oglala soils are on the lower part of slopes and generally have a gradient of less than 20 percent. They have the profile described for the Oglala series.

Included in the areas mapped are Alluvial land and Colby, Goshen, Keith, Rosebud, Tassel, and Ulysses soils. Alluvial land is on narrow bottom lands in ravines, and Goshen soils are on foot slopes. Areas of these two inclusions are generally not more than 5 acres in size. Patches of Colby, Keith, and Ulysses soils are on ridges. Rosebud soils are on mid slopes; in places, they form small drainage divides. Tassel soils are on ridges. The areas of Colby, Keith, Ulysses, Rosebud, and Tassel soils range up to 20 acres in size.

All of this association is used for grazing. It is not suitable for cultivation. Gullies form readily if the vegetation is disturbed. Seeding and other mechanical measures are impractical. Proper use of the range is the most practical way to control erosion. (Canyon: Shallow range site, capability unit VIIs–2, no windbreak group. Rock outcrop: capability unit VIIIs–1, no range site or windbreak group)

Clayey Land

Clayey land (Cy) consists of mixed clayey soil material. It is in badland basins in the northern part of the county.

The slope range is 0 to 6 percent. The areas generally are surrounded and dissected by gullies that carry away most of the runoff and sediment. The soil material generally is calcareous, but it varies as to color, texture, and structure. The surface layer ranges from silt loam to silty clay and generally is darkened by organic matter to a depth of 2 to 6 inches. The subsoil is light-colored material that ranges from silty clay loam to silty clay in texture. It has weak blocky structure, and the horizontal breakage planes are more distinct than the vertical ones. The underlying material ranges from silt loam to silty clay, and in most places it is layered.

Included in some of the areas mapped are areas of Loamy land and Hisle and Swanboy soils. Inclusions generally make up less than 25 percent of the total area mapped.

Almost all areas are in native grass and are used for grazing and hay. Erosion is a hazard if the vegetative cover is disturbed. Proper range use helps to control erosion. Providing adequate water for livestock is a problem in some areas. (Clayey range site, capability unit VIe-1, windbreak group 3)

Colby Series

The Colby series consists of gently sloping to rolling, very friable, calcareous soils. These soils formed in loess and are on the tops of ridges and knolls. They occur in all parts of the county.

In a typical profile, the surface layer, about 4 inches thick, is dark grayish-brown, calcareous silt loam that has weak, granular structure. It is soft when dry and very friable when moist. The transitional layer, about 6 inches thick, is grayish-brown, calcareous silt loam that has weak prismatic and subangular blocky structure and is soft when dry and very friable when moist. The underlying material is pale-brown, calcareous, structureless loam or silt loam that is soft when dry and very friable when moist.

Colby soils are somewhat excessively drained. Surface runoff is moderate to rapid, permeability is moderate to moderately rapid, and the water-holding capacity is high. The soils are high in lime content, low in organic-matter content, and low in fertility. They are easy to work, and they respond to management. Water erosion and soil blowing are hazards.

Many areas of Colby soils in the southeastern part of the county are cultivated. Winter wheat is the main crop. Areas of these soils in other parts of the county are in native grass and are used for grazing.

In Shannon County, Colby soils are mapped with Keith and Ulysses soils.

Profile of a Colby silt loam, located 0.2 mile west of the SE. corner of sec. 2, T. 36 N., R. 42 W., in a cultivated area:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft, very friable; moderately alkaline; calcareous; abrupt boundary.

AC—4 to 10 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, very coarse, prismatic structure breaking to weak, very coarse, subangular blocky; thin, very patchy clay films on vertical ped faces; soft, very friable; moderately alkaline; calcareous; clear, smooth boundary.

C—10 to 60 inches, pale-brown (10YR 6/3) loam or silt loam, brown (10YR 5/3) when moist; structureless; soft, very friable; moderately alkaline; calcareous; few, fine, faint iron stains at a depth of 50 inches.

The A horizon ranges from 2 to 6 inches in thickness and from light brownish gray to dark grayish brown in color. In most places where the color is dark, the layer is thin enough that plowing mixes it with the AC horizon, and the soil appears to be lighter in color. The AC horizon is 4 to 10 inches in thickness. Some profiles lack this layer. Colby soils generally are calcareous in the A horizon, but in places they have been leached to a depth of as much as 7 inches. Silt loam is the most common texture, but in places the texture is loam or very fine sandy loam.

Colby soils are calcareous nearer the surface than Keith and Ulysses soils. They lack the B horizon of Keith and Ulysses soils. The underlying material is softer than that of Canyon and Epping soils and lacks fragments of sandstone and siltstone.

Dawes Series

The Dawes series consists of deep, dark-colored soils that have a moderately thick to thick, medium-textured surface layer and a very firm clayey upper subsoil. These nearly level to very gently sloping soils are on foot slopes and in slightly depressed areas along upland drains in the southeastern part of the county. They formed in silty local alluvium.

In a typical profile, the silt loam surface layer is about 8 inches thick. The upper 6 inches is dark grayish brown and has weak granular structure. The lower 2 inches consists of grayish-brown prisms and blocks that are dusted light brownish gray on the sides and ends. Both parts of the surface layer are soft when dry and friable when moist.

The subsoil, about 17 inches thick, has prismatic structure that breaks to blocky. It is hard when dry and firm when moist. The upper 7 inches is very dark grayish-brown silty clay. The lower 10 inches is silty clay loam that is dark grayish brown in the upper half and brown in the lower part. The lower 5 inches is calcareous.

The underlying material is pale-brown, structureless silt loam that is soft when dry and very friable when moist. It is calcareous and has a few white spots and streaks of soft lime in the upper part. This material is underlain at a depth of about 60 inches by sandy loam that contains bits of sandstone.

Dawes soils are moderately well drained. Surface runoff is slow, and permeability is moderately slow to slow. The water-holding capacity is high, but the claypan releases moisture slowly to plants. The fertility is moderate. The claypan limits the thickness of the root zone.

The native vegetation consists of mid and short grasses. Many areas of this soil in the southeastern part of the county are cultivated. Winter wheat, barley, oats, and alfalfa are the main crops. Row crops are not suitable. Excessive tillage pulverizes the surface layer, which then crusts as it dries out after summer rains.

In Shannon County, Dawes soils are mapped in a complex with Richfield soils.

Profile of a Dawes silt loam, located 0.3 mile east and 0.2 mile south of the NW. corner of sec. 19, T. 36 N., R. 41 W., in a cultivated area:

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

A2—6 to 8 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; peds coated light brownish gray (10YR 6/2); dark gray (10YR 4/1) when moist; soft, friable, slightly sticky; neutral; clear, smooth boundary.

B21t—8 to 15 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) when moist; strong, medium, prismatic structure breaking to strong, medium, blocky; hard, very firm; mildly alkaline; clear, smooth boundary.

B22t—15 to 20 inches, dark grayish-brown (10YR 3/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to strong, medium, blocky; hard, firm; mildly alkaline; clear, smooth boundary.

B23t—20 to 25 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure breaking to strong, medium, blocky; hard, firm; mildly alkaline; calcareous; clear, smooth boundary.

C1ca—25 to 34 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; structureless; soft, very friable; moderately alkaline; calcareous; a few fine spots and streaks of soft lime; gradual, smooth boundary.

C2—34 to 60 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; structureless; loose, very friable; moderately alkaline; calcareous; sandy loam containing many bits of weathered sandstone at a depth of about 60 inches.

The thickness of the A horizon ranges from 6 to 16 inches. In places the A2 horizon has fine platy structure. The thickness of the subsoil layer ranges from 15 to 30 inches. In the upper part of the subsoil, the prisms are slightly rounded and are coated with gray dust in many places. The depth to lime ranges from 20 to 35 inches. The underlying material is generally silt or silt loam, but in places it is loam or sandy loam containing bits of calcareous sandstone.

Dawes soils have a more compact, clayey subsoil than Goshen, Keith, and Richfield soils. They have an A2 horizon, which is lacking in Richfield soils. They contain less salts than Mosher soils.

Dunday Series

This series consists of deep, gently sloping, loose, dark-colored soils on uplands in the southeastern part of the county. These soils formed in eolian sands.

In a typical profile, the surface layer, about 8 inches thick, is loose, dark grayish-brown loamy fine sand. Below the surface layer is a transitional layer, about 7 inches thick, of loose, grayish-brown loamy fine sand that has weak prismatic and subangular blocky structure. The underlying material is pale brown to very pale brown fine sand. It is structureless and loose.

Dunday soils are somewhat excessively drained. Surface runoff is slow, permeability is rapid, and the water-holding capacity is low. The fertility is moderate. Soil blowing is a hazard.

Most areas of these soils are used for grazing. The native vegetation consists of tall and mid grasses. Dunday soils support a more dense stand of grass than Valentine soils.

Profile of a Dunday loamy fine sand, located 150 feet west of fence and 100 feet south of the NE. corner of sec. 27, T. 36 N., R. 41 W.:

A11—0 to 5 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; structureless; loose; neutral; clear, smooth boundary.

A12—5 to 8 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, subangular blocky structure breaking to single grain; slightly hard, loose; neutral; clear, smooth boundary.

AC—8 to 15 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic and medium, subangular blocky structure crumbling easily to single grain; loose; neutral; gradual, smooth boundary.

C1—15 to 40 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; structureless; loose; neutral; gradual boundary.

C2—40 to 60 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; structureless; loose; neutral.

The dark-colored A1 horizon ranges from 6 to 20 inches in thickness, and in places it is black or very dark brown when moist. In places a thin layer of grayish-brown fine sand has been deposited on the surface.

Dunday soils have a thicker, darker colored surface layer than Valentine soils. They are more sandy than Anselmo soils and are better drained than Elsmere soils.

Dunday-Valentine complex, 0 to 5 percent slopes (DvB).—Dunday soils make up 40 to 80 percent of this complex, and Valentine soils make up 20 to 60 percent. These soils are on the sides of valleys and on small flats in the southeastern part of the county. The areas generally are less than 150 acres in size. Dunday soils have plane and concave slopes. They have the profile described as typical for the Dunday series. Valentine soils have convex slopes and are dominant in the more sloping areas. They have a profile like the one described for the Valentine series. Included in some of the more nearly level areas mapped are patches of Elsmere soils.

Nearly all of this complex is in native grass and is used for grazing and hay. A few small tracts, mostly Dunday soils, are cultivated. Alfalfa and tame grass are the principal crops. Control of soil blowing is the main management problem. Proper use is the only practical way to control blowing in areas of range. A combination of stubble mulching and wind stripcropping is effective on the Dunday parts of the complex that are cultivated. (Dunday: Sandy range site, capability unit IVe-4, windbreak group 1. Valentine: Sands range site, capability unit VIe-2, windbreak group 7)

Elsmere Series

This series consists of deep, nearly level to gently undulating, loose, dark-colored soils that formed in eolian and alluvial sands. These soils occupy basins and valleys in the southeastern part of the county. The water table is at a moderate depth.

In a typical profile, the surface layer, about 20 inches thick, is very friable, dark-gray loamy fine sand that is calcareous below a depth of 12 inches. This layer is underlain by a transitional layer, about 16 inches thick, of grayish-brown, loose, calcareous loamy sand. The underlying material is light-gray, structureless loamy sand or fine sand that is mottled with yellowish brown below a depth of 40 inches. It is calcareous to the water table, which is at a depth of 50 inches.

Elsmere soils are somewhat poorly drained. Surface runoff is very slow. Permeability is rapid above the water table, and the water-holding capacity is low, but the water table provides moisture for deep-rooted plants.

These soils are used for hay and grazing. The native vegetation consists of tall and mid grasses. In some years, Elsmere soils are too wet for cultivation. During extended dry periods, soil blowing is a hazard in areas where the vegetation has been removed.

Profile of an Elsmere loamy fine sand, located in the NW¼SW¼ sec. 4, T. 35 N., R. 42 W., about 300 feet northwest of large waterhole and 200 feet east of fence in native pasture:

A11—0 to 5 inches, dark-gray (10YR 4/1) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; loose, very friable; neutral; clear boundary.

A12—5 to 7 inches, very dark gray (10YR 3/1) loamy fine sand, black (10YR 2/1) when moist; weak, medium, subangular blocky structure; soft, very friable; neutral; clear boundary.

A13—7 to 20 inches, dark-gray (10YR 4/1) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, medium to coarse, prismatic structure; soft, very friable; mildly alkaline; calcareous at depth of about 12 inches; abrupt boundary.

AC—20 to 36 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; structureless; loose; moderately alkaline; calcareous; diffuse boundary.

C—36 to 60 inches, light-gray (10YR 7/2) loamy sand, pale brown (10YR 6/3) when moist; yellowish-brown (10YR 5/6) mottles; structureless; loose; moderately alkaline; calcareous to depth of 50 inches; water table at depth of 50 inches.

The A horizon ranges from 8 to 24 inches in thickness. In places a buried or dark-colored layer is at a greater depth. The soil becomes calcareous at a depth ranging from 10 to 50 inches. The water table is at a depth ranging from 3 to 6 feet. It is closest to the surface early in the growing season, and it recedes to a depth of 50 inches or more during the summer.

Elsmere soils are darker colored than Bankard soils, and they have a water table at a moderate depth. They are free of lime to a greater depth than Loup soils, which have a water table closer to the surface.

Elsmere-Loup loamy fine sands (0 to 5 percent slopes) (Ef).—Elsmere soils make up 65 to 75 percent of this complex; Loup soils, about 20 to 30 percent; and other soils, less than 15 percent. This mapping unit is in basins and valleys in the southeastern part of the county. The slope is mostly less than 3 percent but ranges up to 5 percent on the outer edges of the mapped areas. The areas range up to 500 acres in size. Many are roughly oval in shape. Elsmere soils are nearly level to very gently undulating. They have the profile described as typical for the series. Loup soils are in slightly depressed areas, where the water table is closer to the surface.

Included in some of the areas mapped are Dunday and Valentine soils. These inclusions, few more than 10 acres in size, generally are on the outer edges of valleys, but in places they occur in the valleys, as isolated ridges and mounds that range up to 100 feet in width. Dunday soils have plane to concave slopes. Valentine soils have short, convex slopes.

Most areas are used for grazing and native hay. A few areas that once were cultivated have been seeded to tame grasses and legumes. Perennial clover has been interseeded in some native grass meadows.

Wetness from the fluctuating water table is the chief hazard if these soils are cultivated. Elsmere soils are affected only in wet years, but in most years the water table is at or near the surface of the Loup soils early in the growing season. Soil blowing is a hazard, and careful management is needed if the soils are cultivated. (Elsmere: Subirrigated range site, capability unit IVw–1, windbreak group 4. Loup: Subirrigated range site, capability unit Vw–1, windbreak group 4)

Epping Series

This series consists of shallow, gently sloping to steep, very friable, light-colored, calcareous soils that formed in materials weathered from bedded siltstone. These soils are on uplands, mostly in the northeastern and southwestern parts of the county.

In a typical profile, the surface layer, about 2 inches thick, is light brownish-gray, calcareous silt loam that is soft when dry and friable when moist. The underlying layer, about 4 inches thick, is calcareous, light-gray silt loam that is slightly hard when dry and friable when moist and has weak granular structure. It contains a few fine fragments of siltstone. At a depth of 6 inches is light-gray, calcareous silt loam in which there are bits and fragments of siltstone. This material is hard when dry and friable when moist. It contains thin layers that are slightly cemented by lime, and it is difficult to penetrate with an augur or spade.

Epping soils are well drained to excessively drained. Surface runoff is rapid, and permeability is moderately slow. The fertility is low. Water erosion and soil blowing are hazards if the vegetation is disturbed.

Most areas of these soils are used for grazing. The native vegetation consists of a thin stand of short and mid grasses.

Profile of an Epping silt loam, located 0.8 mile west of road junction west of Kyle and 300 feet south of road in the SE¼ sec. 20, T. 40 N., R. 41 W., in native pasture. (Laboratory sample 6613–6615):

A1—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; soft, very friable; mildly alkaline; calcareous; clear, smooth boundary.

C—2 to 6 inches, light-gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) when moist; weak, fine, granular structure and weak, fine, horizontal bedding; moderately alkaline; calcareous; few fine films of soft lime between horizontal bedding planes; few bits and fragments of siltstone; gradual, smooth boundary.

R—6 to 20 inches, light-gray (10YR 7/2) siltstone, silt loam when crushed, grayish brown (10YR 5/2) when moist; bedded Brule Formation; hard, friable; moderately alkaline; calcareous; common fine films of soft lime between horizontal bedding planes; common bits and fragments of siltstone.

The A horizon ranges from 1 to 4 inches in thickness. In places there is an AC horizon, up to 6 inches in thickness, below the A horizon. It has weak, subangular blocky structure. In some areas fragments and chunks of siltstone, up to 3 inches in diameter, make up 5 to 10 percent of the soil mass of these two layers. The depth to bedded siltstone ranges from 5 to 20 inches. In some places the underlying formation contains hard layers of siltstone, but in others the formation is unconsolidated and soft. The color of the underlying formation ranges from very pale brown to pink or pinkish white and influences the color of the soil.

Epping soils are more shallow, are calcareous nearer the surface, and lack the B horizon of Kadoka soils. They are more silty than Canyon soils, and they have a harder substratum than Colby soils.

Epping complex, 9 to 40 percent slopes (EhF).—Epping soils make up 50 to 60 percent of this complex; Kadoka soils, 30 to 40 percent; and other soils, about 10 percent. This complex is on ridges and valley side slopes in the northeastern and southwestern parts of the county. The areas are irregular in shape and range up to 500 acres in size. Epping soils are on ridgetops and on the upper part of the steeper slopes, which usually have gradients of more than 18 percent. These soils have the profile described as typical for the series. Kadoka soils are on the smoother, more gently sloping parts of the complex and have gradients of less than 18 percent. These soils have a profile similar to the one described for the Kadoka series.

Included in some of the areas mapped are Colby, Goshen, Keith, and Ulysses soils. Goshen soils are on foot slopes. Colby, Keith, and Ulysses soils are on rolling ridgetops. Inclusions generally are less than 10 acres in size. In places, outcrops of siltstone, generally less than 3 acres in size, are on the upper part of slopes.

All of this complex is in native grass and is used for grazing. Scattered pines and cedars are on the upper part of some north-facing slopes. Erosion is a hazard if the vegetation is disturbed. Management that keeps the grass cover in good or excellent condition is needed. The Epping soils are too steep for seeding and other mechanical measures. (Epping: Shallow range site, capability unit VIIs-2, no windbreak group. Kadoka: Silty range site, capability unit VIe-1, windbreak group 2)

Epping-Kadoka silt loams, 9 to 18 percent slopes (EkE).—Epping and Kadoka soils each make up 35 to 60 percent of this complex. The areas are on rolling to hilly uplands in the northeastern and southwestern parts of the county. They are irregular in shape and range up to 700 acres in size. Intermittent streams are not so deeply entrenched as in Epping complex, 9 to 40 percent slopes.

Epping soils are on ridgetops, on the upper part of slopes, and on the shorter slopes. They have a profile like the one described for the series. Kadoka soils are on the mid and lower slopes and on some of the broader drainage divides. They have a profile like the one described for the Kadoka series.

Included in some of the areas mapped are Colby, Goshen, Keith, Ulysses, Wanblee, and Wortman soils. Goshen soils are along some of the upland drains. Small areas of Colby, Keith, and Ulysses soils are on some of the rounded ridges. Wanblee and Wortman soils are on some of the foot slopes. Small areas of Kadoka silt loam, 5 to 9 percent slopes, are also in the area. Inclusions make up less than 10 percent of the total area mapped.

Nearly all of this complex is in native grass and is used for grazing. Some areas of Kadoka soils are used for native hay. Erosion is a hazard if the vegetation has been removed. Maintaining the grass cover helps to control erosion. In most areas, seeding and other mechanical measures are feasible. (Epping: Shallow range site, capability unit VIs-2, no windbreak group. Kadoka: Silty range site, capability unit VIe-1, windbreak group 2)

Epping-Rock outcrop complex (9 to 40 percent slopes) (Er).—Epping soils make up 40 to 70 percent of this complex; areas of Rock outcrop, 10 to 25 percent; Kadoka soils, 10 to 25 percent; and other soils, about 10 percent. This complex is on buttes, escarpments, and side slopes and on canyon walls along deeply dissected drainageways, in the northeastern and southwestern parts of the county. The topography is more broken and irregular than that of Epping complex, 9 to 40 percent slopes, and there are more outcrops of siltstone. The areas are irregular in shape and in places are less than 300 feet in width. They range up to 600 acres in size. Epping soils are on ridges and steep side slopes. They have a profile like the one described for the series. Rock outcrop, which consists of siltstone, is intermingled with Epping soils on the upper part of steep slopes and in places occurs as almost vertical canyon walls. These outcrops are mostly less than 2 acres in size, but some range up to 30 acres. Epping soils and Rock outcrop are in areas that generally have a gradient of more than 20 percent; Kadoka soils are in areas that have a gradient of less than 18 percent.

Included in the areas mapped are Alluvial land and Colby, Keith, and Ulysses soils. Alluvial land occurs as very narrow strips on the bottoms of some canyons. Small areas of Colby, Keith, and Ulysses soils are on ridges and on some south- and east-facing slopes. Inclusions make up less than 10 percent of the total area mapped.

This complex is used for grazing. The areas of Rock outcrop are mostly bare, but there are clumps of pine and cedar in and near the outcrops on some north-facing slopes. Erosion is a hazard if the vegetation is not adequate. Active gullies have formed in places. Maintenance of a good grass cover is needed to help control erosion. Except in some areas of Kadoka soils, seeding and other mechanical measures are not feasible. (Epping: Shallow range site, capability unit VIIs-2, no windbreak group. Rock outcrop: capability unit VIIIs-1, no range site or windbreak group)

Goshen Series

This series consists of deep, nearly level, dark-colored, medium-textured soils. These soils formed in alluvium washed down from adjacent slopes. They occupy narrow swales and foot slopes on uplands.

In a typical profile, the surface layer, about 14 inches thick, is dark-gray and dark grayish-brown silt loam that is black when moist. It is soft when dry and very friable when moist. The subsoil, about 26 inches thick, is dark grayish-brown silty clay loam in the upper part and grades to silt loam in the lower part. It has weak prismatic and moderate blocky structure. The upper part is hard when dry and friable when moist; the lower part is slightly hard when dry and friable when moist. The underlying material is brown to pale-brown, calcareous, structureless silt loam. It is slightly hard when dry and friable when moist. In this material are white streaks of soft lime.

Goshen soils are moderately well drained. The fertility is high. Surface runoff is slow, permeability is moderate, and the water-holding capacity is high.

The native vegetation consists of mid grasses mixed with lesser amounts of tall and short grasses. Many areas in the eastern part of the county are cultivated.

Profile of Goshen silt loam, 0 to 3 percent slopes, located 1,500 feet west of the NE. corner of the SE¼ sec. 16, T. 38 N., R. 46 W., in native pasture:

A11—0 to 1 inch, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, fine, granular structure; soft, very friable; neutral; abrupt, smooth boundary.

A12—1 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A13—4 to 14 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, coarse, granular structure; soft, very friable; neutral; clear, smooth boundary.

B2t—14 to 20 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, coarse, prismatic structure; hard, friable; mildly alkaline; noncalcareous; gradual, wavy boundary.

B22t—20 to 34 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, coarse, blocky structure; slightly hard, friable; mildly alkaline; noncalcareous; gradual boundary.

B3—34 to 40 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; slightly hard, friable; mildly alkaline; noncalcareous; gradual boundary.

C1ca—40 to 56 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; structureless; slightly hard, friable; moderately alkaline; calcareous; few, fine, faint streaks of soft lime; gradual boundary.

C2ca—56 to 60 inches, pale-brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) when moist; structureless; slightly hard, friable; moderately alkaline; calcareous; few, fine, faint streaks of soft lime.

The A horizon ranges from 7 to 20 inches in thickness. The B horizon ranges from 15 to 30 inches in thickness and is distinctly more clayey than the A horizon. The depth to lime ranges from 22 to 50 inches. In places the silty underlying material changes abruptly to light-gray loam or sandy loam that contains bits of limy sandstone.

Goshen soils have thicker dark-colored layers than Keith and Richfield soils. They are not underlain by bedrock as are Kadoka and Rosebud soils. They have a less clayey subsoil than Dawes soils, and they are better drained than Hovén soils and are less clayey in the subsoil.

Goshen silt loam, 0 to 3 percent slopes (GoA).—This soil is in valleys and in narrow swales, mainly in the eastern part of the county. Slopes are concave or dish shaped. The areas are long and narrow, generally less than 200 feet in width, and are mostly less than 25 acres in size. This soil has the profile described as typical for the series.

Included in the areas mapped are small areas of Dawes, Hoven, Keith, Richfield, and Rosebud soils. Keith, Richfield, and Rosebud soils are on the outer edges. Hoven soils occur where water is ponded. Inclusions make up less than 10 percent of the total area mapped.

Most areas in the southeastern part of the county are cultivated, and the rest are in range. Winter wheat is the main crop, but spring-sown grain, corn, and alfalfa also are grown. Crops are seldom damaged by lack of moisture, but small grain tends to lodge in wet years. Management that maintains the organic-matter content and fertility and preserves soil structure is needed. (Overflow range site, capability unit IIc-1, windbreak group 2)

Gravelly Land

Gravelly land (Gr) consists of mixed gravelly soils and soil materials on upland ridges, terrace breaks, and the upper part of some escarpments, in the western and northern parts of the county. Many of the slopes are more than 18 percent, though the range is from 6 to 30 percent. The surface layer ranges from sand to clay loam and is underlain by light-colored sandy to clayey material that in many places grades to gravel at a depth of 20 inches. In some places the gravelly material is as much as several feet thick; in others it is underlain by silt, clay, or shale at a depth of less than 3 feet.

Included in some of the areas mapped are small areas of Altvan, Manter, Pierre, and Samsil soils. Inclusions generally make up less than 30 percent of the total area mapped.

All areas are in native grass and are used for grazing. Erosion is a hazard where vegetation is lacking. Proper range use is the best way to control erosion. Because of the steep slopes and gravelly surface, seeding and other mechanical measures are impractical. (Shallow range site, capability unit VIIs-2, no windbreak group)

Haverson Series

This series consists of deep, nearly level, friable to firm, light-colored, calcareous, medium-textured and moderately fine textured soils. These soils formed in alluvium. They are on bottom lands along the White River and some of its tributaries. Areas on the lower part of the flood plains are flooded in some years.

In a typical profile, the surface layer, about 3 inches thick, is grayish-brown, calcareous loam that is soft when dry and very friable when moist. Below it is a transitional layer, about 9 inches thick, of light brownish-gray, calcareous, very fine sandy loam that has very weak prismatic structure and is soft when dry and very friable when moist. The underlying material is very pale brown, calcareous, structureless, stratified alluvium that ranges in texture from very fine sand to silt loam. In this material, at vertical intervals of about 15 inches, are layers of grayish-brown to dark grayish-brown silt loam less than 3 inches thick.

Haverson soils are moderately well drained to well drained. Surface runoff is slow, permeability ranges from moderate to moderately rapid, and the depth to the water table is 10 to 20 feet. The fertility is low, and the water-holding capacity is moderate. The lime content is high. Soil blowing is a hazard.

Many areas are in native grass and are used for pasture and hay. Some areas are used for wintering livestock. The native vegetation consists of tall, mid, and short grasses and scattered thickets of broadleaf trees and shrubs. A few areas are in crops, and alfalfa is the main crop. Haverson soils are well suited to irrigation.

Profile of a Haverson loam in the SE. corner of sec. 30, T. 37 N., R 45 W., 200 feet south and 50 feet east of bridge on U.S. Highway 18:

A1—0 to 3 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft, very friable; moderately alkaline; calcareous; abrupt, wavy boundary.

AC—3 to 12 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; soft, very friable; moderately alkaline; calcareous; clear, smooth boundary.

A1b—12 to 17 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure; soft, very friable; moderately alkaline; calcareous; gradual boundary.

ACb—17 to 22 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; soft, very friable; moderately alkaline; calcareous; clear boundary.

C—22 to 60 inches, very pale brown (10YR 7/3) stratified loam, silt loam, and very fine sand, pale brown (10YR 6/3) when moist; structureless; soft to loose, very friable; moderately alkaline; strongly calcareous; thin layers of grayish-brown (10YR 5/2) A1b material that is very dark gray (10YR 3/1) when moist, at intervals of about 15 inches.

The A horizon ranges from 1 to 5 inches in thickness, from light brownish gray to dark grayish brown in color, and from very fine sandy loam to silty clay in texture. The AC horizon ranges up to 10 inches in thickness. In places the underlying stratified alluvium is loose fine sand or very fine sand at depths generally below 30 inches. The color of the underlying material ranges from white to yellowish brown, the range at a given location depending upon the source of the alluvium.

Haverson soils contain more silt and clay and less sand than Bankard soils. They are not so well drained as Colby soils, and they have layers of contrasting textures.

Haverson loam, high, 0 to 3 percent slopes (HhA).—This soil is along the White River on high bottoms where there is no risk of flooding from streams. The slope is generally less than 1 percent, though the range is from 0 to 3 percent. The areas range up to 300 acres in size. The profile is like the one described for the series. The organic-matter content is low, and the water-holding capacity is moderate.

Included in the areas mapped are small areas of Haverson silty clay loam, 0 to 3 percent slopes, and of mixed alluvial soils similar to those in Alluvial land. The alluvial soils are along stream channels. Inclusions make up less than 10 percent of the total area mapped.

Most areas are in native grass and are used for grazing. A few areas are cultivated. Alfalfa is the main crop. Management that increases the organic-matter content and improves tilth and fertility is needed. Soil blowing is a hazard if the vegetation is disturbed. Live vegetation or well-managed crop residue helps to control blowing. (Silty range site, capability unit IIIc-2, windbreak group 2)

Haverson loam, low, 0 to 3 percent slopes (HlA).—This soil is on bottom lands along the White River and its tributaries. It is flooded in about 1 year out of 5. Many areas have slopes of 1 percent or less, though the range is from 0 to 3 percent. The areas are irregular in shape, usually long and narrow, and about 250 to 400 feet in width. The surface layer is lighter colored in the areas along the White River than in those along some of the tributaries.

Included in some of the areas mapped are small areas of Alluvial land and of Haverson silty clay loam. Inclusions make up less than 10 percent of the total area mapped.

This soil is used mostly for grazing and native hay. It is excellent for wintering livestock. The vegetation consists of native grass and scattered thickets of trees and shrubs. Some areas, mainly along tributaries of the White River, are cultivated. Alfalfa and oats are the main crops. Floods usually are more beneficial than damaging because they supply additional moisture. Soil blowing is a hazard. Management that maintains a good vegetative cover and increases the organic-matter content improves fertility and helps to limit flood damage and to control soil blowing. (Overflow range site, capability unit IIIw-1, windbreak group 2)

Haverson silty clay loam, 0 to 3 percent slopes (HoA).—This soil is on bottom lands along the White River and some of its tributaries. It is flooded in some years. Many areas have slopes of 1 percent or less, though the range is from 0 to 3 percent. Most areas are long and narrow but in places widen to as much as one-fourth of a mile. The surface layer ranges from very fine sandy loam to silty clay but is commonly silty clay loam to a depth of 20 inches or more.

Included in some of the areas mapped are small areas of Haverson loam, low, and Kyle clay, alkali. The Haverson soil generally is close to the main stream channel, and the Kyle soil is on the outer edges of the stream valley. Inclusions make up less than 10 percent of the total area mapped.

Most areas are used for grazing and native hay. Many are used for wintering livestock. The vegetation consists of native grass and scattered thickets of native trees and shrubs. A few areas are cultivated. Alfalfa is the main crop. Soil blowing is a hazard if the vegetation is removed. Management that maintains a good vegetative cover and increases the organic-matter content improves fertility and helps to limit flood damage and control soil blowing. (Overflow range site, capability unit IIIw-1, windbreak group 2)

Hisle Series

This series consists of nearly level to gently sloping, firm, light-colored, fine-textured soils that have a claypan. These soils formed in fine-textured material of variable thickness over clay shale. They are on flats and on plane or concave slopes along drains, on uplands in the western part of the county.

In a typical profile, the surface layer, about 1 inch thick, is light-gray silt loam that is soft when dry and very friable when moist. The subsoil, about 8 inches thick, is light brownish-gray clay that is very hard when dry and firm when moist. The upper 1 inch has moderate columnar and strong blocky structure. The lower 7 inches has weak prismatic and strong blocky structure and is calcareous. The underlying material, to a depth of about 20 inches, is pale-olive to light-gray clay that has weak subangular blocky structure and is very hard when dry and firm when moist. This material is calcareous and contains fine streaks of lime and salts. Numerous small pebbles and shale fragments are in the lower part. Gray to light olive-gray, weathered shale and clay are at a depth of about 20 inches. Bedded gray shale is at a depth of 26 inches.

Hisle soils are moderately well drained to well drained, are low in fertility, and are poor in tilth. Surface runoff is slow to medium. Permeability is very slow, and the alkaline subsoil releases moisture slowly to plants.

These soils are not suitable for cultivation and are used for grazing. The native vegetation consists of a sparse stand of mid and short grasses.

Profile of Hisle clay, located 1,400 feet west and 400 feet north of the SE. corner of sec. 2, T. 39 N., R. 47 W., in native pasture:

A2—0 to 1 inch, light-gray (10YR 7/2) silt loam, dark grayish brown (10YR 4/2) when moist; when dry, forms a crust less than 1/8 inch thick; weak, very thin, platy structure breaking to very weak, fine, granular; soft, very friable; neutral; abrupt, smooth boundary.

B&A—1 to 2 inches, light brownish-gray (2.5YR 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium and fine, columnar structure breaking to strong, medium, blocky; tops of columns thinly coated with A2 material; very hard, firm, sticky, plastic; mildly alkaline; clear, wavy boundary.

B2t—2 to 9 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) when moist; weak, medium, prismatic structure breaking to strong, medium, blocky; very hard, firm, sticky, plastic; strongly alkaline; calcareous; gradual, wavy boundary.

C1—9 to 13 inches, pale-olive (5Y 6/3) clay, olive (5Y 5/3) when moist; moderate, medium, blocky structure; very hard, firm, sticky, plastic; strongly alkaline; calcareous; clear, wavy boundary.

C2ca—13 to 20 inches, light-gray (2.5Y 7/2) clay containing numerous small pebbles and shale fragments, olive (5Y 4/3) when moist; few, coarse, distinct, dark yellowish-brown mottles; weak, medium and fine, subangular blocky structure; very hard, firm, sticky, plastic; strongly alkaline; calcareous; common, fine, distinct segregations of lime and salt, and very fine concretions of lime, iron, and manganese; clear, wavy boundary.

R&C—20 to 26 inches, gray (5Y 6/1) and light olive-gray (5Y 6/2) clay and weathered, soft, fractured, platy clay shale; 50 to 70 percent of mass is shale fragments; very dark gray and olive gray (5Y 3/1, 4/2) when moist; common, medium, distinct, dark yellowish-brown and yellowish-brown mottles; hard, firm, sticky; mildly alkaline; few, fine, faint segregations of lime and salt; clear, wavy boundary.

R—26 to 60 inches, light-gray (5Y 6/1) bedded shale; dark yellowish-brown and yellowish-brown iron stains and mottles in seams.

The A horizon ranges from 1 to 3 inches in thickness, from silt loam to silty clay in texture, and from light gray to pale olive in color. In places rounded pebbles, fragments of iron, and concretions of manganese are scattered on the surface. The subsoil ranges from 5 to 14 inches in thickness. In most areas the color of the subsoil reflects the variations in the color of the underlying shale. The depth to shale ranges from 20 to 40 inches.

Hisle soils are more clayey than Wanblee soils, and they are better drained than Minatare soils. They differ from Swanboy soils in having columnar structure in the upper part of the subsoil.

Hisle clay (0 to 9 percent slopes) (Hs).—This soil occurs on uplands in the western part of the county. It has a claypan. The slopes are plane or concave and are mostly less than 5 percent, though the range is from 0 to 9 percent. The areas are irregular in shape and range from 10 to 300 acres in size. The surface has many depressed spots that are 3 to 6 inches lower than the surrounding soil. The profile of this soil is the one described as typical for the series.

Included in some of the areas mapped are small areas of Kyle, Pierre, Samsil, and Swanboy soils. Inclusions are less than 5 acres in size and make up less than 20 percent of the total area mapped.

Nearly all of this soil is in native grass and is used for grazing. In many areas the range condition has declined, and cactus is a conspicuous part of the vegetation. Because of the strongly alkaline claypan below the thin surface layer, this soil is not suitable for cultivation. Management that maintains the cover of native grass is needed. Range pitting and interseeding help to improve the grass cover in areas that are in poor range condition. (Thin Claypan range site, capability unit VIs-1, no windbreak group)

Hisle-Swanboy clays, saline (0 to 6 percent slopes) (Ht).—These soils are in narrow valleys on uplands in the western part of the county. Hisle and Swanboy soils each make up 40 to 60 percent of this complex. The areas generally are long and narrow. Few of them are more than 100 feet in width, and in most places they are less than 25 acres in size. The surface has many depressed spots that range from 2 to 25 feet in diameter and are 3 to 6 inches lower than the surrounding soil. Runoff collects in these spots and remains until it evaporates.

These soils are more saline than typical Hisle and Swanboy soils. In many areas ground-water seepage causes salts to collect and rise into the soil material. The underlying material is moist, even in dry periods. The Hisle soil has a thin subsoil that has less distinct columnar structure than that in the soil described as typical for the Hisle series. Both the Hisle and the Swanboy soils in this mapping unit have nests of visible salts within 10 inches of the surface. In many depressions, nests of visible salts occur within 5 inches of the surface, and the soils have little or no structure. In some of the better drained areas, Kyle soils are included in the areas mapped, and the Swanboy soils are lacking.

These soils are in native vegetation and are used for grazing. The vegetation includes alkali sacaton, a mid grass that ordinarily does not grow on Hisle and Swanboy soils. Inland saltgrass increases in abundance when the range is in poor condition. The main management need is to encourage the growth of alkali sacaton and other mid grasses and prevent the spread of inland saltgrass. Interseeding helps to restore the desired plant cover in areas that are in poor range condition. (Saline Lowland range site, capability unit VIs-1, no windbreak group)

Hoven Series

This series consists of deep, level, dark-colored soils in closed depressions on uplands. These soils formed in local alluvium washed down from adjacent slopes. They have a very firm, clayey subsoil.

In a typical profile, the surface layer, about 6 inches thick, is gray silt loam that is soft when dry and very friable when moist. The subsoil, about 6 inches thick, is gray clay that has columnar and blocky structure. It is very hard when dry, very firm when moist, and sticky and plastic when wet. The underlying material is gray to grayish-brown clay that is also very hard when dry, very firm when moist, and sticky and plastic when wet. It grades to pale-brown fine sand at a depth of about 42 inches.

Hoven soils are somewhat poorly drained to poorly drained, and they are moderately fertile. Runoff is ponded, and permeability is slow to very slow. In wet years, the use of these soils for crops is limited by wetness in spring and during much of the growing season. Crops drown in some years.

Some of the smaller depressions in the eastern part of the county are used for small grains. Other areas are in native grass and are used for grazing and hay. The native vegetation consists of mid grasses, mostly western wheatgrass.

Profile of Hoven silt loam, located 1,265 feet south and 100 feet east of the NW. corner of sec. 30, T. 36 N., R. 41 W., in native pasture:

A2—0 to 6 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak to moderate, thin, platy structure breaking to weak, fine, granular; soft, friable; neutral; abrupt, wavy boundary.

B2t—6 to 12 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; weak, coarse, columnar structure breaking to strong, medium, blocky; extremely hard, very firm, sticky, plastic; moderately alkaline; diffuse, smooth boundary.

C1—12 to 30 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; weak, coarse, irregular blocky structure to massive; extremely hard, very firm, sticky, plastic; strongly alkaline; diffuse, smooth boundary.

C2—30 to 38 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; structureless; very hard, very firm, sticky, plastic; mildly alkaline; diffuse, wavy boundary.

IIC3—38 to 42 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark brown (10YR 4/3) when moist; structureless; soft, friable; mildly alkaline; gradual boundary.

IIC4—42 to 60 inches, pale-brown (10YR 6/3) fine sand, yellowish brown (10YR 5/4) when moist; structureless; loose; mildly alkaline.

The A horizon ranges from 2 to 9 inches in thickness. In cultivated areas, a gray crust, about ¼ inch thick, forms when the soil is dry. The subsoil ranges from 6 to 20 inches in thickness and has weak to strong columnar structure in the upper part. The underlying material is variable in texture and color. In many places it is calcareous. The reaction ranges from mildly alkaline to strongly alkaline.

Hoven soils are grayer in color, have a thinner surface layer, and are more poorly drained than Dawes soils. They are less saline than Minatare soils.

Hoven silt loam (0 to 1 percent slopes) (Hv).—This soil is in closed depressions on uplands in almost all parts of the county. The areas are oval to circular in shape and are mostly from 2 to 40 acres in size. This soil has the profile described as typical for the series.

Included in some of the areas mapped are spots of Dawes, Goshen, and Mosher soils on the outer edges of the depressions. Inclusions make up less than 10 percent of the total area mapped.

In the eastern part of the county, many of the smaller depressions are in fields that are cultivated. These commonly are cultivated along with the rest of the field and are used principally for winter wheat. Some are mowed for native hay. In other places this soil is used for grazing.

Seasonal wetness, poor tilth, and restricted rooting of plants in the dense, compact, clay subsoil limit the use of this soil for cropland. The native grass cover deteriorates if this soil is grazed in spring and early in summer. (Closed Depression range site, capability unit VIs-1, no windbreak group)

Kadoka Series

This series consists of moderately deep to deep, nearly level to strongly sloping, friable, dark-colored, medium-textured soils that formed in material weathered from bedded silt and siltstone. These soils are on uplands in the northeastern and southwestern parts of the county.

In a typical profile, the surface layer, about 3 inches thick, is dark grayish-brown silt loam that is soft when dry and friable when moist.

The subsoil is about 18 inches thick. The upper part is grayish-brown silty clay loam that has weak prismatic and moderate subangular blocky structure. The middle part is pale-brown silt loam that has weak prismatic and moderate subangular blocky structure. These two layers are hard when dry and friable when moist. The lower part is light-gray, calcareous silt loam that has weak subangular blocky structure and is slightly hard when dry and friable when moist. This material contains bits of gritty siltstone.

The underlying material is white, calcareous silt loam and weathered, bedded siltstone. It is structureless, and it is hard when dry and friable when moist.

Kadoka soils are well drained, are moderately fertile, and are easy to work. Surface runoff is medium, and permeability is moderate. Most of these soils are in the part of the county that receives the least rainfall.

Most areas are used for grazing and hay. Some of the more gently sloping areas are cultivated. Winter wheat, spring-sown grains, and alfalfa are the main crops. The native vegetation consists mainly of mid and short grasses.

Profile of Kadoka silt loam, 5 to 9 percent slopes, located in the SE¼ sec. 20, T. 40 N., R. 41 W., 0.8 mile west and 200 feet south of road junction west of Kyle, in native pasture (Laboratory No. 6608-6612):

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

B21t—3 to 8 inches, grayish-brown (10YR 5/2) silty clay loam, dark gray (10YR 4/1) when moist; mixture of light-gray (10YR 7/2) particles, brown (10YR 5/3) when moist; weak, medium and fine, prismatic structure breaking to moderate, fine and very fine, subangular blocky; thin patchy clay films on all ped faces; hard, friable; neutral; gradual, smooth boundary.

B22—8 to 14 inches, pale-brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) when moist; patchy, grayish-brown (10YR 5/2) ped coats; dark gray (10YR 4/1) when moist; weak, medium and fine, prismatic structure breaking to moderate, fine and very fine, subangular blocky; thin patchy clay films on all ped faces; hard, friable; mildly alkaline; clear, smooth boundary.

B3ca—14 to 21 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure breaking to weak, medium and fine, subangular blocky; thin very patchy clay films on ped faces; slightly hard, friable; common, fine, weathered fragments of siltstone; moderately alkaline; calcareous; soft segregated lime occurring as films between horizontal bedding planes and between vertical faces of prisms; gradual, smooth boundary.

C&R—21 to 30 inches, white (7.5YR 8/1) silt loam and weathered, bedded silt and siltstone, light brownish gray (10YR 6/2) when moist; structureless; hard, friable; strongly alkaline; calcareous; common, soft, segregated lime occurring as films between horizontal bedding planes.

The A horizon ranges from 2 to 8 inches in thickness. The combined thickness of the B horizon ranges from 8 to 22 inches. That part of the subsoil that is distinctly more clayey than the surface layer ranges from 4 to 15 inches in thickness. On slopes of less than 6 percent, the upper part of the B horizon is darker colored than that in the profile described. The depth to lime ranges from 11 to 25 inches. Segregations of lime can be either in the lower B horizon or in the underlying C horizon. The underlying geologic material consists of bedded siltstone ranging in hardness from soft layers that are easy to dig to layers that are hard enough to make chipping with a spade difficult. The color of the underlying material ranges from very pale brown to pinkish white or white.

Kadoka soils are more silty than Rosebud soils. They are more shallow than Keith soils and are underlain by bedrock. Kadoka soils are thicker than Epping soils, and they have distinct subsoil layers.

Kadoka silt loam, 0 to 3 percent slopes (KaA).—This soil is on uplands in the northeastern and southwestern parts of the county. The areas are irregular in shape and are generally less than 40 acres in size. Surface runoff is slow.

The surface layer is 5 to 8 inches thick. In places the subsoil is thicker than that in the profile described for the series. Included in some of the areas mapped are small areas of Dawes, Goshen, and Keith soils. Inclusions make up less than 10 percent of the total area mapped.

This soil is suitable for both cropland and range. A few areas are cultivated, but most are in native grass and are used for grazing and hay.

Moisture conservation is the main management problem. Soil blowing is a hazard in mismanaged fields. Good use of crop residue helps to conserve moisture, to control erosion, and to improve fertility and tilth. Stubble mulching is desirable if winter wheat is part of the cropping sequence. Proper range use helps to conserve moisture in areas of native grass. (Silty range site, capability unit IIIc–1, windbreak group 2)

Kadoka silt loam, 3 to 5 percent slopes (KaB).—This soil occurs as scattered areas on uplands throughout the northeastern and southwestern parts of the county. The areas are irregular in shape and range up to 100 acres in size.

The surface layer averages about 5 inches in thickness, and in places the subsoil is thicker than that in the profile described for the series. Included in some areas mapped are small areas of Epping and Goshen soils. Epping soils are on some ridgetops and knolls. Goshen soils are in slightly depressed swales. Inclusions are less than 5 acres in size and make up less than 10 percent of the total area mapped.

This soil is suitable for both cropland and range. A few areas are used mainly for winter wheat. A large acreage is used for grazing and hay. Control of water erosion and conservation of moisture are the main management needs. Stubble mulching helps to meet these needs in cultivated areas. Proper range use is effective in areas of native grass. (Silty range site, capability unit IIIe–1, windbreak group 2)

Kadoka silt loam, 5 to 9 percent slopes (KaC).—This soil is on uplands throughout the northeastern and southwestern parts of the county. The areas range up to 150 acres in size. The profile of this soil is like the one described for the series.

Included in some of the areas mapped are small areas of Colby, Epping, Goshen, Keith, Ulysses, and Wortman soils. Goshen and Wortman soils are on some foot slopes and along narrow drains. Epping soils are on the crests of some slopes. Small patches of Colby, Keith, and Ulysses soils occur on some south-facing and east-facing slopes. Inclusions make up less than 15 percent of the total area mapped.

This soil is suitable for both cropland and range. Most of the acreage is used for grazing and native hay. A few areas are used for winter wheat, spring-sown grains, and forage crops. The main management needs are control of water erosion and conservation of moisture. These needs can be met by stubble mulching in combination with contouring or by the use of crop residue in combination with terracing. (Silty range site, capability unit IVe–2, windbreak group 2)

Kadoka-Epping silt loams, 3 to 9 percent slopes (KbC).—Kadoka soils make up 45 to 60 percent of this complex; Epping soils, 35 to 45 percent; and other soils, less than 10 percent. This complex is on uplands in the northeastern and southwestern parts of the county. The areas range up to 200 acres in size.

The Kadoka soils are on the longer mid and lower slopes, which range mostly from 3 to 5 percent. The Epping soils are on ridges and on the shorter slopes. The soils of this complex have profiles like the ones described for their respective series.

Included in some areas mapped are small areas of Colby, Goshen, Keith, Ulysses, and Wortman soils. Goshen and Wortman soils are on some foot slopes and along upland drains. Colby, Keith, and Ulysses soils are on south-facing and east-facing slopes. Inclusions occur in patches and make up less than 10 percent of the total area mapped.

Most of this complex is in native grass. A few areas are in crops. Hay and pasture are the best uses. Epping soils erode readily and are droughty.

The principal management needs are control of water erosion and conservation of moisture. Proper range use meets these needs adequately in areas of native grass. Intensive management is needed to control water erosion in areas used for crops. (Kadoka: Silty range site, capability unit IIIe-1, windbreak group 2. Epping: Shallow range site, capability unit VIs-2, no windbreak group)

Keith Series

This series consists of deep, nearly level to rolling, friable, dark-colored, medium-textured soils that formed in loess. These soils are on uplands in almost all parts of the county.

In a typical profile, the surface layer, about 7 inches thick, is grayish-brown silt loam that is soft when dry and very friable when moist.

The subsoil is about 32 inches thick. The upper 21 inches is grayish-brown silty clay loam that has weak prismatic and moderate subangular blocky structure. It is hard when dry and friable to firm when moist. The lower part is light brownish-gray to light-gray, calcareous silty clay loam that has weak prismatic and subangular blocky structure. It is hard when dry and friable when moist. This material contains a few fine spots and streaks of soft lime.

The underlying material is light-gray, calcareous silty clay and loam. It is slightly hard to soft when dry and friable when moist.

Keith soils are well drained, are fertile, and are easy to work. Surface runoff is slow to medium, permeability is moderate, and the water-holding capacity is high.

The native vegetation consists of mid and short grasses. Large areas of these soils in the eastern part of the county are cultivated. Winter wheat is the main crop. In other parts of the county, Keith soils are in native grass and are used for grazing and hay. Much of the winter wheat produced in the county is grown on Keith soils. Trees planted for windbreaks grow well.

Profile of a Keith silt loam, located 0.55 mile west and 90 feet south of the fence corner in the NE. corner of sec. 15, T. 37 N., R. 48 W., in a cultivated field (Laboratory No. 6631-6640):

Ap1—0 to 4 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; fine granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.

Ap2—4 to 7 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure breaking to weak, fine, granular; slightly hard, friable; small worm casts; neutral; abrupt, smooth boundary.

B21t—7 to 11 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, prismatic structure breaking to moderate subangular blocky and weak, fine, granular; thin patchy clay films; slightly hard, friable; common worm casts and filled worm channels; neutral; gradual, smooth boundary.

B22t—11 to 15 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, prismatic structure breaking to moderate, fine, subangular blocky; thin patchy clay films; slightly hard, friable; common worm casts and filled worm channels; neutral; clear, smooth boundary.

B23t—15 to 21 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) rubbing to dark grayish brown (10YR 4/2) when moist; very weak, medium and coarse, prismatic structure breaking to moderate, fine and medium, subangular blocky; thin continuous clay films and moderate patchy clay films; hard, friable; common worm casts and filled worm channels; mildly alkaline; clear, smooth boundary.

B24t—21 to 28 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) rubbing to dark grayish brown (10YR 4/2) when moist; weak, medium and coarse, prismatic structure breaking to moderate, fine and medium, subangular blocky; thin continuous clay films and moderate patchy clay films; very hard, firm; common worm casts and filled worm channels; mildly alkaline; gradual, smooth boundary.

B31ca—28 to 32 inches, light brownish-gray (2.5Y 6/2) silty clay loam, olive brown (2.5YR 4/3) when moist; weak, coarse, prismatic structure breaking to moderate, fine and medium, subangular blocky; thin continuous clay films; hard, friable; few worm casts and filled worm channels; moderately alkaline; calcareous; very few fine threads and seams of soft segregated lime; gradual, smooth boundary.

B32ca—32 to 39 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure breaking to weak, fine and medium, subangular blocky; thin patchy clay films; hard, friable; few filled worm channels; moderately alkaline; calcareous; common fine threads and seams of soft segregated lime; gradual, smooth boundary.

C1ca—39 to 47 inches, light-gray (10YR 7/2) silty clay, grayish brown (10YR 5/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; thin patchy clay films on prisms; slightly hard, friable; moderately alkaline; calcareous; few fine threads and seams of soft segregated lime; clear, wavy boundary.

IIC2ca—47 to 60 inches, light-gray (10YR 7/2) loam, grayish brown (10YR 5/2) when moist; structureless; soft, friable; strongly alkaline; calcareous; few fine threads and seams of soft segregated lime.

The A horizon ranges from 4 to 10 inches in thickness and from silt loam to very fine sandy loam in texture. The subsoil ranges from 12 to 40 inches in thickness. The subsoil always contains a layer that is distinctly more clayey than the surface layer. In most places this layer is silty clay loam, has weak to moderate structure, and is friable to firm when moist. The depth to lime ranges from 15 to 34 inches. The underlying loess ranges from pale brown to light gray in color and from silt loam to very fine sandy loam in texture. The loess in which the soil formed ranges from 3 to 15 feet in thickness and is underlain by clayey to loamy materials or by bedrock.

Keith soils have a thicker surface layer and more distinct layers in the subsoil than Colby and Ulysses soils, and the depth to lime is greater. They have a less clayey subsoil than Dawes and Richfield soils. Keith soils are thicker than Kadoka and Rosebud soils, and they lack the fragments or layers of sandstone or siltstone at a depth of less than 36 inches. They are also more silty than Rosebud soils. Keith soils are not so dark colored as Goshen soils.

Keith silt loam, 0 to 3 percent slopes (KeA).—This soil is on broad tablelands and upland divides in the eastern part of the county and on moderately high stream terraces in other parts of the county. The areas range up to 500 acres in size. Runoff is slow. In most areas the texture of the surface layer is silt loam, but in cultivated areas in the vicinity of Batesland, it is loam. In places the subsoil is only 20 inches thick.

Included in some of the areas mapped are small areas of Dawes, Goshen, Hoven, and Richfield soils. Dawes and Richfield soils are on flats and in slight depressions. Hoven soils are in small spots where water is ponded. Goshen soils occur in narrow strips, less than 50 feet wide, along poorly defined drains. Inclusions are seldom more than 3 acres in size and make up less than 10 percent of the total area mapped.

This soil is suitable for both cropland and range. Most areas in the vicinity of Batesland are cultivated. Winter wheat is the main crop; oats, barley, corn, and alfalfa are grown also. Some scattered areas in other parts of the county are used for crops, but many areas are in native grass and are used for grazing and hay. A few small tracts are irrigated.

Conservation of moisture is the main management problem. Soil blowing is a hazard on clean-fallowed fields. Good use of crop residue helps to conserve moisture, to control erosion, and to maintain fertility and tilth in cultivated areas. Stubble mulching is desirable if wheat and fallow are included in the cropping sequence. Proper range use helps to conserve moisture in areas of native grass. (Silty range site, capability unit, IIc–1, windbreak group 2)

Keith silt loam, 3 to 5 percent slopes (KeB).—This soil is on smooth slopes, generally 300 feet or more in length, on uplands in the western and eastern parts of the county. Runoff is medium. The areas range up to 500 acres in size.

The surface layer is about 6 inches thick and in places is loam. The subsoil is about 24 inches thick. The depth to lime averages about 20 inches.

Included in some of the areas mapped are small areas of Goshen, Kadoka, Rosebud, and Ulysses soils. Goshen soils are on narrow strips along upland drains. Ulysses soils are on the upper part of some slopes. Rosebud soils are on the upper part of some north-facing slopes and on the shoulders of some drains. Inclusions are less than 10 acres in size and make up less than 15 percent of the total area mapped.

In the western part of the county, most of this soil is in native grass and is used for grazing and hay. Many areas in the eastern part are cultivated. Winter wheat is the main crop; oats, barley, corn, and alfalfa are grown also. Control of erosion and conservation of moisture are the main management needs. Either stubble mulching alone or the use of crop residue in combination with contouring is effective in meeting these needs on cropland. These practices also help to maintain fertility and tilth. Proper range use helps to control erosion and conserve moisture in areas of native grass. (Silty range site, capability unit IIe–1, windbreak group 2)

Keith-Colby silt loams, 9 to 12 percent slopes (KhD).—Keith soils make up 45 to 55 percent of this complex; Colby soils, 30 to 40 percent; and other soils, less than 15 percent. The complex is on well-rounded slopes on rolling uplands. It is in all parts of the county except the extreme southeastern.

Keith soils are on mid and lower slopes. Their surface layer is about 5 inches thick. Their subsoil is about 15 inches thick and is slightly less clayey than that in the profile described for the series. Colby soils are on the tops of ridges and knolls and on the steeper short slopes. They have a profile like the one described for the Colby series.

Included in some of the areas mapped are small areas of Canyon, Epping, Goshen, Kadoka, Oglala, and Ulysses soils. In many areas Ulysses soils are on the upper part of slopes. Inclusions make up less than 15 percent of the total area mapped.

This complex is suitable for both cropland and range. Most areas are in native grass and are used for grazing and hay. Some areas in the vicinity of Batesland are cultivated. Control of erosion is the main management problem. Stubble mulching in combination with terracing is effective on cropland. Proper range use is effective in areas of native grass. (Keith: Silty range site, capability unit IVe–1, windbreak group 2. Colby: Thin Upland range site, capability unit IVe–5, windbreak group 2)

Keith-Colby silt loams, 12 to 18 percent slopes (KhE).—Keith soils make up 40 to 50 percent of this complex; Colby soils, 35 to 45 percent; and other soils, less than 15 percent. This complex is similar to Keith-Colby silt loams, 9 to 12 percent slopes. It differs mainly in having steeper slopes.

Keith soils are on mid and lower slopes. Their surface layer is only about 4 inches thick. Their subsoil is about 12 inches thick and in places is brown or pale brown. Colby soils are on ridges and on the upper part of side slopes. They have a profile like the one described for the Colby series.

Small areas of Ulysses soils, on mid and upper slopes, make up more than 15 percent of some of the areas mapped. Also included in some areas are patches of Canyon, Epping, Goshen, Kadoka, and Oglala soils.

Most of this complex is in native grass and is used for grazing and hay. The grass cover helps to control erosion. A few areas north of Batesland are cultivated. Because of the slopes, erosion control is difficult if crops are grown. (Keith: Silty range site, capability unit VIe–1, windbreak group 2. Colby: Thin Upland range site, capability unit VIe–1, windbreak group 2)

Keith-Rosebud silt loams, 0 to 3 percent slopes (KrA).—Keith and Rosebud soils each make up 40 to 55 percent of this complex. Keith soils are dominant in most places, but Rosebud soils are dominant in the more undulating areas. The complex is on upland divides, mainly in the vicinity of Batesland. Surface runoff is slow. The areas are irregular in shape and generally are less than 50 acres in size.

Keith soils are on the longer and smoother slopes. They have a profile like the one described for the series. Rosebud soils are on slight rises. In many areas they are more silty than the soil described as typical for the Rosebud series.

Included in some of the areas mapped are patches of Dawes, Goshen, Hoven, and Richfield soils. Inclusions make up less than 5 percent of the total area mapped.

This complex is suitable for both cropland and range. Most areas are cultivated. Winter wheat is the main crop; oats, barley, corn, and alfalfa are grown also. Conservation of moisture is the main management problem, but soil blowing is a hazard if the soils are mismanaged. Good use of crop residue helps to conserve moisture, to control erosion, and to maintain fertility and tilth. Stubble mulching is desirable if winter wheat and fallow are part of the cropping sequence. (Silty range site, capability unit IIc–1, windbreak group 2)

Keith and Ulysses silt loams, 5 to 9 percent slopes (KuC).—Some areas of this mapping unit consist mainly of Keith soils, and some mainly of Ulysses soils. Others consist of about an equal amount of each. These soils are on uplands in most parts of the county. The areas range up to 400 acres in size.

Keith soils have a thinner surface layer and subsoil than the soil described as typical for the Keith series, and the depth to lime ranges from 15 to 20 inches. Ulysses soils have a profile like the one described for the Ulysses series. In places where these two soils occur together, Ulysses soils are on the upper part of slopes.

Included in some of the areas mapped are small areas of Canyon, Colby, Epping, Goshen, Kadoka, and Rosebud soils. In many areas Colby soils are on ridgetops. Inclusions make up less than 15 percent of the total area mapped.

These soils are suitable for both cropland and range. Most of the acreage in the western part of the county is in native grass and is used for grazing and hay. Many areas in the eastern part of the county are cultivated. Winter wheat is the main crop. Control of erosion and conservation of moisture are the main management needs. Either stubble mulching in combination with contour farming or the use of crop residue in combination with terracing is effective in meeting these needs on cropland. Proper range use is effective in areas of native grass. (Silty range site, capability unit IIIe-1, windbreak group 2)

Kyle Series

This series consists of deep, firm, nearly level to gently sloping, moderately dark colored soils that formed in alluvial clay material. These soils are on terrace flats and fans in the western part of the county.

In a typical profile, the surface layer, about 2 inches thick, is gray, calcareous clay that is hard when dry and firm when moist. The transitional layer, about 4 inches thick, is dark-gray, calcareous clay that has weak prismatic and moderate blocky structure and is hard when dry and firm when moist.

The subsoil is about 32 inches thick. The upper 15 inches is gray, calcareous clay that has weak prismatic and moderate blocky structure. It is very hard when dry and very firm when moist. The lower part is light olive-gray, calcareous clay that has moderate to weak blocky structure and is very hard when dry and very firm when moist. It contains spots and streaks of soft lime and other salts.

The underlying alluvial material is light olive-gray to pale-olive, calcareous clay to silty clay that has weak blocky structure and is hard when dry and firm when moist. This material contains nests of gypsum crystals and spots of lime and other salts.

Kyle soils are moderately well drained to well drained and are moderately fertile. They have poor tilth and are difficult to work. Surface runoff is slow to medium, and permeability is slow. Much of the water enters vertical cracks, which form as the soil dries. The water-holding capacity is high, but water is released slowly to plants.

The native vegetation consists of mid grasses and very small amounts of short grasses that increase under grazing use. Most areas are in native grass and are used for grazing and hay. A few tracts are used for crops, mainly spring-sown grains, alfalfa, and tame grasses.

Profile of Kyle clay, alkali, 0 to 3 percent slopes, located 75 feet west and 200 feet south of the NE. corner of the SE¼ sec. 23, T. 38 N., R. 47 W., in native pasture (Laboratory No. 8869–8876):

A1—0 to 2 inches, gray (5Y 5/1) clay, dark olive gray (5Y 3/2) when moist; weak, medium and thick, platy structure breaking to moderate, very fine, granular; hard, firm; mildly alkaline; calcareous; clear, smooth boundary.

AB—2 to 6 inches, dark-gray (5Y 4/1) clay, olive gray (5Y 4/2) when moist; continuous gray (5Y 5/1) ped coats; weak, medium, prismatic structure breaking to moderate, fine and very fine, blocky; thin very patchy clay films on all ped faces; hard, firm; moderately alkaline; calcareous; gradual, smooth boundary.

B21—6 to 14 inches, gray (5Y 5/1) clay, olive gray (5Y 4/2) when moist; weak, medium and coarse, prismatic structure breaking to moderate, medium and fine, blocky; thin continuous clay films on all prism faces and thin patchy clay films on faces of blocks; very hard, very firm; moderately alkaline; calcareous; gradual, smooth boundary.

B22—14 to 21 inches, gray (5Y 5/1) clay, olive gray (5Y 4/2) when moist; weak, very coarse, prismatic structure breaking to moderate, medium and fine, blocky; thin patchy clay films on all ped faces; very hard, very firm; moderately alkaline; calcareous; clear, smooth boundary.

B31cs—21 to 27 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; patchy gray (5Y 5/1) ped coats; dark gray (5Y 4/1) when moist; moderate, medium and fine, blocky structure; thin patchy clay films on all ped faces; very hard, very firm; mildly alkaline; calcareous; few fine segregations of soft lime and few fine segregations of salt; gradual, smooth boundary.

B32cs—27 to 38 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; patchy gray (5Y 5/1) ped coats, dark gray (5Y 4/1) when moist; weak, medium and fine, blocky structure; thin patchy clay films on all ped faces; very hard, very firm; mildly alkaline; calcareous; common fine segregations of soft lime and common fine segregations of salt; gradual, smooth boundary.

C1cs—38 to 44 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; weak, medium and fine, blocky structure; thin patchy clay films on all ped faces; hard, firm; mildly alkaline; calcareous; few fine segregations of soft lime and common fine segregations of salt; common nests of gypsum crystals; clear, smooth boundary.

C2—44 to 53 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 5/3) when moist; weak, medium and fine, blocky structure; thin patchy clay films on all ped faces; small slickenside faces oriented angularly; hard, very firm; mildly alkaline; calcareous; few fine segregations of soft lime and fine salt; few small nests of gypsum crystals; common iron and manganese stains.

The combined thickness of the A and AB horizons ranges from 2 to 7 inches. This includes a light brownish-gray crust, about one-quarter inch thick, that forms when the soil is dry. The surface layer is clay, silty clay, or silty clay loam. In places it is noncalcareous. The combined thickness of the subsoil ranges from 15 to 40 inches, and the structure is very weak to moderate. In places the underlying alluvium is stratified with layers of silty clay loam and silt loam and contains a few rounded pebbles and thin layers of coarse sand. Vertical cracks, up to 1 inch wide, extend through the subsoil when the soil is dry.

Kyle soils have a thicker subsoil, generally contain more sodium and other salts, and are deeper to shale than Pierre soils. They are darker colored, contain slightly less clay, have a B horizon and are less alkaline than Swanboy soils.

Kyle clay, alkali, 0 to 3 percent slopes (KyA).—This soil is on terraces and flats along the White River and its tributaries, in the western part of the county. The slope commonly is 1 percent or less, though the range is from 0 to 3 percent. Runoff is slow. The areas range up to 500 acres in size. This soil has the profile described as typical for the series. In places the underlying alluvium is stratified with layers of silty clay loam and silt loam.

Included in some of the areas mapped are small areas of Hisle and Swanboy soils. These inclusions are on fans on the outer edge of the terraces and make up less than 5 percent of the total area mapped.

Most of this soil is used for grazing and native hay. A few areas are cultivated. Spring-sown grains, alfalfa, and tame grasses are the main crops. Native hay and grazing are the most suitable uses for this soil, but feed crops can be grown.

This soil is hard when dry and puddles readily when wet. It should not be used for row crops or left fallow. Because of low available water and a high content of sodium in the soil, row crops do not grow well. The surface becomes granulated and is susceptible to blowing if left bare. Timeliness of tillage is important. Strip-cropping and growing high-residue crops help to control soil blowing and to improve tilth. A conservation cropping system that includes tame grasses and legumes also helps to control erosion, to maintain fertility, and to improve tilth. (Clayey range site, capability unit IVs-1, no windbreak group)

Kyle clay, alkali, 3 to 5 percent slopes (KyB).—This soil is on terrace fronts and on foot slopes and fans on the outer edge of stream valleys, in the western part of the county. Many areas are narrow and less than 80 acres in size. Runoff is medium to rapid. The subsoil is thinner than that in the profile described for the series.

Included in some of the areas mapped are small areas of Hisle and Swanboy soils. Inclusions make up less than 5 percent of the total area mapped.

All of this soil is used for grazing and native hay. The terrace fronts are short and irregular; consequently, tillage is impractical. Gullies form easily where the vegetation has been disturbed. Proper range use helps to control erosion and to conserve moisture. (Clayey range site, capability unit VIe-1, no windbreak group)

Kyle silty clay, 0 to 3 percent slopes (KzA).—This soil is on stream bottoms and low terraces along intermittent streams in the western part of the county. Meandering channels are a feature of this unit. In some years, flooding is a hazard on the lower levels. Runoff is slow. The areas are long and narrow; few are more than 150 feet wide.

The surface layer is about 7 inches thick and in places is silty clay or silty clay loam. The subsoil ranges from 10 to 40 inches in thickness and from very weak to moderate in structure. In many areas both the surface layer and the subsoil are darker colored than those in the profile described for the series.

Included in the areas mapped are small areas of Alluvial land and Kyle clay, alkali. Inclusions make up less than 10 percent of the total area mapped.

Nearly all of this soil is in native grass and is used for grazing and hay. A few small areas are cultivated, mainly to grow alfalfa. Slow permeability and poor tilth limit suitability for cultivated crops. Native hay and grazing are the most suitable uses, but some feed crops can be grown. Proper range use helps to maintain range productivity. (Clayey range site, capability unit IVs-1, windbreak group 3)

Lamo Series

This series consists of deep, nearly level, friable, dark-colored, medium-textured soils that have a water table at a moderate depth. These soils are in basins and stream valleys in the northern part of the county.

In a typical profile, the surface layer, about 9 inches thick, is dark-gray, calcareous silt loam that is soft when dry, friable when moist, and sticky when wet. Below this is a transitional layer, about 7 inches thick, of gray, calcareous silt loam that has weak subangular blocky to moderate granular structure. This material is friable when moist and sticky when wet.

The underlying material is light-gray to white, calcareous, stratified alluvium that consists of layers of silt loam and silty clay over loose sand. This material is friable or firm when moist and sticky when wet. The upper part has subangular blocky structure. Yellowish-brown mottles are common.

Lamo soils are poorly drained. The water table is at a depth of 2 to 5 feet. It is close to the surface early in the growing season, and it seldom recedes below a depth of 5 feet. Runoff is slow, and permeability is moderately slow. The fertility is high, but the high water table somewhat limits use of the soils for crops.

Most areas of these soils are used for native hay. The native vegetation consists of tall and mid grasses.

Profile of a Lamo silt loam, located in the NW¼ sec. 26, T. 42 N., R. 43 W., 300 feet north of gate in fence, in hay meadow:

A11—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak to moderate, medium and fine, granular structure; friable, sticky; moderately alkaline; calcareous; abrupt, smooth boundary.

A12—6 to 9 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, medium, subangular blocky structure breaking to moderate, medium, granular; friable, sticky; moderately alkaline; calcareous; clear, smooth boundary.

AC—9 to 16 inches, gray (10YR 5/1) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure breaking to moderate, medium, granular; friable, sticky; moderately alkaline; calcareous; clear, smooth boundary.

C1g—16 to 23 inches, light-gray (10YR 7/1) silty clay, dark grayish brown (10YR 4/2) when moist; common mottles, yellowish brown (10YR 5/4, 5/6) when moist; moderate, coarse, subangular blocky structure; firm, sticky, plastic; moderately alkaline; calcareous; clear, smooth boundary.

C2—23 to 34 inches, white (10YR 8/2) heavy silt loam, light brownish gray (2.5Y 6/2) when moist; moderate, medium, subangular blocky structure; friable, sticky; moderately alkaline; calcareous; gradual, smooth boundary.

C3g—34 to 58 inches, silt loam, gray (5Y 6/1, 5/1) when moist; common mottles, yellowish brown (10YR 5/4, 5/6) when moist; structureless; friable, sticky; moderately alkaline; calcareous; clear, smooth boundary.

IIC4—58 to 65 inches, sand, gray (5Y 5/1) when moist; structureless; loose; mildly alkaline; calcareous.

The combined thickness of the A1 and AC horizons ranges from 12 to 36 inches. The texture of the A1 horizon generally is silt loam, but where wind has deposited sandy material, the texture is loam or fine sandy loam. In places the C horizon is bluish-gray, plastic silty clay loam. Gray sand generally is at a depth of 3 to 6 feet. The entire profile is calcareous, and in places segregated lime occurs in some layers of the C horizon.

Lamo soils are more silty than Elsmere and Loup soils. They are darker colored than Haverson soils, and they developed in areas where the water table is at a moderate depth.

Lamo-Elsmere complex (0 to 5 percent slopes) (Le).—Lamo and Elsmere soils each make up 40 to 45 percent of this complex. Other soils make up the rest. This complex consists of poorly drained silty and sandy soils in basins and valleys in the northern part of the county. The slope generally is less than 3 percent, though the range is from 0 to 5 percent. The areas range up to 100 acres in size.

Lamo soils occur on smooth slopes of less than 3 percent. They have the profile described for the series. Elsmere soils are in the more undulating areas where sandy materials have partially filled the valleys.

Included in some of the areas mapped are small areas of Dunday, Loup, and Valentine soils. Dunday and Valentine soils are on the outer edges of valleys. Loup soils are in low spots within areas of Elsmere soils. Inclusions make up less than 15 percent of the total area mapped.

This complex is used for hay or grazing. Some of the better drained areas are in alfalfa. Wetness is the principal limitation, especially on Lamo soils; the water table is near the surface early in the growing season. Management that maintains a cover of tall grasses is needed. (Lamo: Subirrigated range site, capability unit Vw–1, windbreak group 4. Elsmere: Subirrigated range site, capability unit IVw–1, windbreak group 4)

Loamy Land

Loamy land (Lm) is made up of successive deposits of alluvium. It is on long slopes in Badland basins in the northern part of the county. The slope range is 0 to 6 percent. The areas range up to 700 acres in size. Gullied drainageways cut through or go around these areas; consequently, runoff from the adjacent slopes has little or no effect.

The surface layer consists of light-colored and dark-colored silt loam or loam that has weak platy and granular structure. Below this is light-colored material of about the same texture as the surface layer. This material has weak prismatic and blocky structure. The horizontal breakage planes are more distinct than the vertical ones. In most places the soil material is calcareous at the surface, but in places it is leached of lime to a depth of as much as 14 inches. The underlying materials are almost white in color and generally are stratified. The texture ranges from fine sand to silty clay.

Included in some of the areas mapped are small areas of Epping, Kadoka, and Swanboy soils and a few areas of a clayey soil similar to Clayey land. Inclusions usually make up less than 20 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. A few areas are cultivated as parts of adjacent fields. Oats, barley, sorghum, and alfalfa are the main crops. Most of the soil material is high in lime content, low in organic-matter content, and low in fertility. Water erosion and soil blowing are hazards if the vegetation is removed. Proper range use helps to control erosion in areas of native grass. Grasses and legumes protect cropland. (Silty range site, capability unit VIe–1, windbreak group 2)

Loup Series

This series consists of deep, nearly level, friable to very friable, dark-colored, moderately coarse textured soils. These soils formed in sandy to loamy alluvium and were influenced by a high water table. They occupy basins and stream valleys in the southeastern part of the county.

In a typical profile, the surface layer, about 5 inches thick, is dark-gray, calcareous very fine sandy loam that is soft when dry and friable when moist. It is underlain by about 9 inches of light-gray, calcareous loamy fine sand that is mottled with yellowish brown. This material has weak subangular blocky structure and is loose when dry and very friable when moist. Below this is a 14-inch layer of dark gray to very dark gray, calcareous very fine sandy loam over an 8-inch layer of very dark gray, calcareous silt loam. These layers are soft when dry, very friable when moist, and slightly sticky to nonsticky when wet. The material below a depth of about 36 inches is noncalcareous.

Loup soils are poorly drained. The water table is at or near the surface early in the growing season and rarely recedes below a depth of 4 feet late in summer. Surface runoff is very slow. Permeability above the water table is moderate to rapid. The fertility is high, but the high water table makes cultivation impractical.

Because of the high water table and high fertility, these soils are well suited to hay, and most areas are used for native hay and grazing. The native vegetation consists of tall and mid grasses.

Profile of a Loup very fine sandy loam, located 100 feet south of U.S. Highway 18 in the NE¼NE¼ sec. 4, T. 35 N., R. 42 W.:

A1—0 to 5 inches, dark-gray (10YR 4/1) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, thick and medium, platy structure breaking to moderate, coarse, granular; soft, friable, slightly sticky; moderately alkaline; calcareous; clear boundary.

C1g—5 to 14 inches, light-gray (10YR 7/2) loamy fine sand, pale brown (10YR 6/3) when moist; common mottles, yellowish brown (10YR 5/8) when moist; weak, medium, subangular blocky structure; horizontal breakage more distinct than vertical; loose, very friable, nonsticky; moderately alkaline; calcareous; gradual boundary.

C2—14 to 28 inches, dark-gray (10YR 4/1) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, subangular blocky structure; soft, very friable, nonsticky; moderately alkaline; calcareous; clear boundary.

C3—28 to 36 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; structureless; soft, very friable, slightly sticky; moderately alkaline; calcareous; clear boundary.

C4—36 to 40 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; structureless; soft, very friable, nonsticky; mildly alkaline; clear boundary.
C5—40 to 60 inches, dark-gray (10YR 4/1) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; structureless; nonsticky; mildly alkaline; water table at 48 inches.

An organic mulch, about 1 inch thick, is commonly on the surface. The surface layer ranges from 4 to 15 inches in thickness and from loamy fine sand to loam in texture. In places the soil material is noncalcareous to a depth of as much as 20 inches. The underlying material varies in color and texture and in most places is stratified.

Loup soils are more poorly drained than Elsmere soils and are generally calcareous within 10 inches of the surface. They are less silty than Lamo soils.

Loup soils (0 to 3 percent slopes) (Ls).—These soils occur as oval-shaped areas in basins and as long and narrow areas along streams, in the southeastern part of the county. The areas range up to 300 acres in size. The soils vary in texture. They range from loam to loamy fine sand in the uppermost 20 inches.

In places this mapping unit contains areas of Lamo soils that make up more than 15 percent of the area mapped. Included in some mapped areas are small areas of Elsmere and Valentine soils. Elsmere soils are on slight rises, and Valentine soils are on the outer edges of some areas. Some low areas, mostly less than an acre in size, are marshy.

All of this mapping unit is used for grazing and hay. Some areas are in tame grasses and clover. Hay meadows can be grazed from March to November with no effect on yields the following year. The limitation imposed by the high water table is the main problem. Management that maintains the stand of tall grasses is needed. (Subirrigated range site, capability unit Vw–1, windbreak group 4)

Manter Series

This series consists of deep, nearly level to undulating, friable, dark-colored, moderately coarse textured soils. These soils are on high terraces and tablelands in the northern part of the county. They formed in moderately coarse textured material over stratified sand and gravelly sand.

In a typical profile, the surface layer, about 4 inches thick, is grayish-brown fine sandy loam that is soft when dry and friable when moist.

The subsoil is about 18 inches thick. The upper 12 inches is dark grayish-brown sandy loam. It has weak prismatic to moderate subangular blocky structure and is slightly hard when dry and friable when moist. The lower 6 inches is brown sandy loam. It has weak prismatic to weak subangular blocky structure and is soft when dry and friable when moist.

The underlying material is pale-brown, calcareous sandy loam that is structureless and is soft when dry and very friable when moist. This material contains spots of soft lime. Very pale brown, calcareous loamy sand occurs at a depth of 37 inches. It is structureless and loose.

Manter soils are well drained and are moderately fertile. Runoff is slow to medium, permeability is moderate to moderately rapid, and the water-holding capacity is moderate.

Most areas are in native grass. Many areas that once were cultivated have been seeded to tame grasses. Only a few tracts are cultivated. The native vegetation is a mixture of tall, mid, and short grasses. The tall grasses have disappeared from many areas.

Manter soils in this county are mapped with Tuthill soils and as inclusions in other mapping units.

Profile of a Manter fine sandy loam, located in the NE¼NE¼ sec. 15, T. 41 N., R. 46 W., 150 feet south of road and 0.1 mile west of east section line; area formerly cultivated and now in grass:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, platy structure and weak, fine, granular structure; soft, friable; neutral; abrupt, smooth boundary.
B2t—4 to 16 inches, dark grayish-brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to moderate, coarse, subangular blocky; thin patchy clay films; slightly hard, friable; neutral; gradual, wavy boundary.
B3—16 to 22 inches, brown (10YR 5/3) sandy loam, dark yellowish brown (10YR 4/4) when moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; soft, friable; mildly alkaline; gradual, wavy boundary.
C1ca—22 to 37 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; structureless; soft, very friable; moderately alkaline; calcareous; common spots of soft lime; gradual, wavy boundary.
C2—37 to 60 inches, very pale brown (10YR 7/4) loamy sand, yellowish brown (10YR 5/4) when moist; structureless; loose; moderately alkaline; calcareous.

The surface layer ranges from 2 to 6 inches in thickness and from sandy loam to very fine sandy loam in texture. The subsoil ranges from 8 to 18 inches in thickness. It is more clayey than the surface layer and ranges from light sandy loam and loam to heavy sandy loam in texture. The depth to lime ranges from 15 to 24 inches. The underlying material varies in texture and is stratified. The depth to loamy sand or sand ranges from 25 to 60 inches. Rounded quartz pebbles are common in the lower part of the profile.

Manter soils have a thinner and less clayey subsoil than Tuthill soils. They have more distinct layers in the subsoil than Anselmo soils. The depth to calcareous material is less than in Anselmo and Tuthill soils. Manter soils formed in coarser textured material than Keith soils.

Manvel Series

This series consists of deep, gently sloping, light-colored, moderately fine textured, calcareous soils (fig. 7). These soils are on uplands in the southwestern part of the county.

In a typical profile, the surface layer, about 6 inches thick, is silty clay loam that is soft when dry and very friable when moist. The upper 2 inches is grayish brown and has weak granular structure. The lower part is yellowish brown and has moderate granular structure.

The subsoil is about 26 inches thick. The upper 6 inches is yellowish-brown silty clay loam that has weak prismatic and moderate subangular blocky structure. The middle part, about 10 inches thick, is light yellowish-brown silty clay loam that has moderate prismatic and blocky structure. The lower 10 inches is light yellowish-brown silty clay loam that has weak prismatic and moderate blocky structure. All three parts are calcareous and are hard when dry and friable when moist.

The underlying material is light yellowish-brown, calcareous silty clay loam. It is structureless and is very hard when dry and friable when moist. Spots of soft lime are common in the upper part, and spots and streaks of gypsum are common below a depth of 43 inches.

Manvel soils are well drained. Runoff is medium, and permeability is moderately slow. The soils are high in lime content and low in fertility. They contain selenium but generally in lesser amounts than Minnequa and Penrose soils.

Most areas are in native grass and are used for grazing and hay. A few areas are cultivated. The native vegetation consists of mid and short grasses.

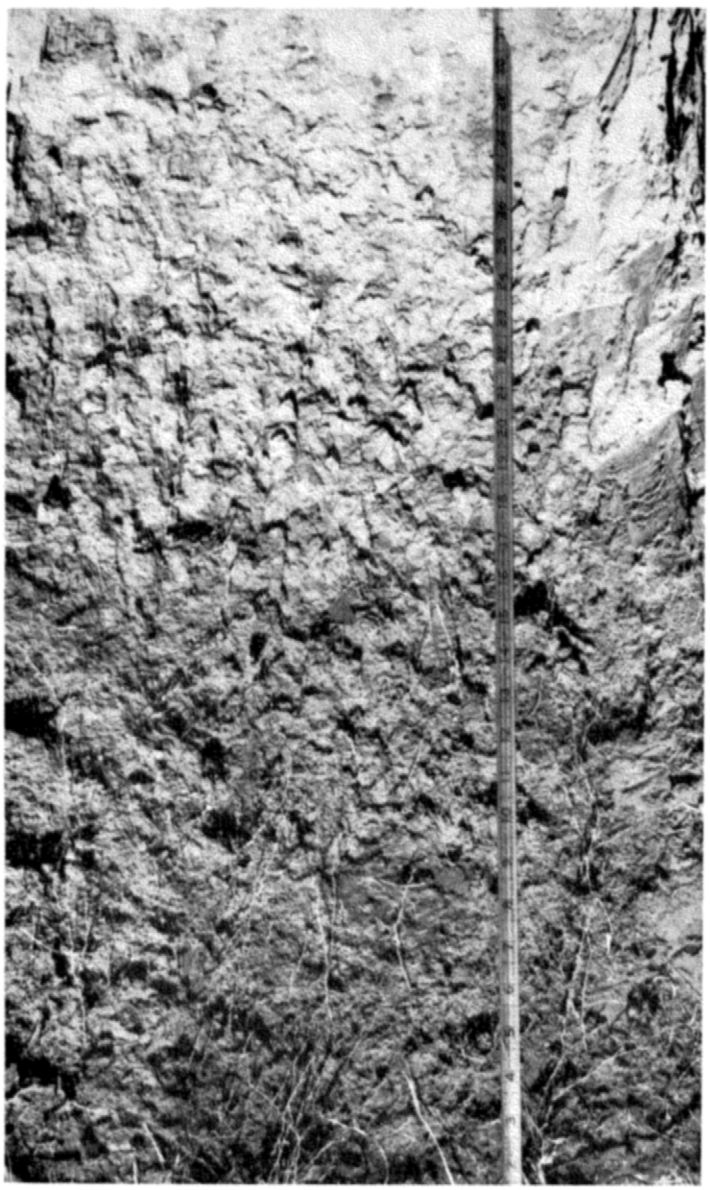

Figure 7.—**Profile of Manvel silty clay loam. Photo by Bureau of Indian Affairs.**

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Profile of Manvel silty clay loam, 0 to 5 percent slopes, located 800 feet west and 400 feet north of the center of sec. 32, T. 36 N., R. 46 W., in native pasture:

A1—0 to 2 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, granular structure; soft, very friable; mildly alkaline; calcareous; abrupt, smooth boundary.

A3—2 to 6 inches, yellowish-brown (10YR 5/4) silty clay loam, dark brown (10YR 4/3) when moist; moderate, fine and medium, granular structure; soft, very friable; moderately alkaline; calcareous; clear, smooth boundary.

B21—6 to 12 inches, yellowish-brown (10YR 5/6) silty clay loam, dark yellowish brown (10YR 4/4) when moist; weak, medium, prismatic structure breaking to moderate, medium and fine, subangular blocky; slightly hard, friable; moderately alkaline; calcareous; clear, smooth boundary.

B22—12 to 22 inches, light yellowish-brown (10YR 6/4) silty clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, medium and coarse, prismatic structure breaking to moderate, medium, blocky; hard, friable; moderately alkaline; calcareous; clear, wavy boundary.

B3—22 to 32 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/6) when moist; weak, medium, prismatic structure breaking to moderate, medium and coarse, blocky; very hard, friable; moderately alkaline; calcareous; few fine spots of soft lime; gradual, smooth boundary.

C1—32 to 43 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/6) when moist; structureless; very hard, friable; moderately alkaline; calcareous; common spots of soft lime; gradual, smooth boundary.

C2cs—43 to 60 inches, light yellowish-brown (10YR 6/4) silty clay loam, yellowish brown (10YR 5/6) when moist; structureless; very hard, friable; strongly alkaline; calcareous; many fine and medium spots and streaks of salts, mostly gypsum.

The A horizon ranges from 3 to 10 inches in thickness and is silty clay loam or silt loam in texture. In some places it is noncalcareous in the upper part. The subsoil ranges from 10 to 30 inches in thickness and from weak to moderate in structure. Fragments of chalk and limestone generally occur in the underlying material and, in places, are scattered throughout the soil material. The color of the material from which these soils formed ranges from brownish yellow to light gray and strongly influences the color of the soil. The underlying material can be either local alluvium or material weathered from chalk and chalky shale, which occur at a depth below 40 inches.

Manvel soils are thicker than Minnequa and Penrose soils. They are less clayey and contain more calcium than Kyle soils, and they have a lighter colored surface layer than Buffington soils.

Manvel silty clay loam, 0 to 5 percent slopes (McB).—This soil is on long slopes, mostly more than 2 percent gradient, on uplands in the southwestern part of the county. It is high in content of lime. The areas range up to 200 acres in size. This soil has the profile described as typical for the series.

Included in some of the areas mapped are small areas of Kyle, Minnequa, and Penrose soils. Minnequa and Penrose soils are on small rises or humps in some areas. Kyle soils occur as small flats along intermittent streams. Inclusions make up less than 15 percent of the total area mapped.

Most areas are used for grazing and native hay. A few areas are cultivated and are used mainly for alfalfa and other feed and forage crops. The low organic-matter content combined with the high content of lime makes this soil susceptible to soil blowing and water erosion. Wind stripcropping and the use of crop residue help to control soil blowing in the more nearly level areas that are used for annual crops. Stubble mulching combined with terracing helps to control water erosion in the more sloping areas. Proper use is effective in controlling erosion on rangeland. (Thin Upland range site, capability unit IVe–5, windbreak group 3)

Minatare Series

This series consists of deep, light-colored, saline soils that have a firm clay subsoil. These soils formed in alluvium and are mostly on flats along Stinking Water Creek and Spring Creek in the southeastern part of the county.

In a typical profile, the surface layer is about 3 inches thick. The upper 2 inches is dark-gray loam. The lower inch is gray loam. The entire layer is soft when dry and very friable when moist.

The subsoil is about 7 inches thick. The upper 4 inches is grayish-brown, calcareous clay that has moderate columnar and blocky structure. It is hard when dry and firm when moist. The lower 3 inches is light-gray, calcareous clay loam that has weak prismatic and subangular blocky structure. It is hard when dry and friable when moist.

The underlying material is light-gray to white, calcareous loam that is soft when dry and very friable when moist. It contains bits and fragments of sandstone.

Minatare soils are poorly drained. Surface runoff is slow, and permeability is slow to very slow. Fertility is low to moderate. The water table generally is at a depth of 2 to 5 feet. In wet years it is near the surface during the growing season. In places the water table is below a depth of 5 feet. Fluctuations in the water table seem to affect the amount of salts in the subsoil.

The native vegetation is a mixture of tall, mid, and short grasses. Inland saltgrass is present in small amounts in pastures that are in excellent condition but becomes dominant when the range condition declines. Salinity, the claypan, and wetness make these soils unsuitable for cultivation.

Profile of a Minatare loam, located in the SE¼NE¼ sec. 4, T. 35 N., R. 43 W., in native grass:

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

A2—2 to 3 inches, gray (10YR 6/1) loam, dark gray (10YR 4/1) when moist; weak, very fine, subangular blocky structure and thin platy structure; soft, very friable; mildly alkaline; abrupt, wavy boundary.

B2t—3 to 7 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) when moist; moderate, medium, columnar structure breaking to moderate, medium and fine, blocky; continuous clay films on all ped faces; hard, firm, sticky, plastic; strongly alkaline; calcareous; clear, smooth boundary.

B3—7 to 10 inches, light-gray (10YR 7/2) clay loam, brown (10YR 5/3) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; thin patchy clay films; hard, friable, sticky, plastic; strongly alkaline; calcareous; clear, smooth boundary.

C1—10 to 18 inches, white (10YR 8/2) loam, pale brown (10YR 6/3) when moist; weak, coarse, subangular blocky structure; soft, very friable, slightly sticky, slightly plastic; strongly alkaline; calcareous; clear, wavy boundary.

C2g—18 to 22 inches, light-gray (10YR 7/2) loam, pale brown (10YR 6/3) when moist; strong-brown (7.5YR 5/8) mottles; structureless; soft, very friable, slightly sticky; moderately alkaline; calcareous; gradual, wavy boundary.

C3—22 to 60 inches, white (10YR 8/1) loam grading to sandy loam in lower part, light brownish gray (10YR 6/2) when moist; structureless; soft, very friable; moderately alkaline; calcareous; few bits and fragments of sandstone in lower part.

The A horizon ranges from 2 to 4 inches in thickness and from fine sandy loam to silt loam in texture. The upper part is black to very dark grayish brown when moist, but when mixed by plowing, it dries to light brownish gray to gray. In many places there are visible salts in the subsoil. The underlying materials vary in texture and color and in places are layered with material of contrasting texture and color.

Minatare soils are lighter colored in the B2 horizon, have a thinner surface layer and subsoil, and are saline closer to the surface than Mosher soils.

Minatare soils (0 to 2 percent slopes) (Me).—These soils occur on flats along Stinking Water Creek and Spring Creek in the southeastern part of the county. They are saline and are poorly drained. The areas are parallel to the creeks and range up to one-half mile in width. Most of the soils in this unit have a profile like the one described for the series, but the surface layer ranges from fine sandy loam to silt loam.

Included in the areas mapped are depressed spots where water remains ponded. These spots support little vegetation. The soil material consists of a grayish crust underlain by massive clay loam to silty clay that has visible salts within a few inches of the surface. Also included are small areas of Lamo, Loup, and Mosher soils. Inclusions make up no more than 20 percent of a mapped area.

These soils are used for grazing and native hay. Salinity and wetness are the main limitations. Careful management is needed to prevent inland saltgrass from becoming dominant. (Saline Lowland range site, capability unit VIs–1, windbreak group 6)

Minnequa Series

This series consists of moderately deep, gently sloping to sloping, friable, light-colored, moderately fine textured soils. These soils formed in material weathered from chalky shale and chalk, on uplands in the southwestern part of the county.

In a typical profile, the surface layer, about 4 inches thick, is dark grayish-brown, calcareous silty clay loam that is soft when dry and friable when moist. Below this is about 9 inches of grayish-brown, calcareous silty clay loam that has weak to moderate prismatic and subangular blocky structure. This material is slightly hard when dry and friable when moist.

The underlying material is pale-brown, structureless, calcareous silty clay loam that is soft when dry and friable when moist. It is underlain at a depth of about 20 inches by very pale brown, calcareous chalk.

Minnequa soils are well drained. They are low in fertility and are high in content of lime. They contain various amounts of selenium. Runoff is medium, and permeability is moderate to moderately slow. Water erosion and soil blowing are hazards.

Most areas are in native grass and are used for grazing. A few small areas are used for feed and forage crops. The native vegetation consists of mid and short grasses.

Profile of Minnequa silty clay loam, 5 to 12 percent slopes, located 0.1 mile west and 200 feet south of the NE. corner of sec. 9, T. 35 N., R. 47 W.; area formerly cultivated but now in pasture:

Ap—0 to 4 inches, dark grayish-brown (10YR 4/2) light silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure breaking to moderate, fine and medium, granular; soft, friable; moderately alkaline; calcareous; clear, smooth boundary.

AC1—4 to 8 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure breaking to moderate, medium and coarse, subangular blocky; slightly hard, friable; moderately alkaline; calcareous; clear, smooth boundary.

AC2—8 to 13 inches, grayish-brown (10YR 5/2) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure; slightly hard, friable; moderately alkaline; calcareous; gradual, smooth boundary.

C—13 to 20 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) when moist; structureless; soft, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

R—20 inches +, very pale brown (10YR 7/3) chalk, pale brown (10YR 6/3) when moist; moderately alkaline; calcareous.

The surface layer ranges from 2 to 6 inches in thickness and from grayish brown to dark grayish brown in color. In cultivated areas, the plow layer includes material from the AC horizon and is lighter in color. The AC horizon ranges from 5 to 15 inches in thickness and from light yellowish brown to grayish brown in color. Fragments of chalk and limestone are common in the underlying material and in places are scattered throughout the soil material. The depth to bedded chalky shale and chalk ranges from 20 to 36 inches.

Minnequa soils are thinner than Manvel soils and thicker than Penrose soils.

Minnequa silty clay loam, 5 to 12 percent slopes (MgD).—This soil is on uplands in the southwestern part of the county. The slopes are shorter than those of Manvel soils. The areas range up to 150 acres in size. This soil has the profile described as typical for the series. The content of lime is high.

Included in some areas mapped are small areas of Manvel and Penrose soils. The Manvel soils are on foot slopes, and the Penrose soils are on the tops of ridges. Inclusions make up less than 20 percent of the total area mapped.

Nearly all of this soil is in native grass and is used for grazing. A few small areas are cultivated as parts of less sloping fields.

Water erosion and soil blowing are the principal hazards. Maintaining a good cover of native grass helps to control erosion in areas used for grazing. The use of tame grasses, alfalfa, and close-sown crops, in combination with the use of crop residue, helps to control erosion in cultivated areas. (Thin Upland range site, capability unit VIe-1, windbreak group 3)

Mosher Series

This series consists of deep, dark-colored soils that have a very firm clayey subsoil. These soils formed in alluvium on flats and terraces in the southwestern, central, and eastern parts of the county.

In a typical profile, the surface layer, about 6 inches thick, is grayish-brown silt loam. The subsurface layer, about 4 inches thick, is gray silt loam that has weak subangular blocky and granular structure. These layers are soft when dry and very friable when moist.

The subsoil is about 16 inches thick and is very hard when dry and very firm when moist. The uppermost 3 inches is very dark gray clay loam that has moderate columnar structure. The middle 7 inches is dark-gray clay loam that has weak prismatic and moderate blocky structure. The lowermost 6 inches is light brownish-gray clay loam that has moderate blocky structure and contains spots and streaks of salts.

The underlying material is light-gray clay loam that contains spots and streaks of salts. This gradually changes to white fine sandy loam at a depth of about 44 inches.

Mosher soils are somewhat poorly drained. Runoff is slow, and permeability is very slow. Fertility is moderate, but the combination of the claypan, salts below the claypan, and occasional wetness limits the use of these soils to tame grasses and legumes.

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

Profile of a Mosher silt loam, located 0.3 mile south and 100 feet east of the NW. corner of sec. 13, T. 36 N., R. 47 W., in native grass:

A1—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A2—6 to 10 inches, gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist; weak, medium, subangular blocky structure breaking to weak, fine, granular; soft, very friable; neutral; abrupt, wavy boundary.

B21t—10 to 13 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) when moist; moderate, medium, columnar structure; very hard, very firm, sticky, plastic; moderately alkaline; clear, wavy boundary.

B22t—13 to 20 inches, dark-gray (10YR 4/1) clay loam, very dark brown (10YR 2/2) when moist; weak, medium, prismatic structure breaking to moderate, medium, blocky; very hard, very firm, sticky, plastic; moderately alkaline; gradual, wavy boundary.

B3sa—20 to 26 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) when moist; brown (10YR 5/3) mottles; moderate, fine, blocky structure; very hard, very firm, sticky, plastic; strongly alkaline; common spots and streaks of salts; clear, wavy boundary.

C1sa—26 to 44 inches, light-gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) when moist; structureless; hard, firm, sticky, plastic; strongly alkaline; calcareous; common spots and streaks of salts; gradual boundary.

C2—44 to 60 inches, white (10YR 8/2) fine sandy loam, light brownish gray (10YR 6/2) when moist; structureless; slightly hard, friable; moderately alkaline; common calcareous bits of sandstone in the lower part.

The A horizon ranges from 5 to 12 inches in thickness, and the texture is silt loam, loam, or very fine sandy loam. The combined thickness of the subsoil ranges from 12 to 30 inches. The texture ranges from clay loam to clay. The texture of the underlying alluvium ranges from loamy sand to clay loam.

Mosher soils are darker colored in the subsoil and have a thicker surface layer and subsoil than Minatare soils. They have a less brownish subsoil than Dawes and Wortman soils and are less well drained.

Mosher-Minatare complex (0 to 6 percent slopes) (Mm).—Mosher soils make up 65 to 80 percent of this complex, and Minatare, 15 to 30 percent. This complex is on terraces in the southwestern, central, and eastern parts of the county. Except for the fans on the outer edges of some valleys, the slope is generally less than 3 percent, though the range is from 0 to 6 percent. The relief is uneven, and there are depressions that range up to 15 feet in diameter and are 3 to 6 inches in depth.

The soils of this complex generally lack a high water table and are better drained than areas mapped as Minatare soils (0 to 2 percent slopes). Salts are not always visible, and in places the strongly alkaline layers are lacking; but the content of sodium is high.

Included in some of the areas mapped are spots of Dawes, Keith, and Richfield soils. Some depressions are bare of vegetation. The soils in these depressions are saline and consist of a grayish crust underlain by massive clayey material in which visible salts occur within 6 inches of the surface. Inclusions make up less than 15 percent of the area.

Most areas are in native grass and are used for grazing. Tame grasses and alfalfa can be grown in parts of the complex, but the occurrence of Minatare soils makes the complex as a whole generally unsuitable for cultivation. Management that maintains a cover of forage plants is needed. (Mosher: Claypan range site, capability unit IVs-2, windbreak group 5. Minatare: Thin Claypan range site, capability unit VIs-1, no windbreak group)

Oglala Series

This series consists of deep, friable, dark-colored, loamy soils on rolling uplands in the central and eastern parts of the county. These soils formed in silty to loamy material underlain by soft, fine-grained sandstone.

In a typical profile, the surface layer, about 7 inches thick, is grayish-brown loam. The upper 3 inches is soft when dry and friable when moist. The lower 4 inches is slightly hard when dry and friable when moist. Below this is about 21 inches of light brownish-gray very fine sandy loam. This material has weak prismatic structure and is slightly hard when dry and very friable when moist.

The underlying material is light-gray to white, calcareous very fine sandy loam and fine sandy loam that are soft when dry and very friable when moist. Fine bits of sandstone occur in the lower part.

Oglala soils are well drained and are moderately fertile. Runoff is medium, permeability is moderate, and the water-holding capacity is moderate. Water erosion and soil blowing are hazards if the vegetation is removed.

Most areas are in native grass and are used for grazing. Some of the more gently sloping areas are cultivated. The native vegetation consists mainly of mid and short grasses.

Profile of an Oglala loam, located 200 feet south of north section line and 100 feet east of the road in the NW¼ sec. 4, T. 38 N., R. 41 W., in native pasture:

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, friable; neutral; clear, smooth boundary.

A12—3 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure; slightly hard, friable; neutral; clear, smooth boundary.

AC—7 to 28 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure becoming coarse prismatic in the lower part; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

C1—28 to 35 inches, light-gray (10YR 7/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; weak, fine and medium, subangular blocky structure; soft, very friable; moderately alkaline; calcareous; gradual boundary.

C2—35 to 48 inches, white (10YR 8/2) fine sandy loam; fine bits of sandstone; light brownish gray (10YR 6/2) when moist; structureless; soft, very friable; moderately alkaline; calcareous.

The A1 horizon ranges from 6 to 15 inches in thickness and is loam, very fine sandy loam, or silt loam. The depth to lime ranges from 20 to 40 inches but commonly is 25 to 30 inches. Beds of soft very fine sand and sandstone generally occur at some depth below 36 inches.

Oglala soils are darker colored and thicker than Canyon soils. They lack the clayey subsoil of Keith and Rosebud soils. They are less silty than Ulysses soils and deeper to lime. They are less sandy than Anselmo soils.

Oglala-Canyon complex, 9 to 18 percent slopes (OcE).—Oglala soils make up 45 to 60 percent of this complex; Canyon soils, 25 to 40 percent; and other soils, less than 15 percent. This complex occurs mainly in the south-central part of the county. In many places, the areas are more than 1,000 acres in size. Oglala soils are on plane to concave, mid and lower side slopes. Canyon soils are on ridgetops and on the shorter convex upper slopes. The Oglala soils on some of the lower slopes have a surface layer thicker than that in the profile described as typical for the series. Canyon soils have a profile like the one described for the Canyon series.

Included in some of the areas mapped are small areas of Colby, Goshen, Keith, Rosebud, and Ulysses soils. Goshen soils are along some of the drainage divides. Colby, Keith, and Ulysses soils occur in patches on some of the east-facing and south-facing slopes and on well-rounded ridges and knolls within the area. Rosebud soils are on some mid slopes and on small drainage divides.

Nearly all of the acreage is in native grass and is used for grazing and hay. A few patches, mainly on mid and lower slopes, are cultivated or have been seeded to tame grasses. Cultivation generally is not practical. Proper range use provides adequate erosion control in most areas. Seeding and other mechanical measures help to restore range that is in poor condition. (Oglala: Silty range site, capability unit VIe-1, windbreak group 2. Canyon: Shallow range site, capability unit VIs-2, no windbreak group)

Orella Series

This series consists of shallow, nearly level to sloping, light-colored, calcareous soils on uplands in the northern part of the county.

In a typical profile, the surface layer, about 2 inches thick, is brown, calcareous clay that is slightly hard when dry and friable when moist. The underlying material is light-gray, calcareous clay. It is structureless and is hard when dry and very firm to firm when moist. Bedded, calcareous clay shale is at a depth of 14 inches. This material is very hard when dry and very firm when moist.

Orella soils are somewhat excessively drained, are low in fertility, and are in poor tilth. Surface runoff is medium to rapid, and permeability is slow to very slow. Sloping areas are subject to erosion.

These soils are used entirely for grazing. The native vegetation consists of a thin stand of mid and short grasses. Western wheatgrass is dominant, but side-oats grama is also present, especially in the more strongly sloping areas.

Profile of Orella clay, 0 to 9 percent slopes, located in the SW¼NE¼ sec. 10, T. 42 N., R. 44 W., in native pasture:

A1—0 to 2 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) when moist; weak, fine, granular structure; slightly hard, friable; common fine shale chips; moderately alkaline; calcareous; surface littered with broken chalcedony up to 2 inches in diameter; clear, smooth boundary.

C1—2 to 8 inches, light-gray (10YR 7/2) clay, brown (10YR 5/3) when moist; structureless; hard, very firm, very plastic; moderately alkaline; calcareous; gradual, wavy boundary.

C2—8 to 14 inches, light-gray (10YR 7/2) clay, light brownish gray (10YR 6/2) when moist; structureless; slightly hard, firm, plastic; moderately alkaline; calcareous; gradual, wavy boundary.

R—14 to 60 inches, bedded clay shale; very hard, very firm; moderately alkaline; calcareous.

The surface layer ranges from 2 to 5 inches in thickness and from light brownish gray to brown in color. The texture commonly is clay, but in places it ranges to very fine sandy loam. In places, an AC horizon that has weak blocky structure occurs below the surface layer. The depth to bedded clay shale ranges from 6 to 24 inches but commonly is about 15 inches.

Orella soils are shallower than Swanboy soils, and the uppermost 10 inches is less alkaline. They are more clayey than Epping soils. They are grayer and less olive in color than Samsil soils.

Orella clay, 0 to 9 percent slopes (OeC).—This soil is on flats and fans in Badland basins in the northern part of the county. The areas range up to 200 acres in size. This soil has the profile described as typical for the series. Some of the areas mapped include Swanboy soils, which occupy the more nearly level areas and generally lower positions. In places there are small spots of Hisle soils. Inclusions make up less than 20 percent of the total area mapped.

All of this soil is used for grazing. It is not suitable for cultivation. Most areas are subject to water erosion and soil blowing if the vegetation is removed. Proper range use provides adequate erosion control on most range sites. Seeding, furrowing, and pitting help to restore range that is in poor condition. (Shallow range site, capability unit VIs-2, no windbreak group)

Orella-Shale outcrop complex (3 to 18 percent slopes) (Os).—Orella clay makes up 50 to 60 percent of this complex; Shale outcrop, 20 to 30 percent; and other soils, about 20 percent. This complex is on the sloping parts of Badland basins in the northern part of the county. With its barren exposures of silty clay shale, it resembles Badlands in appearance. The areas range up to 500 acres in size. Runoff is rapid in areas of Shale outcrop.

Most areas of Orella soils have a cover of vegetation. In places the surface is littered with rounded and angular gravel, much of which is agatized. The depth to bedded shale commonly is about 10 inches, but in places it is less. Shale outcrop consists of bare areas of gray clay and clay shale on eroded side slopes. In places an entire rounded knoll, about 50 to 150 feet wide, 100 to 300 feet long, and 10 to 30 feet high, is Shale outcrop.

Included in some of the areas mapped are small areas of Hisle and Swanboy soils and of unclassified, mixed, clayey soils.

All of this complex is used for grazing. The large amount of sediment carried in runoff shortens the life of water developments for livestock. Proper range use helps to control erosion. (Orella: Shallow range site, capability unit VIs-2, no windbreak group. Shale outcrop: capability unit VIIIs-1, no range site or windbreak group)

Penrose Series

This series consists of shallow, gently sloping to steep, light-colored, moderately fine textured soils. These soils formed in material weathered from chalky shale. They are on uplands in the southwestern part of the county.

In a typical profile, the surface layer, about 1 inch thick, is gray, calcareous silty clay loam that is soft when dry and friable when moist. The subsurface layer, about 2 inches thick, is light-gray, calcareous silty clay loam that has moderate granular structure. It is slightly hard when dry and firm when moist.

The underlying material, about 10 inches thick, is light-gray, calcareous silty clay loam that has moderate platy structure. It is slightly hard when dry and firm when moist. Chips of weathered shale are common in the lower part. Weathered chalky shale occurs at a depth of 13 inches.

Penrose soils are somewhat excessively drained. They are high in content of lime, and they contain selenium. Fertility is low. Runoff is medium to rapid, and permeability is moderately slow.

Penrose soils are in native vegetation and are used for grazing. The native vegetation consists of a thin stand of short and mid grasses. Alkali princesplume, two-grooved loco, racemed loco, and other plants that indicate the presence of selenium generally are part of the native vegetation.

Profile of a Penrose silty clay loam, located 900 feet north and 500 feet west of the center of sec. 16, T. 35 N., R. 47 W., in native pasture:

A1—0 to 1 inch, gray (10YR 6/1) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, granular structure; soft, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

AC—1 to 3 inches, light-gray (10YR 7/2) silty clay loam, brown (10YR 5/3) when moist; moderate, medium, granular structure; slightly hard, firm; moderately alkaline; calcareous; abrupt, smooth boundary.

C1—3 to 8 inches, light-gray (10YR 7/1) silty clay loam, light brownish gray (10YR 6/2) when moist; moderate, medium, platy structure; slightly hard, firm; moderately alkaline; calcareous; abrupt, smooth boundary.

C2—8 to 13 inches, light-gray (10YR 7/1) silty clay loam, light brownish gray (10YR 6/2) when moist; weak, very thick, platy structure breaking to moderate, medium, platy; slightly hard, firm; many chips of weathered shale; moderately alkaline; calcareous; clear, smooth boundary.

R&C—13 to 27 inches, light-gray (10YR 7/1) weathered chalky shale and silty clay loam, light gray (10YR 7/2) when moist; bedded; moderately alkaline; calcareous; easily penetrated with hand auger.

R—27 to 60 inches, chalky shale and chalk.

The soils range from gray to brownish yellow and yellowish brown in color. The surface layer ranges from 1 to 4 inches in thickness and in places is silt loam in texture. The depth to shale or chalk ranges from 5 to 27 inches. Fragments of chalk and brittle fragments of limestone commonly occur on the surface and throughout the soil material. Gypsum salts are common in the underlying material and in the weathered shale. Layers of hard chalk and thin, brittle fragments of limestone usually are present in the shale.

Penrose soils are more shallow than Minnequa soils. They are more clayey than Canyon and Epping soils, and they are less clayey than Samsil soils.

Penrose and Minnequa silty clay loams, 5 to 20 percent slopes (PcE).—Some areas of this mapping unit consist almost entirely of Penrose soils, some are almost entirely Minnequa soils, and many areas contain significant amounts of both soils. These soils are on uplands in the southwestern part of the county. The areas are irregular in shape and range from 20 to 400 acres in size.

Penrose soils commonly occupy short convex slopes on ridges, on knolls, and on the shoulders of intermittent drains; but in places they are in nearly level, benchlike areas and are shallow over brittle limestone and shale. Minnequa soils are on the longer mid and lower slopes and the broader drainage divides. These soils have the profile described for their respective series.

Included in some of the areas mapped are small areas of Manvel, Wanblee, and Wortman soils. Outcrops of chalk and shale, generally less than 1 acre in size, occur in places. Inclusions make up less than 20 percent of the total area mapped.

Nearly all of this mapping unit is in native grass and is used for grazing. A few small tracts that consist mainly of Minnequa soils are cultivated.

Erosion is a hazard if the range is in poor condition. Proper range use helps to control erosion. Seeding, contour furrowing, and pitting are practices needed to restore areas where the vegetation is sparse. Livestock that graze continuously on these soils are subject to selenium poisoning. (Penrose: Shallow range site, capability unit VIs–2, no windbreak group. Minnequa: Thin Upland range site, capability unit VIe–1, windbreak group 3)

Penrose-Rock outcrop complex (5 to 40 percent slopes) (Pd).—Penrose soils make up 60 to 70 percent of the complex; Rock outcrop, about 20 to 30 percent; and other soils, about 10 percent. This complex is on uplands in the southwestern part of the county. Most slopes are steep, but some are less than 20 percent. The areas are irregular in shape and range from 20 to 200 acres in size. Penrose soils are intermingled with outcrops of chalk, limestone, and shale. Most areas are dissected by numerous gullied drains.

Penrose soils occur throughout the complex. The profile usually is thinner than the one described as typical for the series. In places the depth to shale and chalk is as little as 5 inches. Rock outcrop consists of eroded exposures of chalk, limestone, and silty shale. These range from 1 to 20 acres in size and are on steep side slopes of buttes, ridges, and escarpments or on eroded side slopes along intermittent drains.

Included in some of the areas mapped are Manvel, Minnequa, Wanblee, and Wortman soils. Inclusions make up less than 20 percent of the total area mapped.

All of this complex is in native vegetation and is used for grazing. Control of water erosion is the main management problem. Proper range use is the only practical means of control. Livestock that are grazed continuously in these areas are subject to selenium poisoning. (Penrose: Shallow range site, capability unit VIIs–2, no windbreak group. Rock outcrop: capability unit VIIIs–1, no range site or windbreak group)

Pierre Series

This series consists of moderately deep, firm, nearly level to moderately steep, moderately dark colored soils on uplands in the western part of the county.

In a typical profile, the surface layer is a crust, about 2 inches thick. It is grayish-brown clay that is slightly hard when dry, friable when moist, and sticky and plastic when wet.

The subsoil is about 24 inches thick. The uppermost 4 inches is olive-gray, calcareous clay that has weak to moderate prismatic to angular blocky structure. It is hard when dry, firm when moist, and sticky and plastic when wet. The middle 10 inches is grayish-brown, calcareous clay that has weak prismatic to angular blocky structure. It is extremely hard when dry, extremely firm when moist, and sticky and plastic when wet. The lowermost 10 inches is grayish-brown clay that has weak prismatic to angular blocky structure.

The underlying material is light olive-gray, calcareous clay that has weak platy structure. It is very hard when dry, very firm when moist, and sticky and plastic when wet. A few spots of lime and nests of salts occur in this material. Bedded shale is at a depth of 36 inches.

Pierre soils are well drained and are moderately fertile. Surface runoff is medium to rapid, permeability is slow, and release of water to plants is slow. Water erosion and soil blowing are hazards in sloping areas if the vegetation is removed.

Most areas of these soils are in native grass and are used for grazing and hay. The native vegetation consists of mid and short grasses. A few areas are cultivated. Occasionally, spring-sown grains grow well, but generally yields are low or crops fail.

Profile of Pierre clay, 3 to 9 percent slopes, located 0.25 mile east of the NW. corner of sec. 15, T. 37 N., R. 48 W., in native pasture:

A1—0 to 2 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, granular structure; slightly hard, friable, sticky, plastic; neutral; clear, smooth boundary.

B21—2 to 6 inches, olive-gray (5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak to moderate, coarse, prismatic structure breaking to weak, medium, angular blocky; shiny ped faces; hard, firm, sticky, plastic; moderately alkaline; calcareous; gradual, smooth boundary.

B22—6 to 16 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium and coarse, prismatic structure breaking to weak, coarse, angular blocky; shiny ped faces; extremely hard, extremely firm, sticky, plastic; moderately alkaline; calcareous; gradual, smooth boundary.

B23ca—16 to 26 inches, grayish-brown (2.5Y 5/2) clay, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, angular blocky; shiny ped faces; many, medium, soft masses of disseminated lime; extremely hard, extremely firm, sticky, plastic; moderately alkaline; calcareous; clear, smooth boundary.

C1—26 to 34 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 4/2) when moist; weak, thick, platy structure; ped faces mostly shiny; very hard, very firm, sticky, plastic; moderately alkaline; calcareous; very few soft segregations of lime and gypsum; clear, smooth boundary.

R1—34 to 36 inches, olive (5Y 4/3) clayey shale, a darker olive (5Y 4/3) when moist; partially weathered shale and clay; few fine masses of calcium carbonate; shale chips not calcareous; shale chips soft but brittle; abrupt, smooth boundary.

R2—36 to 60 inches, olive (5Y 4/3) bedded shale.

Profile of a Pierre soil, located 0.2 mile south and 285 feet east of the NW. corner of sec. 13, T. 37 N., R. 48 W., in native pasture (Laboratory No. 6624–6630):

A1—0 to 3 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; slightly hard, friable, sticky, plastic; neutral; clear, smooth boundary.

B21—3 to 6 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, fine, prismatic structure breaking to moderate, very fine, subangular blocky; thin patchy clay films; hard, firm, sticky, plastic; moderately alkaline; calcareous; gradual, smooth boundary.

B22—6 to 11 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium and fine, blocky; moderate continuous clay films; very hard, very firm, sticky, plastic; moderately alkaline; calcareous; few pebbles and concretionary fragments; clear, smooth boundary.

B23ca—11 to 17 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure breaking to moderate, medium, blocky; thin continuous clay films; few slickensides; very hard, very firm, sticky, plastic; moderately alkaline; calcareous: few, medium, soft segregations of lime; few pebbles and concretionary fragments; clear, smooth boundary.

B3ca—17 to 25 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 4/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; thin patchy clay films; few slickensides; very hard, very firm, sticky, plastic; moderately alkaline; calcareous; few, medium, soft segregations of lime and salt nests; few pebbles and concretionary fragments; gradual, smooth boundary.

Ccs—25 to 36 inches, light brownish-gray (2.5Y 6/2) silty clay, olive brown (2.5Y 4/3) when moist; few, fine, faint, light olive-brown (2.5Y 5/6) iron stains, yellowish brown (10YR 5/8) when moist; very weak, very coarse, prismatic structure; thin patchy clay films; few slickensides; very hard, very firm, sticky, plastic; mildly alkaline; calcareous; very few soft segregations of lime and few salt and gypsum nests; few pebbles and concretionary fragments; clear, smooth boundary.

R1cs—36 to 44 inches, light olive-gray (5Y 6/2) partially weathered shale and clay, olive gray (5Y 5/2) when moist; common, medium, distinct, brownish-yellow iron stains and dark-gray manganese stains; bedded; mildly alkaline; common salt nests; gradual, smooth boundary.

R2—44 to 60 inches, pale-olive (5Y 6/3) shale, olive (5Y 5/3) when moist; many, large, prominent iron and manganese stains; bedded.

The surface layer ranges from 2 to 6 inches in thickness and from clay to silty clay in texture. When plowed, it is usually clay in texture. Locally, the surface texture is siltier when Pierre soil is in association with windblown soils, such as Richfield, Keith, and Ulysses. The subsoil layer ranges from 10 to 30 inches in thickness. The depth to shale ranges from 20 to 40 inches. The color of the shale ranges from pale olive and light olive brown to dark gray and influences the color of the soil above the shale. Soft lime segregations are not always present, but visible gypsum and other salts usually are in the weathered material between the subsoil and the shale.

Pierre soils are thicker than Samsil soils, and they have a distinct B horizon. They are less deep over shale than Kyle soils.

Pierre clay, 3 to 9 percent slopes (PeC).—This soil is on uplands in the western part of the county. The slope is mostly 3 to 5 percent, though the range is from 3 to 9 percent. The areas range up to 400 acres in size. This soil has the profile described as typical for the series.

Included in some of the areas mapped are small areas of Hisle, Kyle, and Samsil soils. Kyle soils are on some of the longer mid slopes. The surface layer is more friable than that in the profile described as typical for the Kyle series. Samsil soils are on the crests of some slopes. Hisle soils occur along some drains and in depressions on the side slopes of divides. Inclusions make up less than 15 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. Some areas that formerly were cultivated are now in native grasses, or have been seeded to tame grasses. A few are in crops, mainly spring-sown grains, alfalfa, and tame grasses.

The main management problem is control of water erosion and soil blowing, but conservation of moisture and improvement of tilth are also important. Proper range use provides adequate erosion control in areas of native grass. Growing close-sown, high-residue crops, stubble mulching, and contour stripcropping are effective in cultivated areas. Contour farming and the use of crop residue control erosion adequately if tame grasses and alfalfa are grown about half the time. (Clayey range site, capability unit IVe–6, windbreak group 3)

Pierre-Samsil clays, 9 to 25 percent slopes (PsE).—Pierre soils make up 45 to 70 percent of this complex; Samsil soils, 15 to 40 percent; and other soils, about 15 percent. This complex is on rolling to hilly uplands in the western part of the county. The slope is mostly less than 18 percent, though the range is from 9 to 25 percent. The areas range up to more than 1,000 acres in size.

Pierre soils are on the longer, smoother slopes. The subsoil is thinner than that in the profile described as typical for the series, and in many areas the depth to shale is only about 24 inches. Samsil soils are on the shorter, steeper slopes of ridges or points and on the shoulders of drainageways. These soils have a profile similar to the one described for the Samsil series.

Included in the areas mapped are Hisle, Kyle, and Swanboy soils and spots of Gravelly land and Shale outcrop. Kyle soils are on some of the foot slopes. Hisle and Swanboy soils are along some of the drainageways. Mixed gravelly materials occur on ridges that are rounded.

All of this complex is in native grass and is used for grazing. The soils are subject to water erosion if the vegetation is destroyed. Gullies start easily. Proper range use is the most practical method of controlling erosion. Interseeding, pitting, and contour furrowing help to restore range that is in poor condition. (Pierre: Clayey range site, capability unit VIe–1, windbreak group 3. Samsil: Shallow range site, capability unit VIs–2, no windbreak group)

Richfield Series

This series consists of deep, dark-colored, silty soils that have a firm subsoil. These soils are on uplands and high terraces in the eastern and northern parts of the county.

In a typical profile, the surface layer, about 9 inches thick, is grayish-brown silt loam that is soft when dry and friable when moist.

The subsoil is about 14 inches thick. The uppermost 3 inches is dark grayish-brown silty clay loam that has weak prismatic and subangular blocky structure. It is hard when dry and friable when moist. The middle 8 inches is dark grayish-brown silty clay loam that has moderate prismatic and angular blocky structure. It is hard or very hard when dry and firm to friable when moist. The lowermost 3 inches is brown silt loam that has weak prismatic and subangular blocky structure. It is hard when dry and friable when moist.

The underlying material is light-gray, calcareous silt loam to a depth of about 36 inches and pale-brown very fine sandy loam below this depth. It is structureless and is soft when dry and very friable when moist. Spots and streaks of soft lime occur in this material.

Richfield soils are well drained, are fertile, and are in good tilth. Surface runoff is slow to medium, permeability is moderately slow, and the water-holding capacity is high.

These soils are well suited to winter wheat, and many areas in the eastern part of the county are cultivated. In the northern part of the county, areas formerly cultivated are in tame or native grasses. The native vegetation consists of mid and short grasses.

Profile of a Richfield silt loam, located 0.1 mile south and 0.35 mile west of the NE. corner of sec. 1, T. 36 N., R. 42 W., in native pasture:

A11—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A12—6 to 9 inches, grayish-brown (10YR 5/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, prismatic structure breaking to weak, fine, granular; soft, friable; neutral; clear, smooth boundary.

B1—9 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam very dark grayish brown (10YR 3/2) when moist; weak, fine, prismatic structure breaking to weak, medium, subangular blocky; patchy clay films on all ped faces; hard, friable; neutral; abrupt, smooth boundary.

B21t—12 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure breaking to moderate to strong blocky; continuous clay films on all ped faces; very hard, firm; mildly alkaline; clear, smooth boundary.

B22t—16 to 20 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure breaking to moderate, medium, angular blocky; patchy clay films on all ped faces; hard, friable; mildly alkaline; clear, smooth boundary.

B3—20 to 23 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, medium and coarse, prismatic structure breaking to weak, coarse, subangular blocky; very patchy clay films on all ped faces; hard, friable; mildly alkaline; abrupt, smooth boundary.

C1ca—23 to 36 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; structureless; soft, very friable; moderately alkaline; calcareous; common, fine, distinct spots and streaks of soft lime; gradual boundary.

C2—36 to 60 inches, pale-brown (10YR 6/3) very fine sandy loam, brown (10YR 5/3) when moist; structureless; soft, very friable; moderately alkaline; calcareous; few fine streaks of soft lime.

The A horizon ranges from 6 to 12 inches in thickness. The subsoil ranges from 12 to 30 inches in thickness and, in places, is calcareous in the lower part. The depth to lime ranges from 18 to 40 inches. In the eastern part of the county, the underlying material commonly is silt loam or very fine sandy loam, but in places it changes abruptly to loam or sandy loam and contains bits of sandstone. On high terraces in the northern part of the county, sand and gravel occur below a depth of 40 inches.

Richfield soils have more clay in the subsoil than Keith soils. They have slightly less clay in the subsoil than Dawes soils, and they lack the A2 horizon of the Dawes soils.

Richfield and Altvan silt loams, 0 to 3 percent slopes (RaA).—Some areas of this mapping unit consist mainly of Richfield soils, some are mainly Altvan soils, and a few areas contain both soils. These soils are on terraces and tablelands in the northern part of the county. The areas range up to 500 acres in size. In many areas, the Richfield soils are underlain by sand and gravel at a depth below 40 inches. Otherwise, they have the profile described as typical for the series. Altvan soils have the profile described as typical for the Altvan series.

Included in some of the areas mapped are small areas of Dawes, Goshen, Hoven, Keith, and Tuthill soils. Inclusions make up less than 15 percent of the total area mapped.

Many areas that formerly were cultivated are now in tame or native grasses and are used for grazing. Cultivated areas are used mainly for winter wheat and alfalfa.

Conservation of moisture is the main management problem if the soils are cultivated. The problem is more severe on Altvan soils because of the moderate depth to sand and gravel. Soil blowing is a hazard if fields are mismanaged. On cropland, soil blowing can be controlled and moisture conserved through the proper use of crop residue. Stubble mulching is desirable if winter wheat is grown. Proper range use conserves moisture and controls erosion in areas of native grass. (Richfield: Silty range site, capability unit IIc–1, windbreak group 2. Altvan:

Silty range site, capability unit IIIs–2, windbreak group 2)

Richfield and Altvan silt loams, 3 to 5 percent slopes (RaB).—This mapping unit occupies terrace fronts and the more strongly sloping parts of terraces and tablelands in the northern part of the county. Runoff is medium. The areas are mostly less than 80 acres in size.

The Richfield and Altvan soils in this mapping unit have a thinner surface layer and subsoil than the soils described as typical for their respective series. Included in some of the areas mapped are small areas of Keith and Tuthill soils. Inclusions make up less than 15 percent of the total area mapped.

Most areas are used for grazing. Only a few are cultivated. These are used chiefly for winter wheat. Control of water erosion is the main problem. Stubble mulching alone helps to control erosion and conserve moisture in cultivated areas. The use of various combinations of soil-improving crops, the use of crop residue, contour farming, and terracing are other effective measures. Proper range use controls erosion in areas of native grass. (Richfield: Silty range site, capability unit IIe–1, windbreak group 2. Altvan: Silty range site, capability unit IIIe–1, windbreak group 2)

Richfield-Dawes silt loams, 0 to 3 percent slopes (RdA).—Richfield soils make up 45 to 60 percent of this complex; Dawes soils, 30 to 45 percent; and other soils, about 10 percent. This complex occurs mainly in swales on uplands in the southeastern part of the county (fig. 8). Most areas are less than 25 acres in size.

Richfield soils occupy the better drained parts of each area, and Dawes soils the less well drained. In many areas, the two soils are closely intermingled. Both soils have the profile described as typical for their respective series.

Included in some of the areas mapped are small areas of Goshen, Hoven, and Keith soils. The Hoven soils occupy small spots, less than 1 acre in size, where water is ponded for brief periods. Inclusions make up less than 10 percent of the total area mapped.

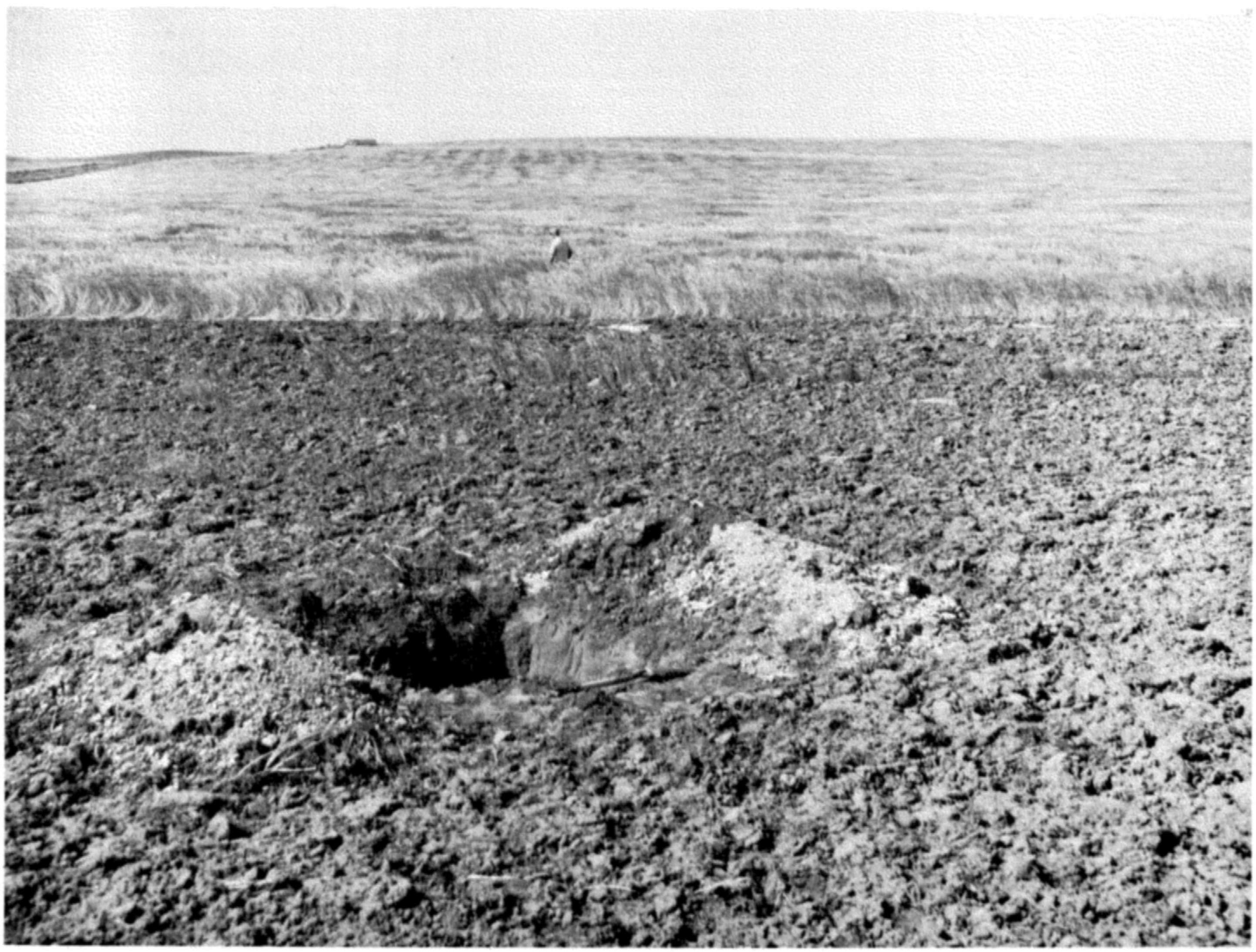

Figure 8.—Richfield and Dawes silt loams in foreground. Pit was dug so profile could be studied. Wheat on Keith and Rosebud soils in background.

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Many areas of this complex in the vicinity of Batesland are cultivated. Winter wheat is the main crop. Some areas are in native grass. Measures are needed to conserve moisture, to maintain good tilth, and to control soil blowing. The use of crop residue helps to conserve moisture and to control soil blowing. Stubble mulching is desirable in areas used for winter wheat. These practices also help to maintain good tilth on the Dawes part of this complex. (Richfield: Silty range site, capability unit IIc-1, windbreak group 2. Dawes: Silty range site, capability unit IIIs-1, windbreak group 3)

Rosebud Series

This series consists of nearly level to rolling, moderately deep, dark-colored, loamy soils on uplands in the central and southern parts of the county.

In a typical profile, the surface layer, about 4 inches thick, is dark-gray loam that is soft when dry and friable when moist.

The subsoil is about 16 inches thick. The uppermost 3 inches is dark grayish-brown loam that has weak prismatic structure. It is slightly hard when dry and friable when moist. The middle 7 inches is grayish-brown to light brownish-gray loam that has weak prismatic to subangular blocky structure. It is hard when dry and friable when moist. The lowermost 6 inches is light-gray, calcareous loam that has weak prismatic to subangular blocky structure. It is hard when dry and friable when moist. Fine bits of sandstone occur throughout the subsoil.

The underlying material consists of white, calcareous sandy loam that contains few to many fragments of sandstone. It is structureless and is soft when dry and friable when moist. It grades to bedded sandy loam and sandstone at a depth of 31 inches.

Rosebud soils are well drained. They are moderately fertile and are easy to work. Runoff is medium, and permeability is moderate.

These soils are suitable for use as cropland or as pasture. Many gently sloping areas are cultivated. Winter wheat is the main crop, but spring-sown grains, corn, and alfalfa are grown also. The native vegetation consists mainly of mid and short grasses.

Profile of a Rosebud loam, located 780 feet east and 65 feet south of the NW. corner of sec. 6, T. 35 N., R. 41 W, in a cultivated area (Laboratory No. 6592-6598):

Ap—0 to 4 inches, dark-gray (10YR 4/1) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft, friable; neutral; false plow-depth boundary.

B1—4 to 7 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to weak, very fine, granular and subangular blocky; thin patchy clay films on all ped faces; slightly hard, friable; few fine bits of sandstone; neutral; gradual, smooth boundary.

B21t—7 to 10 inches, grayish-brown (2.5Y 5/2) loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic structure breaking to weak, fine, granular and subangular blocky; thin continuous clay films on vertical ped faces, and thin patchy clay films on horizontal ped faces; slightly hard, friable; few fine bits of calcareous sandstone; mildly alkaline; gradual, smooth boundary.

B22t—10 to 14 inches, light brownish-gray (2.5Y 6/2) loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic structure breaking to weak, fine, granular and subangular blocky; thin continuous clay films on vertical prism faces, and thin patchy clay films on all other ped faces; hard, friable; few fine bits of calcareous sandstone; mildly alkaline; clear, smooth boundary.

B3ca—14 to 20 inches, light-gray (2.5Y 7/2) loam, light olive brown (2.5Y 5/3) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; thin patchy clay films on all ped faces; hard, friable; common fine bits and fragments of calcareous sandstone; moderately alkaline; calcareous; gradual, smooth boundary.

C1ca—20 to 25 inches, white (10YR 8/1) sandy loam, pale yellow (2.5Y 7/3) when moist; structureless; soft, friable; many large fragments of hard, calcareous sandstone; moderately alkaline; calcareous; gradual, smooth boundary.

C2ca—25 to 31 inches, white (7.5YR 8/1) sandy loam, light yellowish brown (2.5Y 6/3) when moist; structureless; soft, friable; few large fragments of hard, calcareous sandstone; moderately alkaline; calcareous; gradual, smooth boundary.

R—31 inches +, white (10YR 8/1) bedded sandstone, light brownish gray (10YR 6/2) when moist; moderately alkaline; calcareous.

The surface layer ranges from 3 to 7 inches in thickness and is loam, silt loam, or very fine sandy loam. The subsoil ranges from 10 to 25 inches in thickness and in places includes a clay loam layer. The structure of the subsoil is weak to moderate. The depth to lime ranges from 12 to 24 inches, and the depth to bedded sandy materials and sandstone ranges from 14 to 40 inches. In places there is a distinct layer of cemented sandstone or caliche. In other areas the geologic beds consist of very fine sand and silt and scattered fragments of sandstone.

Rosebud soils are thicker than Canyon soils, and they have a distinct B horizon. They have a more clayey subsoil than Oglala soils and are calcareous nearer the surface. They are less silty than Kadoka, Keith, and Ulysses soils. The underlying material is harder than that of Keith and Ulysses soils, and it contains fragments of sandstone.

Rosebud-Canyon loams, 5 to 9 percent slopes (ReB).—Rosebud soils make up 50 to 70 percent of this complex; Canyon soils, 25 to 45 percent; and other soils, 5 to 15 percent. This complex is on uplands in the central and southern parts of the county. It consists of moderately deep and shallow soils. The areas range up to 300 acres in size.

Rosebud soils occupy the longer side slopes. Canyon soils are on the tops of ridges and knolls and on the shoulders of small upland drainageways. In cultivated areas, Canyon soils are eroded in places and are easily recognized by their almost white color. Rosebud soils have the profile described as typical for the series, except in areas where they occur near spots of eroded Canyon soils. In those areas, light-colored material, washed downslope from Canyon soils, has formed a thin layer over the Rosebud soils.

Included in some of the areas mapped are spots of Colby, Goshen, Keith, Oglala, and Ulysses soils. Inclusions are less than 5 acres in size and make up less than 15 percent of the total area mapped.

Many areas of this complex are in native grass, and some formerly cultivated areas have been seeded to tame grasses. The areas now cultivated are mostly in the southeastern part of the county. Control of water erosion where the vegetation is sparse is the main problem. Seeding with grass is the most effective way to control erosion.

Stubble mulching in combination with contour farming helps to control erosion on cropland. Proper range use provides adequate control in areas of native grass. (Rosebud: Silty range site, capability unit IIIe-1, windbreak group 2. Canyon: Shallow range site, capability unit VIs-2, no windbreak group)

Rosebud-Keith silt loams, 3 to 9 percent slopes (RkC).—Rosebud soils make up 50 to 80 percent of this complex, Keith soils 15 to 40 percent, and other soils 5 to 15 percent. This complex is on uplands in the central and southern parts of the county. Most areas have slopes of 3 to 5 percent, but some have a range of 5 to 9 percent. The areas range up to 200 acres in size.

Rosebud soils are on convex upper slopes. Keith soils are on the longer mid slopes and in many places face south and east. The Rosebud soils in this complex have the profile described as typical for the series, except for the texture of the surface layer. The Keith soils have a surface layer and a subsurface layer that are thinner than those in the profile described as typical for the Keith series.

Included in some of the areas mapped are small areas of Canyon and Goshen soils. Canyon soils are on the tops of some ridges and knolls (fig. 9). Goshen soils occur in narrow strips along drainageways.

In the southeastern part of the county, much of this complex is cultivated and is used mainly for winter wheat. Areas in other parts of the county are used for grazing and native hay. Control of water erosion is the main problem. Stubble mulching alone or contour farming in combination with the use of crop residue is effective in areas where the slope range is mostly less than 5 percent. More intensive measures, such as the use of crop residue and terraces, are needed in areas where the slope range is mostly between 5 and 9 percent. Proper range use provides adequate erosion control in areas of native grass. (Silty range site, capability unit IIe-1, windbreak group 2)

Samsil Series

This series consists of shallow, firm, gently sloping to steep, moderately dark colored soils on uplands in the western part of the county. These soils formed in clay weathered from soft shale.

In a typical profile, the surface layer, about 2 inches thick, is light olive-brown, calcareous silty clay that is slightly hard when dry and friable when moist. The transitional layer, about 5 inches thick, is light olive-brown, calcareous clay that has weak subangular blocky

Figure 9.—Lighter colored Canyon soils in areas of Rosebud-Keith silt loams, 3 to 9 percent slopes.

structure. It is slightly hard when dry and firm when moist. It contains a few fine chips of shale.

The underlying material is light olive-brown, calcareous clay that contains numerous chips of weathered shale. It is structureless and is slightly hard when dry and firm when moist. In this material are a few fine spots of soft lime and gypsum. Bedded shale occurs at a depth of 10 inches.

Samsil soils are somewhat excessively drained to excessively drained. They are shallow to shale and are readily eroded. Fertility is low. Surface runoff is rapid, and permeability is slow.

Nearly all areas are in native grass and are used for grazing. The native vegetation consists of a thin stand of mid grasses and a very sparse understory of short grasses. Yucca is usually a part of the plant community.

Profile of a Samsil silty clay, located in the SW¼ sec. 1, T. 39 N., R. 48 W., in native grass:

A1—0 to 2 inches, light olive-brown (2.5Y 5/3) silty clay, olive brown (2.5Y 4/3) when moist; moderate, medium, granular structure; slightly hard, friable; moderately alkaline; calcareous; abrupt, smooth boundary.

AC—2 to 7 inches, light olive-brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard, firm; few fine chips of shale; moderately alkaline; calcareous; clear, smooth boundary.

Cca—7 to 10 inches, light olive-brown (2.5Y 5/4) shaly clay, olive brown (2.5Y 4/4) when moist; structureless; slightly hard, firm; moderately alkaline; calcareous; few fine spots and streaks of soft lime and gypsum; clear, smooth boundary.

R—10 inches +, bedded shale; mildly alkaline; calcareous in the upper part; few nests of gypsum crystals in the upper part.

The surface layer ranges from 1 to 6 inches in thickness and is clay or silty clay. The AC horizon ranges up to 9 inches in thickness. In places the AC is lacking. In many places manganese concretions and small fragments of limestone and ironstone are scattered on the surface and throughout the soil material. The depth to bedded shale ranges from 5 to 20 inches but most commonly is from 10 to 14 inches. The shale ranges from pale olive and light olive brown to dark gray in color and strongly influences the color of the soil.

Samsil soils lack the distinct B horizon that is characteristic of Pierre soils, and they are more shallow to shale. They are more clayey than Penrose soils. They are less alkaline than Orella soils and are more olive in color.

Samsil-Shale outcrop complex (3 to 40 percent slopes) (Ss).—Samsil soils make up 50 to 70 percent of this complex; Shale outcrop, 10 to 30 percent; and other soils, less than 20 percent. This complex is in the western part of the county. The areas range from 200 to 1,000 acres in size. In some areas the soils are gently sloping to rolling and have slopes of less than 18 percent. Other areas consist of rough broken land along the Cheyenne River, where the slopes range up to 40 percent. Gullied drainageways have formed in most areas.

Samsil soils and Shale outcrop are closely intermingled in many areas. Samsil soils have the profile described as typical for the Samsil series. Shale outcrop consists of eroded exposures of soft bedded shale. These exposures are scattered through the complex and are common around the heads of drainageways. Some areas along the Cheyenne River are almost vertical. Landslides are common in these areas.

Other soils included in the areas mapped are Hisle, Kyle, Pierre, and Swanboy. Hisle soils occur on foot slopes, along small drainageways, and in slightly depressed "saddles" on drainage divides. Kyle and Swanboy soils are on fans and small flats. Pierre soils are in gently sloping areas that range up to 20 acres in size.

All of this complex is used for grazing. Shale outcrop is bare or nearly so. Control of water erosion is the main management problem. Gullies form quickly if the native vegetation is destroyed or is in poor condition. Seeding, pitting, and contour furrowing help to restore the grass cover on the more gently sloping Samsil soils. Proper range use is the only practical way to control erosion on the steeper slopes. (Samsil: Shallow range site, capability unit VIIs–2, no windbreak group. Shale outcrop: capability unit VIIIs–1, no range site or windbreak group)

Swanboy Series

This series consists of deep, very firm, light-colored soils. These soils formed in dense clay alluvium washed from clay soils on adjacent slopes. They occupy upland valleys, fan slopes, and stream terraces in the northern and western parts of the county.

In a typical profile, the surface layer is light olive-gray, calcareous silty clay, about 1 inch thick, and it has a thin, light-gray crust. It is hard when dry, friable when moist, and sticky and plastic when wet. Beneath this is a transitional layer, about 11 inches thick, consisting of light-gray, calcareous clay that has weak to moderate blocky structure. It is extremely hard when dry, very firm when moist, and sticky and very plastic when wet.

The underlying material is pale-yellow, calcareous clay. It is structureless and is very hard when dry, very firm when moist, and sticky and very plastic when wet. It contains a few spots of soft lime and gypsum.

Swanboy soils are well drained. They have low fertility and very poor tilth. Surface runoff is medium to rapid, permeability is very slow, and moisture is released slowly to plants.

These soils are not suitable for cultivation. The native vegetation consists of sparse stands of mid grasses, mostly western wheatgrass. There is no understory of short grasses.

Profile of Swanboy clay, located 700 feet north of the southeast corner of sec. 15, T. 40 N., R. 47 W., about 0.2 mile west of gravel road, in native grass:

A1—0 to 1 inch, light olive-gray (5Y 6/2) clay, olive (5Y 5/3) when moist; light-gray (5Y 7/1) crust about one-quarter inch thick, olive gray (5Y 5/2) when moist; moderate, fine and medium, granular structure; hard, friable, sticky, plastic; moderately alkaline; calcareous; abrupt, wavy boundary.

AC1—1 to 6 inches, light-gray (5Y 7/2) clay, pale olive (5Y 6/3) when moist; weak, coarse, subangular blocky structure breaking to moderate, medium and fine, blocky; extremely hard, very firm, sticky, very plastic; strongly alkaline; calcareous; clear, wavy boundary.

AC2—6 to 12 inches, light-gray (5Y 7/2) clay, pale olive (5Y 6/3) when moist; weak, coarse, blocky structure breaking to wedge shaped, moderate, fine, blocky;

extremely hard, very firm, sticky, very plastic; strongly alkaline; calcareous; gradual, wavy boundary.

C—12 to 60 inches, pale-yellow (5Y 7/3) clay, pale olive (5Y 6/3) when moist; massive; very hard, very firm, sticky, very plastic; strongly alkaline; calcareous; very few, fine and medium, distinct segregations of soft lime and gypsum.

The surface layer ranges from one-half inch to 2 inches in thickness. The AC horizon ranges from 8 to 16 inches in thickness and has weak to moderate blocky structure. Cracks up to 2 inches in width extend downward through these layers when the soil is dry. The color of the soil depends on the source of the clay sediments. The material is strongly calcareous where the sediments were derived from clays of the Badlands and weakly calcareous where they were derived from bedded shales. In places the underlying material is stratified with material of coarser texture, and in a few places a few chips of shale are present.

Swanboy soils are deeper to shale than Orella, Pierre, and Samsil soils. They are more alkaline, lighter colored, and less well developed than Kyle and Pierre soils.

Swanboy clay (0 to 6 percent slopes) (Sw).—This is a dense, crusty soil. It occurs in basins in Badlands in the northern part of the county and on foot slopes, fans, and small stream flats in the western part. The slopes are mostly less than 3 percent, though the range is from 0 to 6 percent. This soil has the profile described as typical for the series.

Included in the areas mapped in the northern part of the county are small areas of Orella soils. These make up as much as 20 percent of some areas. Some of the areas in the western part of the county include small areas of Hisle, Kyle, and Pierre soils.

All of this soil is in native grass, and most areas are used for grazing. In good years, native hay is cut. Strong alkalinity, very slow permeability, and low fertility are the main limitations. The response to water spreading generally is not satisfactory. Proper range use is essential to maintain the sparse stand of western wheatgrass. Seeding helps to restore the grass cover where the range is in poor condition. (Dense Clay range site, capability unit VIIs-1, no windbreak group)

Tassel Series

This series consists of shallow, very friable, light-colored, moderately coarse textured, calcareous soils over sandstone. These soils are on rolling to hilly uplands in the southern part of the county.

In a typical profile, the surface layer, about 2 inches thick, is light brownish-gray fine sandy loam. Below this is about 10 inches of light-gray, structureless, fine sandy loam. These layers are loose, very friable, and calcareous and contain bits and fragments of sandstone. Consolidated sandstone is at a depth of 12 inches.

Tassel soils are somewhat excessively drained and have low fertility. Runoff is slow to medium, permeability is moderately rapid, and the water-holding capacity is low.

All areas are in native grass and are used for grazing. The native vegetation consists mainly of mid and short grasses and smaller amounts of tall grasses.

Profile of a Tassel fine sandy loam, located 0.1 mile west and 120 feet north of the SE. corner of lot 4, sec. 15, T. 35 N., R. 44 W., in native grass:

A1—0 to 2 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine and medium, granular structure; loose, very friable; moderately alkaline; calcareous; common bits and fragments of sandstone up to 4 inches in diameter; clear, smooth boundary.

C—2 to 12 inches, light-gray (10YR 7/1) fine sandy loam, brown (10YR 5/3) when moist; structureless; loose, very friable; moderately alkaline; calcareous; common bits and fragments of sandstone; gradual, irregular boundary.

R—12 inches +, consolidated calcareous sandstone.

The surface layer ranges from 1 inch to 4 inches in thickness and from loamy sand to fine sandy loam in texture. In places it is grayish brown in color and is underlain by a transitional layer that has weak subangular blocky structure. The thickness of the underlying material depends on the depth to sandstone. The depth to sandstone ranges from 6 to 25 inches.

Tassel soils are shallow to sandstone and calcareous, and they are lighter colored than Anselmo soils. They are more sandy than Canyon, Colby, and Epping soils.

Tassel-Anselmo complex, 10 to 40 percent slopes (TaF).—Tassel soils make up 60 to 85 percent of this complex, and Anselmo soils 15 to 40 percent. This complex consists of moderately coarse textured soils on uplands in the southern part of the county. The slope range is 10 to 40 percent but is dominantly 10 to 20 percent. The areas are mostly less than 50 acres in size.

Tassel soils are on the tops of ridges and on the steeper side slopes. They have the profile described as typical for the series. Anselmo soils are on the more gentle mid and lower slopes. They have a profile similar to the one described for the Anselmo series, but in places the underlying material contains fragments of sandstone.

Included in some of the areas mapped are small sand blowouts and small areas of Dunday and Valentine soils. The blowouts generally are just below the crests of ridges and are partly surrounded by Valentine soils. Dunday soils are on some foot slopes. Inclusions make up less than 10 percent of the total area mapped.

All of this complex is in native grass and is used for grazing. Cultivation generally is impractical because the Tassel soils are shallow and both soils are susceptible to erosion. Proper range use is the most practical way to control erosion. Seeding, pitting, and contour furrowing to help restore the vegetation are practical on slopes of less than 20 percent. (Tassel: Shallow range site, capability unit VIs-2, no windbreak group. Anselmo: Sandy range site, capability unit VIe-2, windbreak group 1)

Terrace Escarpments

Terrace escarpments (Te) is made up of mixed, light-colored soils and soil materials on terrace fronts and breaks along the White River and its tributaries. The slope range is 9 to 30 percent. Slopes are short, steep, and irregular.

Generally there is little or no soil development in the light-colored soil material. The texture is variable but commonly is loam, silt loam, or clay. There are pockets of sand and gravel in some places. Included in some of the areas mapped are small areas of Epping, Samsil, and Valentine soils.

This land type supports sparse stands of mid and short grasses. All areas are used for grazing. Erosion is a hazard where the vegetation is sparse. Proper range use is the most practical way to control erosion. The irregular, steep slopes make seeding and other mechanical measures impractical. (Shallow range site, capability unit VIIs–2, no windbreak group)

Tuthill Series

This series consists of deep, nearly level to undulating, dark-colored soils that formed in sandy to loamy material over stratified sand and gravelly sand. These soils are on high terraces and tablelands in the northern part of the county.

In a typical profile, the surface layer, about 6 inches thick, is soft when dry and friable when moist. The upper 3 inches is grayish-brown very fine sandy loam. The lower part is dark grayish-brown very fine sandy loam.

The subsoil is about 26 inches thick. The upper 20 inches is grayish-brown to brown sandy clay loam that has moderate prismatic and blocky structure. It is very hard when dry and firm when moist. The lower 6 inches is pale-brown sandy loam that has weak prismatic and subangular blocky structure. It is slightly hard when dry and friable when moist.

The underlying material is pale-brown, loose, structureless sand that becomes calcareous at a depth of 54 inches.

Tuthill soils are well drained and are moderately fertile. Runoff is slow to medium, and permeability is moderate. The water-holding capacity in the upper 30 inches or more is high.

Most areas are in native grass and are used for grazing and hay. Only a few scattered areas are cultivated. The native vegetation consists mainly of mid and short grasses, but there are some tall grasses.

Profile of a Tuthill very fine sandy loam, located in the NE¼NW¼ sec. 11, T. 42 N., R. 47 W., in native grass:

A11—0 to 3 inches, grayish-brown (10YR 5/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, thin, platy and granular structure; soft, friable; neutral; abrupt, smooth boundary.

A12—3 to 6 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; soft, friable; neutral; clear, smooth boundary.

B21t—6 to 16 inches, grayish-brown (10YR 5/2) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, coarse, prismatic structure breaking to moderate, coarse and medium, blocky; very hard, firm; neutral; clear, smooth boundary.

B22t—16 to 26 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium, prismatic structure breaking to moderate, medium, blocky; very hard, firm; neutral; smooth boundary.

B3—26 to 32 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; slightly hard, friable; neutral; clear, smooth boundary.

IIC1—32 to 54 inches, pale-brown (10YR 6/3) sand, yellowish brown (10YR 5/4) when moist; structureless; loose; mildly alkaline; gradual boundary.

IIC2—54 to 64 inches, pale-brown (10YR 6/3) sand, yellowish brown (10YR 5/4/) when moist; structureless; loose; moderately alkaline; calcareous.

The A horizon ranges from 3 to 10 inches in thickness and from fine sandy loam to loam in texture. The B horizon ranges from 14 to 30 inches in thickness. The texture is sandy clay loam. The depth to lime ranges from 24 to 60 inches but commonly is 30 to 40 inches. The underlying material varies in texture and in places is stratified with material of contrasting texture ranging from loam to coarse sand and fine, rounded quartz gravel. The calcareous layer is very weakly to strongly effervescent.

Tuthill soils have a more clayey subsoil than Anselmo and Manter soils. They become calcareous at a greater depth than Manter soils. They are less silty and more sandy than Keith and Richfield soils.

Tuthill and Anselmo fine sandy loams, 0 to 3 percent slopes (TnA).—This mapping unit is on tablelands in the northern part of the county. Many areas are partly Tuthill fine sandy loam and partly Anselmo fine sandy loam, but some contain only one or the other of these. The Tuthill soil makes up the smoother, more nearly level parts of the unit. The Anselmo soil makes up the more undulating parts and is commonly on the crests of short, very gentle slopes.

The profile of the Tuthill soil in this unit is like the one described as typical for the series, except for the texture of the surface layer. A typical profile of Anselmo sandy loam is described under the heading "Anselmo series." The profile of the Anselmo soil in this unit has a thinner and less coarse textured surface, and it is browner in color.

Included in some of the areas mapped are small areas of Manter soils. These inclusions are on very gentle rises, where the depth to lime is less than 24 inches. They generally make up less than 15 percent of a mapping area.

Most areas of this mapping unit are in the former bombing range and are used for grazing. Only a few tracts are cultivated. Control of soil blowing is the main management problem. Proper range use provides adequate control in areas of native grass. Stubble mulching and wind stripcropping help to control erosion in cultivated areas. (Sandy range site, capability unit IIIe–2, windbreak group 1)

Tuthill and Anselmo fine sandy loams, 3 to 9 percent slopes (TnC).—This mapping unit is in the northern part of the county. Many areas contain both soils, but some contain only one or the other of them. The areas range up to 500 acres in size.

Tuthill soils make up the longer, smoother slopes. Anselmo soils are on upper slopes, which are more undulating.

Included in some of the areas mapped are small areas of Manter soils. These inclusions are on the upper part of slopes, where the depth to lime is less than 24 inches. They ordinarily make up less than 20 percent of the area mapped.

Most areas of this unit are in native grass and are used for grazing and hay. Soil blowing and water erosion are hazards in areas where the vegetation is sparse. Proper range use provides adequate erosion control in areas of native grass. The use of tame grasses and legumes in the cropping system, in combination with wind stripcropping and the use of crop residue, helps to control erosion in cultivated areas. (Sandy range site, capability unit IVe–3, windbreak group 1)

Tuthill and Manter soils, 0 to 3 percent slopes (TuA).—This mapping unit is on high terraces and tablelands in the northern part of the county. Many areas contain both soils, but some contain only one or the other. Tuthill soils make up the more nearly level areas. Manter soils are mostly on slight rises or in slightly undulating areas. The texture of the surface layer of both soils ranges from fine sandy loam to loam.

Included in some of the areas mapped are small areas of Altvan, Anselmo, and Goshen soils. Inclusions make up less than 10 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. Only a few tracts are cultivated. Conservation of moisture is the main management problem. Soil blowing also is a hazard. Proper range use conserves moisture and controls erosion in areas of native grass. The use of crop residue is effective in cultivated areas. Stubble mulching is desirable if winter wheat is the main crop. (Tuthill: Silty range site, capability unit IIIe–2, windbreak group 1. Manter: Sandy range site, capability unit IIIe–2, windbreak group 1)

Tuthill and Manter soils, 3 to 5 percent slopes (TuB).—This mapping unit is on tablelands in the northern part of the county. Many areas contain both Tuthill and Manter soils, but some contain only one or the other. Tuthill soils make up the longer and smoother slopes, and Manter soils the upper part of slopes. The texture of the surface layer of both soils ranges from loam to fine sandy loam.

Included in some of the areas mapped are small areas of Altvan, Anselmo, and Goshen soils. Inclusions make up less than 15 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. Only a few small tracts are cultivated. Conservation of moisture and control of water erosion and soil blowing are the management problems. Proper range use controls erosion in areas of native grass. Stubble mulching or contour stripcropping, in combination with the use of crop residue, is effective in cultivated areas. (Tuthill: Silty range site, capability unit IIIe–3, windbreak group 1. Manter: Sandy range site, capability unit IIIe–3, windbreak group 1)

Tuthill and Manter soils, 5 to 9 percent slopes (TuC).—This mapping unit is on tablelands in the northern part of the county. It occurs in an irregular pattern, and some areas lack one or the other of the major soils. Tuthill soils make up the longer, smoother slopes, and Manter soils generally the shorter slopes. The texture of the surface layer is commonly loam to fine sandy loam. The depth to lime is only about 16 inches in the Manter soils.

Included in some of the areas mapped are small areas of Altvan, Anselmo, and Goshen soils. Inclusions make up less than 15 percent of the total area mapped.

Most areas are in native grass and are used for grazing and hay. Only a few small tracts are cultivated. Conservation of moisture and control of soil blowing and water erosion are management problems. Proper range use provides adequate control of erosion in areas of native grass. In cultivated areas, suitable combinations of stubble mulching, contour farming, stripcropping, terracing, and the use of grasses and legumes are needed for adequate erosion control. (Tuthill: Silty range site, capability unit IVe–3, windbreak group 1. Manter: Sandy range site, capability unit IVe–3, windbreak group 1)

Ulysses Series

This series consists of deep, friable, gently sloping to rolling, dark-colored, silty soils that formed in loess. These soils are on uplands throughout most of the county.

The surface layer, about 5 inches thick, is grayish-brown silt loam that is soft to slightly hard when dry and friable when moist. The subsoil, about 5 inches thick, is brown silt loam that has weak prismatic and moderate subangular blocky structure. It is slightly hard when dry and friable when moist.

The underlying material is friable, very pale brown to pale brown, calcareous silt loam. It has weak prismatic structure in the upper part.

Ulysses soils are well drained and are moderately fertile. Surface runoff is medium, permeability is moderate, and the water-holding capacity is high.

Many areas in the southeastern part of the county are cultivated. In other parts of the county, most of the areas are in native grass and are used for grazing and hay. The native vegetation consists of mid and short grasses.

Ulysses soils in this county are mapped only with Keith and Colby soils.

Profile of a Ulysses silt loam, located 1,140 feet north and 700 feet west of the SE. corner of sec. 15, T. 40 N., R. 41 W., in native grass:

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

A12—3 to 5 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, subangular blocky structure breaking to weak, fine, granular; slightly hard, friable; neutral; clear, smooth boundary.

B2—5 to 10 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; thin patchy clay films; slightly hard, friable; mildly alkaline; abrupt, wavy boundary.

C1—10 to 18 inches, very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) when moist; weak, medium, prismatic structure; slightly hard, friable; moderately alkaline; calcareous; gradual, smooth boundary.

C2—18 to 56 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; structureless; soft, friable; moderately alkaline; calcareous; grades to very fine sandy loam at a depth of 56 inches.

The A horizon ranges from 4 to 7 inches in thickness and from silt loam to very fine sandy loam in texture. The B horizon ranges from 5 to 12 inches in thickness and has little or no increase in clay content over the surface layer. In some places this layer is entirely calcareous or is calcareous in the lower part. The depth to lime ranges from 5 to 15 inches. In places underlying material grades to very fine sandy loam, which may be underlain by fine sand.

Ulysses soils have a less clayey subsoil than Keith soils, and they are calcareous nearer the surface. They are deeper to lime than Colby soils. Lime is closer to the surface in Ulysses soils than in Oglala soils.

Ulysses-Colby complex, sand substratum, 3 to 9 percent slopes (UcC).—Ulysses soils make up 60 to 70 percent of this complex, and Colby soils 30 to 40 percent. This complex is on undulating benches along the White River in the western part of the county. The Ulysses soils are on side slopes, and the Colby soils are on the upper slopes of ridges and knolls. The slope is mostly less than 5 percent, though the range is from 3 to 9 percent.

In most places the upper horizon of both soils is very fine sandy loam. The surface layer of Ulysses soil is lighter colored than that in the profile described as typical for the series. The texture throughout both the Ulysses and Colby soils is coarser than that in the typical profiles.

Small areas of Anselmo soils are included in the areas mapped.

Most areas of this complex are in native grass and are used for grazing. Control of water erosion and control of soil blowing are management problems. Droughtiness is a hazard. Proper range use provides adequate erosion control in areas of native grass. Various combinations of stubble mulching, use of crop residue, stripcropping, and terracing are needed in cultivated areas. (Ulysses: Silty range site, capability unit IIIe–1, windbreak group 2. Colby: Thin Upland range site, capability unit IVe–5, windbreak group 2)

Valentine Series

This series consists of deep, loose, light-colored, sandy soils on rolling to hilly uplands in the southeastern and northern parts of the county. These soils formed in sand deposited or locally reworked by wind.

In a typical profile, the surface layer, about 3 inches thick, is light brownish-gray, loose fine sand. Below this is a transitional layer, about 6 inches thick, of loose, pale-brown fine sand that has very weak subangular blocky structure.

The underlying material to a depth of 60 inches is very pale brown fine sand. It is structureless and loose.

Valentine soils are excessively drained. Surface runoff is very slow, permeability is very rapid, and the water-holding capacity is low. Moisture is released readily to plants. The fertility is low, and soil blowing is a hazard.

All areas are in native grass and are used for grazing. The native vegetation consists mainly of tall and mid grasses.

Profile of Valentine fine sand, rolling, located in the SE¼ sec. 14, T. 35 N., R. 42 W., in native grass:

A1—0 to 3 inches, light brownish-gray (10YR 6/2) fine sand, dark brown (10YR 4/3) when moist; single grain; loose; neutral; clear boundary.

AC—3 to 9 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; very weak, medium, subangular blocky structure or single grain; loose; neutral; gradual boundary.

C—9 to 60 inches, very pale brown (10YR 7/3) fine sand, pale brown (10YR 6/3) when moist; single grain; loose; neutral.

The combined thickness of the surface layer and the transitional layer ranges from 3 to 15 inches. In many places there is no AC horizon. In a few places in the southeastern part of the county, the underlying material changes to calcareous sandstone and very fine sand below a depth of 50 inches. In the northern part of the county, the underlying material in many places is stratified with fine to coarse sand.

Valentine soils are lighter colored and coarser textured than Anselmo and Dunday soils. They are not calcareous like Bankard soils.

Valentine fine sand, rolling (3 to 18 percent slopes) (VaC).—This soil is on a succession of rounded ridges and knolls in the southeastern part of the county. The slopes are short, mostly less than 150 feet in length. This soil has the profile described as typical for the series.

Included in some of the areas mapped are small areas of Dunday, Elsmere, and Tassel soils. Dunday and Elsmere soils are in swales and valleys. Tassel soils occur where the wind-deposited sand thins out over weakly cemented sandstone. Sand blowouts, mostly less than 3 acres in size, occur in some areas. Inclusions make up less than 15 percent of the total area mapped.

All of this soil is in native grass and is used for grazing. Control of soil blowing is the main management problem. Proper range use is the best means of controlling erosion. Smoothing, seeding, mulching, and fencing are needed to restore the grass cover in blowouts. (Sands range site, capability unit VIe–2, windbreak group 7)

Valentine fine sand, hilly (15 to 35 percent slopes) (VaD).—This soil is on uplands in the southeastern part of the county. The shorter slopes are generally angular in shape and are less than 150 feet in length. The areas are less than 300 acres in size.

The surface layer is less than 3 inches thick and is only slightly darker colored than the underlying sand. Sand blowouts that range up to 5 acres in size are common. Included in some of the areas mapped are small areas of Dunday and Elsmere soils. Inclusions make up less than 10 percent of the total area mapped.

All of this soil is used for grazing. Control of soil blowing is the main management problem. Proper range use is the most practical means of control. Steepness and irregularity of slopes make mechanical treatment impractical. (Choppy Sands range site, capability unit VIIe–1, windbreak group 7)

Valentine sand (3 to 30 percent slopes) (Vs).—This soil is on rolling tablelands in the northern part of the county. The areas range up to 1,000 acres in size. Most slopes are less than 18 percent, but some of the areas mapped have a gradient up to 30 percent.

In many places the underlying material is coarser textured sand than that in the profile described as typical for the Valentine series. It generally is stratified by size and contains thin lenses of coarse sand and fine, rounded quartz pebbles.

Included in some of the areas mapped are small areas of Anselmo, Dunday, and Manter soils. These inclusions are in the more gently sloping areas and make up less than 10 percent of the total area mapped.

All of this soil is in native grass and is used for grazing. It has good cover of mid and tall grasses, but careful management is needed to control soil blowing and to prevent the occurrence of sand blowouts. (Sands range site, capability unit VIe–2, windbreak group 7)

Wanblee Series

This series consists of moderately deep, nearly level to gently sloping, light-colored soils that have a very firm to firm clayey subsoil. These soils are in swales and on foot slopes and fans in most parts of the county.

In a typical profile, the surface layer, about 3 inches thick, is light brownish-gray, calcareous silt loam that is soft when dry and friable when moist.

The subsoil is about 11 inches thick. The upper 3 inches is brown, calcareous silty clay that has moderate columnar structure. It is very hard when dry and very firm when moist. The lower 8 inches is pale-brown, calcareous silty clay that has weak prismatic and moderate blocky structure. It is very hard when dry and firm when moist.

The underlying material is very pale brown, calcareous silty clay and silty clay loam. It is structureless and is hard when dry and firm when moist. In this material are spots of salt segregation.

Wanblee soils are somewhat poorly drained. Moisture is released slowly to plants, fertility is low, and tilth is very poor. Runoff is slow to very slow, and water ponds in low spots on the uneven surface. In these spots, the surface layer is very thin and crusty.

These soils are mostly in native grass. Only a few scattered tracts are cultivated. The native vegetation consists of a sparse stand of mid and short grasses. The low spots either are bare or have only a thin cover of grass.

Wanblee soils in this county are mapped only as a complex with Wortman soils.

Profile of a Wanblee silt loam, located 1,100 feet west and 400 feet north of the SE. corner of sec. 30, T. 36 N., R. 46 W., in native grass:

A2—0 to 3 inches, light brownish-gray (10YR 6/2) silt loam, very dark grayish brown (10YR 3/2) when moist; upper one-quarter inch is a thin, light-gray (10YR 6/1) crust; moderate, fine, granular structure; soft, friable; moderately alkaline; calcareous; abrupt, wavy boundary.

B21t—3 to 6 inches, brown (10YR 5/3) silty clay, dark brown (10YR 4/3) when moist; moderate, fine and medium, columnar structure breaking to moderate, fine, blocky; clay films on peds; very hard, very firm; light brownish-gray A2 material coats tops and sides of columns; strongly alkaline; calcareous; abrupt, smooth boundary.

B22t—6 to 14 inches, pale-brown (10YR 6/3) silty clay, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure breaking to moderate, medium, blocky; clay films on peds; very hard, firm; strongly alkaline; calcareous; abrupt, smooth boundary.

C1—14 to 20 inches, very pale brown (10YR 7/3) silty clay, brown (10YR 5/3) when moist; structureless; hard, firm; strongly alkaline; calcareous; clear, smooth boundary.

C2sa—20 to 36 inches, very pale brown (10YR 7/4) silty clay, yellowish brown (10YR 5/4) when moist; structureless; hard, firm; strongly alkaline; calcareous; common spots of salts; gradual boundary.

C3sa—36 to 60 inches, very pale brown (10YR 7/4) silty clay loam, yellowish brown (10YR 5/4) when moist; structureless; slightly hard, firm; strongly alkaline; calcareous; many spots of salts.

The surface layer ranges from one-half inch to 4 inches in thickness and from fine sandy loam to silt loam in texture. The subsoil ranges from 6 to 15 inches in thickness and from sandy clay loam to clay in texture. It has weak to strong columnar structure in the upper 2 to 4 inches. The color, which depends upon the source of the underlying material, ranges from grayish brown to yellowish brown. In most places the thin surface layer and the upper part of the subsoil are calcareous. The underlying material ranges from silty clay loam to silt loam or very soft siltstone.

Wanblee soils lack the water table that is present in Minatare soils, and they have harder underlying materials. They are lighter colored and more alkaline than Wortman soils, and they have a thinner surface layer and subsoil. They are less clayey than Hisle soils.

Wortman Series

This series consists of moderately deep to deep, nearly level to gently sloping, dark-colored soils that have a very firm clayey layer in the subsoil. These soils are in swales and on foot slopes and fans on uplands in most parts of the county.

In a typical profile, the surface layer is about 4 inches thick. The upper 3 inches is grayish-brown silt loam that is soft when dry and friable when moist. The lower 1 inch is light brownish-gray very fine sandy loam that is soft when dry and very friable when moist.

The subsoil is about 17 inches thick. The uppermost 3 inches is grayish-brown silty clay loam that has moderate columnar and blocky structure. It is very hard when dry and firm when moist. The middle 5 inches is grayish-brown silty clay that has strong blocky structure. It is very hard when dry and very firm when moist. The lowermost 9 inches is pale-brown silty clay loam that has moderate subangular blocky structure. It is hard when dry and friable when moist.

The underlying material is very pale brown, calcareous silt loam that has weak subangular blocky structure. It is slightly hard when dry and friable when moist. This material contains many streaks and spots of soft lime and salts. At a depth of about 37 inches, it becomes pink silt loam or very soft siltstone.

Wortman soils are moderately well drained and are moderately fertile. Runoff is slow, and permeability is slow to very slow. Moisture is released slowly to plants.

Most areas are in native grass and are used for grazing. A few areas are cultivated. The native vegetation consists of mid and short grasses.

Profile of a Wortman silt loam, located in the SW¼ SE¼ sec. 35, T. 37 N., R. 47 W., about 0.1 mile west of drain and 100 feet north of road, in native grass:

A1—0 to 3 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, granular structure; soft, friable; neutral; abrupt, smooth boundary.

A2—3 to 4 inches, light brownish-gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, very thin, platy structure breaking to weak, fine, granular; soft, very friable; neutral; abrupt, smooth boundary.

B21t—4 to 7 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, columnar structure breaking to moderate, medium, blocky; continuous clay films; very hard, firm; mildly alkaline; clear, smooth boundary.

B22t—7 to 12 inches, grayish-brown (10YR 5/2) silty clay, dark brown (10YR 3/3) when moist; strong, medium and fine, blocky structure; continuous clay films; very hard, very firm; moderately alkaline; clear, wavy boundary.

B3—12 to 21 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, coarse and medium, subangular blocky structure; hard, friable; moderately alkaline; few fine segregations of lime; clear, wavy boundary.

C1casa—21 to 37 inches, very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; slightly hard, friable; strongly alkaline; calcareous; many spots and streaks of soft lime and salts; gradual boundary.

C2—37 to 60 inches, pink (7.5YR 7/4) silt loam or very soft siltstone, brown (7.5YR 5/4) when moist; structureless; slightly hard, friable; moderately alkaline; calcareous.

The A horizon ranges from 4 to 10 inches in thickness and from sandy loam to silt loam in texture. The lower part of this layer ranges from light brownish gray to light gray in color. The subsoil ranges from 7 to 25 inches in thickness and has moderate to strong columnar structure in the upper part. In places the lower part is calcareous. The depth to lime ranges from 10 to 30 inches. The underlying material ranges from pink to light yellowish brown in color. In places bedded chalky shale and siltstone are at a depth ranging from 25 to 50 inches.

Wortman soils are darker colored than Wanblee soils, and their surface layer and subsoil are thicker and less alkaline. They have a browner subsoil than Mosher soils, and they usually do not have a water table. They have a thinner surface layer than Dawes soils, they are more alkaline, and their columnar structure is more pronounced.

Wortman-Wanblee complex (0 to 6 percent slopes) (Ww).—Wortman soils make up 45 to 80 percent of this complex, and Wanblee soils 20 to 55 percent. These soils are in swales and on foot slopes and fans in most parts of the county. They are closely intermingled, and soil differences occur within distances of only a few feet. The slope is mostly less than 3 percent, though the range is from 0 to 6 percent.

The surface is uneven, and Wanblee soils occupy the many slight depressions. Wortman soils are in the intervening areas, which are 1 to 6 inches above the depressions. The soils of this complex have profiles like the ones described as typical for their respective series.

The areas mapped in the vicinity of Batesland include small areas of Minatare and Mosher soils. In other parts of the county, small areas of Kadoka, Manvel, and Minnequa soils are included in some of the areas mapped. Inclusions commonly make up less than 20 percent of the mapped area.

Most of this complex is in native grass and is used for grazing. Only a few areas are cultivated. Alfalfa is the main crop. Tame grasses have been seeded in a few fields that formerly were cultivated.

Wortman soils are suitable for crops, although the claypan limits production. Wanblee soils are not suited to crops, and their pattern of occurrence is such that in most areas cultivation is impractical. (Wortman: Claypan range site, capability unit IVs-2, windbreak group 5. Wanblee: Thin Claypan range site, capability unit VIs-1, no windbreak group)

Use and Management of the Soils

This section discusses the use and management of soils as range, as cropland, for windbreaks, for wildlife, and for engineering purposes.

Use of the Soils as Range [2]

Most of Shannon County was once covered with native grass, and about 87 percent still is. In all parts of the county except where Keith and Rosebud soils are, cropland occurs only as isolated tracts within larger areas of range. Mid and short grasses are common in much of the county. Tall and mid grasses are dominant in the extreme southeastern part of the county and in the areas of the northern part where Valentine and Anselmo soils are predominant. The rangeland is mostly rolling to hilly. All of it except a few isolated mesas in areas of Badlands is accessible to livestock.

Native grass for pasture and hay is the most important crop in the county. Beef cattle are the main kind of livestock, and breeding stock predominate. There are also dairy cattle and horses and a few sheep.

Range sites and condition classes

A range site is a distinctive kind of range that, because of its particular combination of climate, soil, and topography, is capable of producing certain kinds and amounts of native vegetation. Grazing, drought, fire, tillage, or other forces may change or destroy the vegetation, but the potential of a given site for grass production remains the same.

The climax vegetation on a site consists of the plants that make the best use of their natural environment and are the most productive. These plants survive without the benefit of fertilizer, irrigation, or cultivation. The composition of the vegetation changes under intensive grazing.

The plants on any given range site are grouped, according to their response to grazing, as decreasers, increasers, and invaders. Decreasers are plants in the climax vegetation that tend to die out if the site is heavily grazed. Generally they are the tallest perennial grasses and forbs, and the ones most palatable to livestock. Increasers are climax plants that become more abundant as the decreasers decline but start to die out if heavy grazing continues. They are generally shorter than the decreasers and also less palatable to livestock. Invaders are mostly annual grasses, weeds, and shrubs, not part of the climax vegetation, that become established when the climax vegetation has been overgrazed or otherwise severely damaged.

Changes in plant cover can be controlled by management of grazing. In appraising the condition of range and planning its management, the basis for comparison is the degree of departure from the climax vegetation brought about by grazing use. Four range condition classes are recognized: excellent, good, fair, and poor. They indicate the difference between what is now growing on a particular site and the native vegetation that once grew there. A range is in excellent condition if 76 to 100 percent of the vegetation is the same as that in the climax vegetation. It is in good condition if the percentage is 51 to 75, in fair condition if the percentage is 26 to 50, and in poor condition if the percentage is less than 26.

[2] By RALPH S. COLE, range conservationist, Soil Conservation Service.

The following are signs of improvement in range condition: (1) the more palatable grasses are vigorous and are spreading; (2) little bare ground is visible, and there is an abundance of mulch; (3) grass is beginning to cover old gullies, and there are no active raw gullies; and (4) undesirable plants are few or lacking, and those present are small and stunted.

The following are signs that range condition is deteriorating: (1) the more palatable grasses are thinning out or are small and stunted, and the decreasers are not reproducing; (2) very little grass mulch is visible, and areas of bare ground are spreading; (3) gully erosion is active in the natural drainageways; (4) pricklypear, fringed sagewort, curlycup gumweed, western ragweed, plantain, and other undesirable indicator plants are increasing; and (5) big bluestem, little bluestem, green needlegrass, leadplant amorpha, and other desirable indicator plants are gradually disappearing.

The soils of Shannon County have been grouped into 14 range sites, which are described in the following pages.

Unless a site contains only one soil, the soils are identified only by the name of the series. Listing of the series does not mean that all of the soils of that series are in the particular site. To find the classification of the individual soils, refer to the "Guide to Mapping Units" at the back of this soil survey.

SUBIRRIGATED RANGE SITE

This site consists of soils of the Elsmere, Lamo, and Loup series. These are deep, nearly level, dark-colored soils. They occur mainly in basins and valleys in or adjacent to the sandhills. A few isolated tracts are in spring-fed valleys and stream bottoms in the central and northern parts of the county. The water table is near the surface early in the growing season, but it recedes to a depth of 20 to 60 inches by midsummer. Moisture from the water table is available to plant roots during most of the growing season.

Big bluestem, switchgrass, little bluestem, prairie cordgrass, and indiangrass are the main decreasers in the climax vegetation. Western wheatgrass and slim sedge are increasers. Kentucky bluegrass, foxtail barley, Canada thistle, and verbena are invaders.

This site is used mostly for native hay. It also provides good summer grazing.

If this site is in excellent condition, the total annual yield is about 5,000 pounds, air-dry weight, per acre.

OVERFLOW RANGE SITE

This site consists of soils of the Bankard, Goshen, and Haverson series, and Alluvial land. These are sandy to clayey alluvial soils on bottom lands. The water table is not within reach of plant roots, but occasionally the soils receive additional moisture from stream flooding and from runoff from adjacent upland slopes.

Big bluestem, green needlegrass, little bluestem, prairie sandreed, and switchgrass are decreasers in the climax vegetation. Western wheatgrass, needle-and-thread, side-oats grama, blue grama, and inland saltgrass are increasers. Curlycup gumweed, Japanese brome, common sunflower, Kentucky bluegrass, kochia, and western ragweed are invaders.

Some areas of this site are in alfalfa, but most areas are used for grazing and native hay. Scattered stands of native trees and shrubs along streams provide some protection to livestock in winter.

If this site is in excellent condition, the total annual yield is about 3,000 pounds, air-dry weight, per acre.

CLOSED DEPRESSION RANGE SITE

Hoven silt loam is the only soil in this site. This soil has a claypan. It occupies closed depressions on uplands. These depressions regularly receive runoff from the adjacent slopes. The areas range from less than 1 acre to 40 acres in size. They lack outlets and consequently are ponded until the water is slowly absorbed or evaporates.

Western wheatgrass is the main decreaser in the climax vegetation. Small sedges and rushes are the main increasers, and buffalograss is an increaser in some of the drier areas. Foxtail barley, knotweed, and other invaders take over if the areas are ponded for long periods.

Some areas of this site in the southeastern part of the county are cultivated, and some small depressions within cropped areas are used for native hay. Elsewhere, the site is used for grazing. Grazing this site when the soils are wet causes the condition of the range to decline because of trampling by livestock.

If this site is in excellent condition, the total annual yield is about 2,800 pounds, air-dry weight, per acre.

SALINE LOWLAND RANGE SITE

This site consists of saline phases of the Hisle and Swanboy series and of Minatare soils that have a high water table. These are saline and saline-alkali soils. The salts occur within the uppermost 15 inches because of a fluctuating water table or the ponding of runoff. In the western part of the county, the site is in narrow areas along upland drains. In the southeastern part, it is on flats in stream valleys and is only 2 to 3 feet above the level of the adjacent Subirrigated range site.

Western wheatgrass, alkali sacaton, and green needlegrass are decreasers in the climax vegetation in the western part of the county. In addition to these grasses, prairie cordgrass, switchgrass, prairie sandreed, and alkali cordgrass are decreasers in the southeastern part. Buffalograss, blue grama, and inland saltgrass are increasers. Kochia, pursh seepweed, curlycup gumweed, Russian-thistle, and foxtail barley are invaders. Kentucky bluegrass is an additional invader in the southeastern part.

This site is used almost entirely for grazing and hay. The hay meadows are in the southeastern part of the county.

If this site is in excellent condition, the total annual yield is about 2,300 pounds, air-dry weight, per acre in the western part of the county and about 3,500 pounds, air-dry weight, per acre in the southeastern part.

SANDS RANGE SITE

This site consists of soils of the Valentine series. These are deep, loose, coarse-textured, undulating to rolling soils. They occur in the southeastern and northern parts of the county.

Sand bluestem, little bluestem, big bluestem, switchgrass, and leadplant amorpha are decreasers in the climax vegetation. Prairie sandreed and needle-and-thread are important increasers. Others are blue grama, hairy grama, sand dropseed, threadleaf sedge, field sagewort, and yucca. Sandbur, western ragweed, annual brome, and annual dropseed are invaders.

This site is used almost entirely for grazing.

If this site is in excellent condition, the total annual yield is about 2,300 pounds, air-dry weight, per acre.

SANDY RANGE SITE

This site consists of soils of the Anselmo, Dunday, Manter, and Tuthill series. These are deep, nearly level to undulating, dark-colored, moderately coarse textured soils. Most areas are in the southeastern and northern parts of the county.

Prairie sandreed, little bluestem, sand bluestem, big bluestem, and switchgrass are decreasers in the climax vegetation. Western wheatgrass, needle-and-thread, blue grama, sand dropseed, threadleaf sedge, and green sagewort are increasers. Sand sagebrush is an increaser in the northwestern part of the county. Annual brome, western ragweed, common sunflower, Russian-thistle, and plantain are invaders.

Small areas of this site are cultivated, but most of it is used for grazing. The tall, warm-season decreasers have almost disappeared from some areas, and increasers make up a large proportion of the plant cover.

If this site is in excellent condition, the total annual yield is about 2,100 pounds, air-dry weight, per acre.

SILTY RANGE SITE

This site consists of soils of the Altvan, Dawes, Haverson, Kadoka, Keith, Oglala, Richfield, Rosebud, Tuthill, and Ulysses series, and Loamy land. These are moderately deep and deep, permeable, medium-textured, nearly level to sloping soils. This is an extensive site that occurs in all parts of the county except where the Valentine soils are predominant.

Western wheatgrass and green needlegrass and small amounts of big bluestem, little bluestem, and prairie sandreed are decreasers in the climax vegetation. Needle-and-thread, blue grama, fringed sagewort, and small amounts of threadleaf sedge are increasers. Annual brome, curlycup gumweed, plantain, Russian-thistle, and pricklypear are invaders.

Where Keith and Rosebud soils are predominant, extensive areas are in crops. In the rest of the county, this site is mostly in native grass and is used for grazing and hay.

If this site is in excellent condition, the total annual yield is about 2,000 pounds, air-dry weight, per acre.

CHOPPY SANDS RANGE SITE

Valentine fine sand, hilly, is the only soil in this site. This site occurs in the southeastern part of the county. It differs from the Sands range site in that the slopes are abrupt, irregular, and in places angular. Most slopes have a gradient of 20 percent or more. Narrow ridges and sharp peaks are common, and there are numerous blowouts and dunes.

Big bluestem, sand bluestem, little bluestem, and leadplant amorpha are decreasers in the climax vegetation. Prairie sandreed and needle-and-thread are the major increasers; and yucca, sand dropseed, blue grama, and hairy grama are minor increasers. Sandbur and western ragweed are invaders.

All of this site is used for grazing. Careful management to prevent the occurrence of blowouts is needed.

If this site is in excellent condition, the total annual yield is about 2,000 pounds, air-dry weight, per acre.

CLAYEY RANGE SITE

This site consists of soils of the Buffington, Kyle, and Pierre series, and Clayey land. These are moderately deep and deep, slowly permeable, moderately fine textured and fine textured, nearly level to sloping soils. They occur in the western and northern parts of the county.

Western wheatgrass and green needlegrass are the principal decreasers in the climax vegetation. Blue grama, buffalograss, and pricklypear are increasers. Annual brome, curlycup gumweed, broom snakeweed, and common sunflower are invaders.

A small acreage of this site is in crops. Most areas are in native grass and are used for grazing and hay. Short grasses and pricklypear make up the plant cover in areas that have been heavily grazed.

If this site is in excellent condition, the total annual yield is about 1,700 pounds, air-dry weight, per acre.

CLAYPAN RANGE SITE

This site consists of soils of the Mosher and Wortman series. These are nearly level to very gently sloping soils on slight rises between shallow depressions. They have a moderately thick surface layer over a slowly permeable claypan subsoil. This site occurs mostly in the eastern half of the county.

Western wheatgrass and green needlegrass are the principal decreasers in the climax vegetation. Blue grama, buffalograss, needle-and-thread, fringed sagewort, and pricklypear are increasers. Annual brome, curlycup gumweed, plantain, and common sunflower are invaders.

Small areas of this site are cultivated, but most of it is used for grazing.

If this site is in excellent condition, the total annual yield is about 1,600 pounds, air-dry weight, per acre.

SHALLOW RANGE SITE

This site consists of soils of the Canyon, Epping, Orella, Penrose, Samsil, and Tassel series, Gravelly land, and Terrace escarpments. These are shallow soils and soil materials underlain by bedded geologic material at a depth of 5 to 20 inches. Most of the underlying geologic formations consist of relatively soft material interbedded with cemented or hard layers. Only a few grass roots penetrate the underlying material. These soils are weakly to strongly calcareous. Large areas of this site occur in all parts of the county.

Little bluestem, western wheatgrass, green needlegrass, prairie sandreed, and, in places, big bluestem and sand bluestem are decreasers in the climax vegetation. Sideoats grama is a major increaser, and needle-and-thread, blue grama, and threadleaf sedge are less important increasers. Broom snakeweed, plantain, curlycup gumweed, and annual brome are invaders.

Most areas of this site are in native grass and are used for grazing. Native grasses are most suitable for reseeding cropland to grass.

If this site is in excellent condition, the total annual yield is about 1,600 pounds, air-dry weight, per acre.

THIN UPLAND RANGE SITE

This site consists of soils of the Colby, Manvel, and Minnequa series. These soils are thin, friable, and high in lime content. They formed in calcareous parent material. This site occurs in all parts of the county.

Needle-and-thread, green needlegrass, and western wheatgrass are decreasers in the climax vegetation. Sideoats grama, blue grama, broom snakeweed, and threadleaf sedge are increasers. Curlycup gumweed and annual plants are invaders.

This site is mostly in native grass and is used for grazing. Some areas in the southeastern corner of the county are cultivated.

If this site is in excellent condition, the total annual yield is about 1,600 pounds, air-dry weight, per acre.

DENSE CLAY RANGE SITE

Swanboy clay is the only soil in this site. This dense, nearly level to gently sloping soil occurs in the western and northern parts of the county. It has a very thin, crusty surface layer over a strongly alkaline subsoil. Permeability is very slow.

Western wheatgrass and green needlegrass are decreasers in the climax vegetation. There is no understory of turf grass in the climax vegetation. American vetch, yellow wild parsley, biscuitroot, and pricklypear are increasers. Broom snakeweed, common sunflower, and sweetclover are invaders.

All of this site is in native grass and is used for grazing. The vegetation is sparse, and the ground between the wheatgrass plants is bare.

If this site is in excellent condition, the total annual yield is about 1,200 pounds, air-dry weight, per acre.

THIN CLAYPAN RANGE SITE

This site consists of soils of the Hisle, Minatare, and Wanblee series. These soils have a thin surface layer over a claypan. The topography is uneven, and there are many slight depressions that range from 2 feet to many feet in width and to as much as 6 inches in depth. The depressions have only a sparse cover of vegetation and in places are bare because of ponding.

Western wheatgrass and green needlegrass are decreasers in the climax vegetation. Blue grama, buffalograss, inland saltgrass, fringed sagewort, and pricklypear are increasers. Annual brome, broom snakeweed, curlycup gumweed, plantain, and common sunflower are invaders.

Almost all of this site is used for grazing. In many areas, the range condition is moderately good to fair or poor. If this site is grazed when the soils are wet, the condition declines because of trampling by livestock.

If this site is in excellent condition, the total annual yield is about 950 pounds, air-dry weight, per acre.

Range management practices

Conservation of water and control of erosion are the major management needs for range improvement in this county. Measures effective in meeting these needs include proper degree of use; proper season of use; deferment or distribution of grazing; range seeding; pitting and contour furrowing; dune stabilization; control of fire, brush, and weeds; mowing; and water spreading.

Proper degree of use, under which not more than half the yearly growth of forage is eaten, benefits all the range sites and especially the Sands site and the Choppy Sands site. Proper season of use varies according to the range site. Each site should be grazed when the vegetation grows best. The Silty site and the Clayey site are examples of sites that produce cool-season grasses, such as western wheatgrass and green needlegrass. The Shallow site and the Sands site are examples of sites that produce warm-season grasses, such as bluestem and prairie sandreed.

Deferment of grazing is the practice of excluding livestock during part or all of the growing season. The Shallow range site and the Sands range site are examples of sites on which grazing should be deferred in summer and early in fall. The Silty range site and the Clayey range site are examples of sites on which grazing should be deferred in spring and early in summer. Distribution of grazing can be effected by fencing and by spacing water facilities and salting areas. Examples of sites benefited by the distribution of grazing are the Silty, Clayey, Sands, and Shallow range sites.

Range seeding helps to establish grass on rangeland that is in poor or fair condition and on cropland converted to range. Native grass should be used. For example, a mixture of western wheatgrass and green needlegrass should be used on the Clayey range site and the Silty range site; a mixture of little bluestem and side-oats grama on the Shallow range site; and a mixture of sand bluestem, prairie sandreed, and little bluestem on the Sands range site.

Range pitting helps to retard runoff and conserve moisture and encourages the growth of the taller grasses. It is beneficial if the range is in poor or fair condition and the slope is less than 10 percent. Contour furrowing also encourages growth of the taller grasses and is suitable if the slope range is up to 20 percent. Examples of range sites benefited by pitting and furrowing are the Sandy, Silty, Clayey, Shallow, and Claypan range sites. Grazing of pitted areas should be deferred for two growing seasons.

Dunes can be stabilized by smoothing, fencing, and mulching the areas, or by establishing a cover of rye or sudangrass and then seeding the range. Areas needing dune stabilization occur within the Sands range site and the Choppy Sands range site. Firebreaks are especially needed in the south-central and western parts of the county where cropland areas, roads, and natural barriers do not exist. Control of brush and weeds is particularly needed on the Choppy Sands, Sands, and Sandy range sites, if they are in fair condition.

Some range sites are suitable for use as hayland (fig. 10). The Subirrigated site and the Saline Lowland site can be mowed annually. In cycles of wet weather, the

Figure 10.—Crop of hay in an area of the Clayey range site. A water-spreading system distributes rainfall to best advantage.

Overflow site can be mowed each year without damage. The sites on uplands should not be mowed more than once in 2 years and should not be cleared of mulch. Some parts of the Overflow, Clayey, and Silty sites are benefited by water spreading.

Additional information about range management can be obtained from the local offices of the Soil Conservation Service and the Bureau of Indian Affairs.

Management of Cropland [3]

About 6 percent of the area of Shannon County is cropland. Much of this is in the southeastern part of the county. Winter wheat is the main crop. Although the acreage is small, cropland accounts for about 33 percent of farm income in the county.

The cultivated soils in Shannon County need management that will conserve moisture, control erosion, and maintain or improve tilth and fertility.

Conserving moisture and controlling erosion

In this county winter wheat is commonly grown in a sequence with fallow. This practice results in water erosion and soil blowing (fig. 11).

Measures needed to conserve moisture and to control water erosion and soil blowing include use of crop residue, stubble mulching, stripcropping, a conservation cropping system, terracing, contour farming, grassed waterways, and emergency tillage.

Leaving crop residue on the surface or incorporating it into the surface layer helps to maintain the organic-matter content, to improve fertility and tilth, and to increase the capacity of the soils to absorb and retain moisture. The use of crop residue alone keeps soil losses to a minimum and helps to conserve moisture in Kadoka and Keith soils and in other nearly level, medium-textured soils.

Stubble mulching is a system of managing residue during seedbed preparation, planting, and cultivation and after harvest, in order to keep a protective cover on the surface the year round (fig. 12). It is effective on all cropland in the county and is especially so on Anselmo, Buffington, Colby, and Manvel soils. The amount of residue needed per acre depends on the texture of the soil. Help in determining the correct amount for a given soil can be obtained from the local office of the Soil Conservation Service, from the Bureau of Indian Affairs, or from the county agent.

Stripcropping is the practice of alternating strips of close-growing crops with strips of row crops or fallow. Stripcropping at right angles to the prevailing wind helps to control soil blowing. The Anselmo, Buffington, and Kyle soils are examples of soils that benefit from such protection. Stripcropping on the contour helps to control water erosion on sloping soils of the Keith and Rosebud series.

[3] By WALTER N. PARMETER, conservation agronomist, Soil Conservation Service.

Figure 11.—Soil material blown from Keith and Rosebud soils and deposited in a ditch along a highway. Keith and Rosebud soils are used extensively for winter wheat.

A conservation cropping system includes legumes and tame grasses for soil improvement and high-residue crops for control of erosion and conservation of moisture. These crops reduce the need for other practices for control of erosion, especially on such soils as Anselmo, Manvel, and Pierre.

Terracing and contour farming, generally used in combination, are effective practices for control of erosion and conservation of moisture on cropland that has a slope of more than 2 percent. Keith and Rosebud soils are examples of soils that need such protection.

Figure 12.—Stubble residue from a previous crop on Keith soils planted to winter wheat. Stubble mulch protects the soils and conserves moisture.

Grassed waterways are broad, grass-covered channels built to carry runoff at a nonerosive rate. They are most likely to be needed in cultivated areas of Keith and Rosebud soils.

Roughening the soil surface by listing, ridging, duckfooting, or chiseling is an effective practice where there is not enough crop residue or growing vegetation to protect the soils against blowing. Emergency tillage is most likely to be needed on Anselmo, Buffington, Haverson, Kyle, and Tuthill soils, but it may be needed on any cultivated soil during dry periods.

Maintaining tilth and fertility

Tilth and fertility are difficult to maintain in areas that have limited precipitation. Effective measures for soil improvement include the use of minimum tillage, high-residue crops, and fertilization.

Fallowed fields should be tilled only enough to control weeds. Frequent tillage of Dawes, Keith, Richfield, and similar soils tends to pulverize the surface layer and to impair the soil structure and tilth. These soils then puddle and crust, fail to absorb water readily, and become more susceptible to blowing and water erosion. Frequent tillage of Keith and Richfield soils also leads to the formation of a tillage pan, or traffic pan, just below plow depth. Formation of a pan can be avoided by not working the soils when they are wet and by alternating the depth of tillage. A pan can be broken up by chiseling every third or fourth year and by growing deep-rooted legumes and grasses.

Growing high-residue crops helps to maintain the organic-matter content in Keith, Richfield, and similar soils. Green manure and manure obtained from feedlots help to maintain the organic-matter content in Anselmo soils and other coarse-textured soils and in Colby soils and other soils that are high in lime content.

The soils in Shannon County have been cultivated for a relatively short time and generally have been productive without applications of commercial fertilizer. Soils that are high in lime content (for example, Colby and Haverson soils) are likely to be low in available nitrogen and phosphorus. A nitrogen deficiency shows up occasionally in fields of Keith, Rosebud, and similar soils that have been in continuous cultivation for 40 years or more. Nitrogen deficiencies are most likely to be evident in years of above-average rainfall.

Recent field trials in neighboring Bennett County indicate that winter wheat grown after fallow on Keith, Richfield, and Rosebud soils shows little or no response to applications of nitrogen and phosporus. Spring-sown grain grown after another crop on Keith and Richfield soils showed only a slight response to applications of nitrogen.

Information about fertilization can be obtained from the office of the county agricultural agent or from the local office of the Soil Conservation Service.

Irrigating

About 750 acres in this county is irrigated. Most of this acreage consists of Keith and Haverson soils. The White River and wells in the southeastern part of the county are potential sources of water for expansion of irrigation. During periods of below normal precipitation, the streamflow of the White River is not dependable.

Successful irrigation requires suitable soils, enough water of good quality, and an efficient means of delivering the water. Good management requires a knowledge of how to apply the water, when to apply it, and how to distribute it evenly. Also, Keith and similar productive soils need to be fertilized if crops are to benefit fully from irrigation. Higher planting rates and greater inputs of labor are needed also, to make irrigation worthwhile.

Help in planning an irrigation system can be obtained from the local offices of the Soil Conservation Service, the Bureau of Indian Affairs, or the Agricultural Extension Service of South Dakota State University.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, the risk of damage when they are used, and the way they respond to treatment when used for the common field crops and pasture plants. The classification does not apply to most horticultural crops or to rice and other crops that have special requirements. The soils are classified according to the degree and kind of permanent limitation but without consideration of major and generally expensive alterations in slope, depth, or other characteristics, and without consideration of possible but unlikely major reclamation projects.

In the capability system, all kinds of soils are grouped at three levels: the capability class, the subclass, and the unit.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I. Soils have few limitations that restrict their use. No soils in Shannon County are in class I.

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

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

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

Class V. Soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms have limitations that preclude their use for commercial plant 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.

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 be similar in productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs. The Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability groups

In the following pages, the capability units in Shannon County are described, and use and management of the soils are discussed.

Unless a unit contains only one soil, the soils are identified only by the name of the series. Listing of the series does not mean that all of the soils of that series are in the particular unit. To find the classification of the individual soils, refer to the "Guide to Mapping Units" at the back of this soil survey.

CAPABILITY UNIT IIe-1

This unit consists of soils of the Keith, Richfield, and Rosebud series. These are deep and moderately deep, very gently sloping silt loams and loams on uplands and stream terraces. In most cultivated fields, they are slightly eroded to moderately eroded.

These soils have good tilth, moderate to high water-holding capacity, and moderate permeability. Water erosion, soil blowing, and a periodic moisture deficiency are hazards. Conservation of moisture, control of water erosion and soil blowing, and improvement of fertility and tilth are management needs.

Wheat, oats, barley, rye, corn, sorghum, alfalfa, and tame grasses are suitable crops. Winter wheat, the main crop, is grown in sequence with summer fallow. These soils are well suited to trees and wildlife habitat.

Stubble mulching or a combination of crop-residue use and contour farming helps to control erosion. Terraces and field windbreaks also help to control erosion and to conserve moisture. The use of tame grasses and alfalfa in the conservation cropping system reduces the need for erosion control measures. Grass cover keeps natural drainageways from eroding.

CAPABILITY UNIT IIc-1

This unit consists of soils of the Goshen, Keith, Richfield, and Rosebud series. These are deep and moderately deep, nearly level silt loams and loams on uplands and stream terraces.

These soils have good tilth, moderate to high water-holding capacity, and moderate permeability. Periodic moisture deficiency and soil blowing are hazards. Conservation of moisture is the main management need. Improving fertility and tilth and maintaining the organic-matter content are management problems. Control of soil blowing is a secondary problem on fields that are mismanaged.

Wheat, oats, barley, rye, alfalfa, corn, sorghum, and tame grasses are suitable crops. Winter wheat, the main crop, is grown in sequence with fallow. These soils are well suited to trees and wildlife habitat.

The use of crop residue helps to conserve moisture and to control erosion. Stubble mulching is beneficial if the cropping system consists of winter wheat and summer fallow. Other measures generally are not required, but contour farming, terracing, wind stripcropping, and windbreaks may be desirable in some areas.

CAPABILITY UNIT IIIe-1

This unit consists of soils of the Altvan, Kadoka, Keith, Rosebud, and Ulysses series. These are moderately deep and deep, very gently sloping to gently sloping silt loams and loams on uplands. In many cultivated areas, they are slightly eroded to moderately eroded.

These soils have good tilth, moderate to high water-holding capacity, and moderate permeability. Water erosion, soil blowing, and a periodic moisture deficiency are hazards. Control of erosion, conservation of moisture, and maintenance or improvement of fertility and tilth are management needs.

Wheat, oats, barley, rye, corn, sorghum, alfalfa, and tame grasses are suitable crops. Winter wheat is the main crop. These soils are suited to trees and wildlife habitat.

A combination of stubble mulching and contour farming or of crop-residue use and terracing helps to control erosion and to conserve moisture where the cropping system consists of winter wheat and summer fallow. Crop residue can be used alone where tame grasses and legumes are grown half the time. Field windbreaks help to control erosion and conserve moisture. Grass cover keeps the natural drainageways from eroding.

CAPABILITY UNIT IIIe-2

This unit consists of soils of the Anselmo, Manter, and Tuthill series. These are deep, nearly level and very gently undulating, loamy and moderately sandy soils on uplands. In most cultivated fields, the soils are slightly eroded to moderately eroded.

These soils are easy to work. They take in water readily and have moderate water-holding capacity. Permeability is moderate to moderately rapid. Cultivation breaks down the structure of the surface layer and increases susceptibility to soil blowing. Maintaining the organic-matter content and improving fertility are management needs.

Wheat, oats, barley, rye, alfalfa, corn, sorghum, and tame grasses are suitable crops. Winter wheat is grown in some areas, but intensive management is required to control soil blowing. These soils are suited to trees and wildlife habitat.

Stubble mulching or a combination of crop-residue use and wind stripcropping helps to control soil blowing and to conserve moisture. Field windbreaks and a cropping system consisting of grasses and legumes are also beneficial.

CAPABILITY UNIT IIIe-3

This unit consists of Tuthill and Manter soils, 3 to 5 percent slopes. These are deep, gently sloping loams and very fine sandy loams on uplands. They have a fine sandy loam and sandy clay loam subsoil. In fields that are cultivated or have been cultivated, the soils are slightly eroded to moderately eroded.

These soils have good tilth, moderate water-holding capacity, and moderate to moderately rapid permeability. The surface soil is susceptible to water erosion and soil blowing. Control of water erosion and soil blowing, conservation of moisture, and improvement of fertility are management needs.

Wheat, oats, barley, alfalfa, corn, sorghum, and tame grasses are suitable crops. Winter wheat can be grown, but if it is, areas of fine sandy loam need intensive management to control soil blowing.

A combination of stubble mulching and contour farming or of crop-residue use and terracing helps to control erosion and to conserve moisture.

CAPABILITY UNIT IIIw-1

This unit consists of soils of the Haverson series. These are nearly level, loamy, alluvial soils on bottom lands. Erosion seldom occurs, but occasionally floods deposit sediment on the soils.

The soils of this unit are flooded only about 1 year out of 5. Deposition of sediment and debris is the main hazard. Management that provides for adjustment to these occasional periods of wetness is needed.

Corn, sorghum, wheat, oats, barley, rye, alfalfa, and tame grasses are suitable crops.

The use of grasses, alfalfa, crop residue, and manure improves the tilth and the fertility and increases the organic-matter content. Grasses and alfalfa are the crops least affected by flooding.

CAPABILITY UNIT IIIs-1

This unit consists of the Dawes part of Richfield-Dawes silt loams, 0 to 3 percent slopes. This soil has a thick surface layer and a claypan subsoil. The claypan limits the choice of crops in years when rainfall is low.

This soil has moderate fertility and high water-holding capacity. The claypan slows moisture penetration and prevents the deep rooting of plants. Maintaining the organic-matter content and improving fertility and tilth are management problems. Control of soil blowing is a secondary problem.

Wheat, oats, barley, rye, alfalfa, and tame grasses are suitable crops. Winter wheat is the main crop. Row crops generally are not suitable.

Crop-residue use alone is adequate for control of erosion, and it helps to maintain the organic-matter content and to improve tilth. Stubble mulching is especially beneficial if the cropping system consists of winter wheat and summer fallow. The inclusion of grasses and legumes in the cropping system helps to increase moisture intake and to improve tilth and fertility.

CAPABILITY UNIT IIIs-2

This unit consists of the Altvan part of Richfield and Altvan silt loams, 0 to 3 percent slopes. This soil is underlain by gravel at a depth of 20 to 40 inches.

This soil has moderate natural fertility and good tilth. The water-holding capacity is moderate. The underlying material causes the soil to be droughty in years of low rainfall. Conservation of moisture is the main management need. Control of soil blowing is a secondary problem.

Spring-sown grains, sorghum, alfalfa, and tame grasses are suitable crops. Crop-residue use or stubble mulching helps to conserve moisture and to control erosion. Wind stripcropping helps to control blowing in fields that have been mismanaged.

CAPABILITY UNIT IIIc-1

Kadoka silt loam, 0 to 3 percent slopes, is the only soil in this unit. This is a deep and moderately deep, nearly level silt loam on uplands. It occurs in the northern and western parts of the county, the areas that receive the least rainfall.

This soil has moderate natural fertility and good tilth. The surface soil and subsoil have high water-holding capacity, but the underlying material consists of bedded siltstone. Conservation of moisture is the main management need. Control of soil blowing is a secondary problem.

Wheat, oats, barley, rye, alfalfa, corn, sorghum, and tame grasses are suitable crops. Winter wheat is the main crop. This soil is suited to trees and wildlife habitat.

Crop-residue use alone is adequate for control of erosion and helps to conserve moisture. Stubble mulching, also, conserves moisture and controls soil blowing. Wind stripcropping helps to control soil blowing in areas that have been mismanaged.

CAPABILITY UNIT IIIc-2

This unit consists of soils of the Buffington and Haverson series. These are deep, nearly level, moderately dark colored to light-colored, loamy to clayey soils on high bottoms and on terraces. They are rarely flooded.

These soils are moderate to low in organic-matter content, low in natural fertility, and high in lime content. They are somewhat droughty and blow readily if used for annual crops. Improvement of organic-matter content and fertility, conservation of moisture, and control of soil blowing are management needs.

Most areas are in native grass and are used for grazing and hay. Alfalfa is the main crop on the few tracts used for crops. Small amounts of small grain are grown also.

Crop-residue use and stubble mulching help to conserve moisture and to control soil blowing. The use of tame grasses and alfalfa in the conservation cropping system and the application of manure help to increase the organic-matter content and to improve fertility.

CAPABILITY UNIT IVe-1

This unit consists of the Keith part of Keith-Colby silt loams, 9 to 12 percent slopes. This is a deep soil on uplands. In many cultivated fields, it is slightly eroded to moderately eroded.

Tilth is good, and the water-holding capacity is high. Organic matter has declined in the cultivated areas. Consequently, erosion is a hazard in these areas if the soil is not properly managed. Control of water erosion is the main management need. Other management needs include conservation of moisture, maintenance of the organic-matter content, and improvement of fertility and tilth.

Wheat, oats, barley, rye, alfalfa, and tame grasses are suitable crops. Winter wheat is the main crop. Row crops generally are less suitable because of the slope. This soil is suited to trees.

A combination of stubble mulching, terracing, and contour farming is needed to control erosion and to conserve moisture. Grasses and legumes in the cropping system help to maintain fertility and tilth. They also reduce the need for mechanical measures. Grass cover helps to keep natural drainageways from eroding.

CAPABILITY UNIT IVe-2

Kadoka silt loam, 5 to 9 percent slopes, is the only soil in this unit. This is a moderately deep and deep, gently sloping soil on uplands in the northern and western parts of the county.

This soil has moderate fertility, good tilth, and moderate water-holding capacity. Control of water erosion is the main management need in cultivated areas. Other needs are conservation of moisture, maintenance of organic-matter content, and improvement of fertility and tilth.

Winter wheat is the main crop grown in the few areas used for crops, but oats, barley, rye, sorghum, alfalfa, and tame grasses are also suitable crops. This soil is suited to trees.

A combination of stubble mulching and contour farming or terracing helps to control erosion in intensively cropped areas. The inclusion of tame grass and legumes in the cropping system reduces the need for other protective measures. Crop-residue use and contour farming help to limit erosion. Grassed waterways control erosion along natural drainageways.

CAPABILITY UNIT IVe-3

This unit consists of soils of the Anselmo, Manter, and Tuthill series. These are deep, gently sloping, loamy, and moderately coarse textured soils on uplands. Cultivated areas are slightly eroded to moderately eroded by both wind and water.

These soils take in water readily but have only moderate water-holding capacity. If cultivated, they lose organic matter rapidly and are readily susceptible to water erosion and soil blowing. Maintenance of organic-matter content and conservation of moisture are management needs.

Wheat, oats, barley, rye, alfalfa, corn, sorghum, and tame grasses are suitable crops. Winter wheat generally is not suitable, because of the erosion hazard. These soils are suited to trees and wildlife habitat.

Grasses and legumes in the cropping system about half the time and the use of crop residue the other half keep erosion losses to a minimum. Stubble mulching and wind stripcropping help to control erosion in the more intensively cropped areas. Field windbreaks are beneficial in some areas.

CAPABILITY UNIT IVe-4

This unit consists of the Dunday part of the Dunday-Valentine complex, 0 to 5 percent slopes. This is a deep, loose, dark-colored loamy fine sand on uplands. Soil blowing has occurred in the few areas that have been cultivated. Most of these areas are now in native grass.

This soil has moderate natural fertility but low water-holding capacity. Control of soil blowing is the main management need.

Oats, barley, alfalfa, corn, and tame grasses are suitable crops. This soil is well suited to trees.

Very careful management is needed if this soil is cultivated. The use of tame grasses and alfalfa in the cropping system is necessary for control of erosion. Summer fallow is not suitable. An adequate cover of growing crops or crop residue is needed continuously. During periods when the soil is in annual crops, stubble mulching and wind stripcropping help to control soil blowing.

CAPABILITY UNIT IVe-5

This unit consists of soils of the Colby and Manvel series. These are deep, light-colored, loamy to clayey soils that are high in lime content. They are on gently sloping to sloping uplands.

These soils are low in organic-matter content and in natural fertility. If the surface is unprotected, they wash and blow readily. Management that increases the organic-matter content, improves fertility, and controls erosion is needed.

Many of the cultivated areas are in alfalfa, but wheat, oats, barley, rye, sorghum, and tame grasses are also suitable crops.

The use of grasses and legumes in the cropping system, combined with crop-residue use or stubble mulching when annual crops are grown, controls erosion and increases the organic-matter content. Terraces, waterways, and contour stripcropping help to control erosion in sloping areas. Applications of manure increase the organic-matter content and improve fertility.

CAPABILITY UNIT IVe-6

Pierre clay, 3 to 9 percent slopes, is the only soil in this unit. It is a moderately deep clay soil on uplands. In fields that are cultivated or have been cultivated, it is slightly eroded to moderately eroded.

This soil has fair tilth and slow permeability. It takes in water slowly and releases it slowly to plants. It has moderate natural fertility and is low in organic-matter content. Cultivation decreases the organic-matter content, and the soil washes and blows. Control of erosion is the main management need. Other needs are conservation of moisture and improvement of organic-matter content, fertility, and tilth.

Wheat, oats, barley, rye, sorghum, alfalfa, and tame grasses are suitable crops. Alfalfa stands generally do not survive dry years. Spring wheat is more suitable than winter wheat.

Stubble mulching, in combination with either contour stripcropping or terracing, controls erosion and conserves moisture in areas continuously cultivated. Growing grasses and legumes in the cropping system about half the time improves tilth and organic-matter content. Crop-residue use and contour farming help to control erosion. Grass cover helps to keep natural drainageways from eroding.

CAPABILITY UNIT IVw-1

This unit consists of the Elsmere part of Elsmere-Loup loamy fine sands and the Lamo-Elsmere complex. These are deep soils that have a moderately high water table. They are in the southeastern part of the county.

In wet years the fluctuating water table drowns out some crops. In dry years soil blowing is a hazard in cultivated fields. Management that adjusts to these contrasting moisture conditions is needed.

Alfalfa and tame grasses are the most suitable crops. Small grains and corn can be grown under very careful management.

CAPABILITY UNIT IVs-1

This unit consists of Kyle clay, alkali, 0 to 3 percent slopes, and Kyle silty clay, 0 to 3 percent slopes. These are deep soils on terraces and uplands. Some of the cultivated areas have been slightly eroded by blowing.

These soils are very hard when dry and very firm and plastic when wet. They take in water slowly and release it slowly to plants. Permeability is slow. Unless the surface layer is protected by vegetation, it granulates readily and is susceptible to blowing.

Wheat, oats, barley, sorghum, alfalfa, and tame grasses are suitable crops. Alfalfa usually does not survive prolonged dry periods. Spring wheat is better suited than winter wheat, which is subject to winterkill. Only a few small areas are in cultivation. Crop failures are frequent.

The use of crop residue and the inclusion of grasses and legumes in the cropping system improve tilth, conserve moisture, and control soil blowing. Stubble mulching or a combination of crop-residue use and wind stripcropping helps to control erosion, conserve moisture, and improve tilth in cropped areas.

CAPABILITY UNIT IVs-2

This unit consists of the Mosher part of the Mosher-Minatare complex and the Wortman part of the Wortman-Wanblee complex. These are deep, nearly level and gently sloping soils that have a moderately thick, silty surface layer and a claypan subsoil. Most areas show little or no evidence of soil blowing.

These soils have moderate natural fertility. They take in water slowly and release it slowly to plants. The surface layer is friable but has a tendency to puddle. The claypan subsoil slows moisture penetration and restricts root growth. Improving tilth, maintaining the organic-matter content, and loosening the claypan are management problems.

Alfalfa is the main crop grown on the few areas used for crops, but wheat, oats, barley, rye, and tame grasses are also suitable. Row crops are not suitable.

The use of crop residue and the inclusion of grasses and legumes in the cropping system improve tilth, accelerate intake of soil moisture, and control erosion. Stubble mulching is beneficial if high-residue grain crops are grown.

CAPABILITY UNIT Vw-1

This unit consists of soils of the Lamo and Loup series. These are deep, nearly level to gently sloping, sandy to loamy soils in basins and valleys in or near the sandhills. The water table is at or near the surface early in the growing season and rarely recedes to a depth below 4 feet late in summer.

Drainage generally is not practical. The soils are suited to use as hayland, pasture, and wildlife habitat. Most areas are used for hay meadows and pasture. Wells and dugouts are sources of water for livestock.

CAPABILITY UNIT VIe-1

This unit consists of soils of the Colby, Kadoka. Keith, Kyle, Minnequa, Oglala, Pierre, and Rosebud series, and Clayey land and Loamy land. These are moderately deep and deep, loamy to clayey soils on uplands.

The soils of this unit are too erodible for use as cropland and should be cultivated only enough to establish trees or reestablish grasses. They are suitable for windbreak plantings.

Most areas are in grass and are used for grazing and hay. Proper range use helps to control erosion and to conserve moisture. Contour furrowing helps to slow runoff and to restore the grass cover. Water for livestock is obtained from wells, springs, dams, or dugouts. The source depends on the nature of the underlying material.

CAPABILITY UNIT VIe-2

This unit consists of soils of the Anselmo, Bankard, and Valentine series. These are deep, moderately sandy and sandy, loose soils that are too erodible for cultivation. The unit includes nearly level soils on bottom lands and undulating to moderately steep soils on uplands. The soils are highly susceptible to blowing.

Proper range use helps to control soil blowing. Sand blowouts can be treated and seeded to native grasses. Shallow wells provide water for livestock in most areas.

CAPABILITY UNIT VIw-1

This unit consists of Alluvial land on bottom lands. These areas are susceptible to damaging floods. Many areas are narrow and have been cut by meandering streams. Some small parcels are inaccessible. Streambank erosion and deposition of sediment and debris are the main hazards.

Most areas are in native grass and are used for grazing and hay. In many areas there are clumps of native trees and shrubs, which provide winter protection for livestock and game animals. Small acreages along some streams are used as garden plots.

Proper range use helps to minimize flood damage. Water-retarding and grade-stabilizing structures help to control floods in some areas.

CAPABILITY UNIT VIs-1

This unit consists of soils of the Hisle, Hoven, Minatare, and Wanblee series and a saline phase of the Swanboy series. These soils have a thin surface layer and a dense clay subsoil. They are moderately to strongly alkaline within a few inches of the surface.

Tilth is very poor, and the natural fertility is low. Permeability is very slow. These qualities make the soils unsuitable for cultivation. Maintaining a vegetative cover is the main management problem.

Most areas are in native grass and are used for grazing. Proper range use helps to maintain the grass cover. Interseeding with suitable grasses helps to improve pasture. Areas now cultivated should be seeded to native grasses.

CAPABILITY UNIT VIs-2

This unit consists of soils of the Canyon, Epping, Orella, Penrose, Samsil, and Tassel series. These are shallow, gently sloping to hilly, moderately sandy to clayey soils on uplands.

The soils of this unit are too shallow for satisfactory cultivation, and they are erodible if the vegetative cover is disturbed. Conservation of moisture and control of erosion are management needs.

Proper range use helps to control erosion and to conserve moisture in areas in native grass. On most slopes, contour furrowing and interseeding help to improve range. Small areas of these soils that occur in larger cultivated fields can be seeded to native grasses. Manure should be applied prior to seeding. Wells and springs provide water for livestock in areas of silty and moderately sandy soils. Dams are the only source of water in areas of clayey soils.

CAPABILITY UNIT VIIe-1

Valentine fine sand, hilly, is the only soil in this unit. It has steeper, more irregular slopes than the soils in unit VIe-2. Soil blowing is a serious hazard. The main management problem is maintenance of a vegetative cover needed to control soil blowing.

The choppy, hilly topography makes mechanical treatment impractical. Proper range use is the only effective means of controlling erosion. Grazing should be deferred if the range is in poor or fair condition. Blowouts should be seeded by hand, mulched with hay, and fenced.

CAPABILITY UNIT VIIs-1

Swanboy clay is the only soil in this unit. This is a strongly alkaline, dense soil that has a very thin, crusty surface layer and an extremely hard subsoil.

Tilth is very poor, natural fertility is low, and permeability is very slow. These qualities make the soil unsuitable for cultivation. Maintaining a vegetative cover is the main management requirement.

All areas are used for grazing. Proper range use helps to maintain the sparse grass cover.

CAPABILITY UNIT VIIs-2

This unit consists of soils of the Canyon, Epping, Penrose, and Samsil series and of Gravelly land and Terrace escarpments. All are on steep uplands. The soils are shallow and are too steep for cultivation. Proper range use is the only practical way of maintaining the vegetative cover and controlling erosion. Most slopes are so steep or so irregular that mechanical measures are impractical. Grazing should be deferred if the range is in poor or fair condition. Deep ravines in some areas provide food and protection for game animals.

CAPABILITY UNIT VIIIs-1

In this unit are eroded barren badlands and outcrops of sandstone, siltstone, chalk, and shale. These areas support little or no vegetation. They are of use mainly as scenery and for recreation.

Predicted Yields

Table 2 lists, for each soil in the county judged suitable for crops, the predicted average yields of winter wheat, barley, oats, corn, and alfalfa. The predictions are for dryfarmed soils under two levels of management. Predictions of yields under irrigation are not available. The acreage irrigated is small and is mostly in alfalfa. The yield from two cuttings is about 2 to 2.5 tons per acre.

Columns A of table 2 show yields that can be expected under the kind of management that is commonly practiced in this county. The following are part of such a management system: (1) winter wheat followed by summer fallow is the usual cropping sequence, though some spring-sown grain and a little corn and sorghum are grown for livestock feed; (2) alfalfa and tame grasses are part of the cropping pattern but are not grown in a systematic sequence and generally remain in the field until the stand declines or fails; (3) crop residue is used to some extent, but the objectives of stubble mulching are seldom achieved; (4) weeds are controlled, but the number of tillage operations required to do this causes deterioration of soil structure and the formation of a tillage pan; (5) most fallow fields are left bare in summer until winter wheat is sown; (6) water erosion and soil blowing cause soil losses in some years; and (7) no commercial fertilizer, barnyard manure, or green manure is used.

Columns B show yields that can be expected under the highest level of management that is practical. The following are part of such a system: (1) using cropping systems that supply organic matter and help to maintain fertility and tilth; (2) controlling erosion and conserving moisture by a combination of practices; (3) using fertilizer in amounts indicated by soil tests and field trials; (4) tilling at the proper time; (5) controlling weeds; and (6) using adapted varieties of seeds.

The predicted yields in table 2 were based on results of field trials by the South Dakota State University, on information furnished by farmers, on records kept by the county office of the Agricultural Stabilization and Conservation Service, and on observations by agriculturists of State and Federal agencies. These predictions were then compared with annual statistics of the South Dakota Crop and Livestock Reporting Service (*13*).[4]

The period of records and tests was 1950–65. During this period, there were years when the moisture supply was good and years when the supply was limited. Yields from the same kind of soil differ from one field to another, depending on past management and on the combination of management practices currently used.

Use of the Soils for Windbreaks[5]

Sparse stands of ponderosa pine and cedar are scattered in the hilly areas of the south-central, northeastern, and southwestern parts of Shannon County. Scattered stands of cottonwood and other broadleaf trees grow along the main streams. Chokeberry, American plum, and other shrubs are on stream bottoms and along ravines in the hilly areas.

Some of the native trees are cut for fuelwood and fenceposts. Very few are used for rough lumber, because they have many limbs and are very crooked and in poor condition.

Shannon County has very few completely effective farmstead windbreaks. Some trees grow around most of the farmsteads, but supplemental planting is needed for

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[4] Italic numbers in parentheses refer to Literature Cited, p. 84.

[5] By Elmer L. Worthington, woodland conservationist, Soil Conservation Service.

TABLE 2.—*Predicted average acre yields 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. Only soils suitable for crops are listed. Absence of yield figure indicates that crop is not commonly grown on the soil]

Soil	Winter wheat		Barley		Oats		Corn		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Anselmo sandy loam, 0 to 5 percent slopes	19	25	16	19	23	30	25	31	1.1	1.6
Anselmo sandy loam, 5 to 9 percent slopes	17	22	13	16	21	28	17	25	1.8	1.3
Buffington silty clay loam	20	26	17	21	19	25	16	25	1.3	1.8
Dunday-Valentine complex, 0 to 5 percent slopes:										
Dunday soil	------	------	12	15	13	19	14	21	.8	1.5
Valentine soil	------	------	------	------	------	------	------	------	------	------
Elsmere-Loup loamy fine sands:										
Elsmere soil	------	------	------	------	------	------	------	------	1.7	2.5
Loup soil	------	------	------	------	------	------	------	------	------	------
Goshen silt loam, 0 to 3 percent slopes	34	41	29	36	37	46	24	34	1.4	2.1
Haverson loam, high, 0 to 3 percent slopes	14	23	11	15	19	31	------	------	1.3	2.0
Haverson loam, low, 0 to 3 percent slopes	17	26	15	19	20	34	15	26	1.3	1.7
Haverson silty clay loam, 0 to 3 percent slopes	18	27	15	19	21	29	15	26	1.3	2.2
Kadoka silt loam, 0 to 3 percent slopes	19	27	20	25	20	25	------	------	1.0	1.2
Kadoka silt loam, 3 to 5 percent slopes	16	25	19	24	20	24	------	------	.9	1.1
Kadoka silt loam, 5 to 9 percent slopes	14	23	16	20	17	21	------	------	.7	1.0
Keith silt loam, 0 to 3 percent slopes	33	40	25	31	33	42	24	32	1.3	1.6
Keith silt loam, 3 to 5 percent slopes	31	37	24	30	30	39	20	26	1.2	1.5
Keith-Colby silt loams, 9 to 12 percent slopes:										
Keith soil	25	30	18	22	21	28	------	------	.9	1.1
Colby soil	17	22	14	19	16	22	------	------	.7	.9
Keith-Rosebud silt loams, 0 to 3 percent slopes:										
Keith soil	33	40	25	31	33	40	22	30	1.3	1.6
Rosebud soil	29	35	23	29	30	38	20	25	1.1	1.4
Keith and Ulysses silt loams, 5 to 9 percent slopes	27	35	22	28	25	33	16	20	1.0	1.3
Kyle silty clay, 0 to 3 percent slopes	13	17	13	17	17	22	------	------	.8	1.1
Manvel silty clay loam, 0 to 5 percent slopes	16	20	13	16	16	21	------	------	.6	1.0
Pierre clay, 3 to 9 percent slopes	12	16	12	14	16	21	------	------	.7	1.0
Richfield and Altvan silt loams, 0 to 3 percent slopes:										
Richfield soil	31	36	24	30	32	39	------	------	1.2	1.5
Altvan soil	20	26	16	21	18	29	------	------	.7	1.2
Richfield and Altvan silt loams, 3 to 5 percent slopes:										
Richfield soil	28	36	22	28	28	35	------	------	1.1	1.4
Altvan soil	17	24	15	20	17	27	------	------	.6	1.1
Richfield-Dawes silt loams, 0 to 3 percent slopes:										
Richfield soil	31	36	24	30	33	40	------	------	1.2	1.6
Dawes soil	24	28	19	23	26	32	------	------	.9	1.3
Rosebud-Canyon loams, 5 to 9 percent slopes:										
Rosebud soil	23	30	19	24	23	30	16	21	.8	1.0
Canyon soil	------	------	------	------	------	------	------	------	------	------
Rosebud-Keith silt loams, 3 to 9 percent slopes:										
Rosebud soil	24	31	20	25	24	30	15	22	.9	1.1
Keith soil	32	40	23	32	33	42	20	26	1.2	1.5
Tuthill and Anselmo fine sandy loams, 0 to 3 percent slopes:										
Tuthill soil	17	27	18	24	20	26	13	16	1.0	1.3
Anselmo soil	15	25	16	19	15	21	11	14	.8	1.2
Tuthill and Anselmo fine sandy loams, 3 to 9 percent slopes:										
Tuthill soil	17	24	16	20	18	24	12	16	.9	1.4
Anselmo soil	14	21	13	16	13	19	10	13	.7	.9
Tuthill and Manter soils, 0 to 3 percent slopes:										
Tuthill soil	17	25	20	25	20	24	13	16	1.0	1.3
Manter soil	16	21	16	20	18	23	12	15	.8	1.0
Tuthill and Manter soils, 3 to 5 percent slopes:										
Tuthill soil	16	23	19	24	18	24	12	15	1.0	1.3
Manter soil	14	20	15	19	17	22	11	14	.7	.9
Tuthill and Manter soils, 5 to 9 percent slopes:										
Tuthill soil	14	20	17	22	15	21	10	13	.9	1.2
Manter soil	12	17	13	18	15	20	10	13	.7	.9
Ulysses-Colby complex, sand substratum, 3 to 9 percent slopes:										
Ulysses soil	17	21	14	18	16	20	------	------	.6	.7
Colby soil	13	17	10	12	12	16	------	------	.4	.6

keeping snow from drifting into farmyards, for protecting livestock, fruit trees, and gardens, and for providing food and cover for wildlife. None of the experimental windbreak plantings made by the Northern Great Plains Field Station of Mandan, North Dakota, were in Shannon County.

Field windbreaks protect cropland from soil blowing and hold snow on the fields. One-row windbreaks are usually adequate for Keith and Rosebud soils in the southeastern part of the county, where most of the cropland occurs. Field windbreaks are especially needed in cultivated areas of Anselmo, Dunday, Manter, and Tuthill soils.

Information about the establishment and care of windbreaks can be obtained from the local offices of the Soil Conservation Service, the county agent, or the Bureau of Indian Affairs. Among the necessary practices are adequate preparation of the planting site and protection of the trees against fire, insects, disease, and grazing.

Windbreak groups

Some species of trees and shrubs grow well only on certain soils, and a few grow well on many soils. Some soils are not suitable for tree plantings. The soils in Shannon County that are suitable for tree plantings are placed in seven windbreak groups. In these groups the soils are identified only by the name of the series. Listing of the series does not mean that all of the soils of that series are in the particular group. To find the windbreak group of any given mapping unit, refer to the "Guide to Mapping Units."

Table 3 shows the estimated condition and height of various trees and shrubs at 20 years of age for each windbreak group in the county. Some of the estimated heights are based on actual measurements. Both the condition and height indicate potentials for growth where the trees planted are given adequate care and treatment. The criteria for condition classes are as follows:

Good. One or more of the following conditions apply: leaves or needles are normal in color and growth; only small amounts of deadwood are within the live crowns; evidence of damage by disease, insects, and climate is limited; slight evidence of suppression or stagnation may exist.

Fair. One or more of the following conditions generally apply: leaves or needles are obviously abnormal in color and growth; substantial amounts of deadwood are within the live crowns; evidence of moderate damage by disease, insects, and climate is obvious; definite suppression or stagnation exists; the current year's growth is less than normal.

TABLE 3.—*Estimated condition and height of trees and shrubs in windbreaks at 20 years of age*

[Condition represented as G—good; F—fair; P—poor. No height range given for poor condition]

Species	Windbreak group 1		Windbreak group 2		Windbreak group 3		Windbreak group 4		Windbreak group 5		Windbreak group 6		Windbreak group 7	
	Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition	Height	Condition	Height
Trees:		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*		*Ft.*
Black Hills spruce	P	-------	F	17–19	P	-------	G	18–20	P	-------	P	-------	P	-------
Boxelder	P	-------	F	15–17	P	-------	F	14–16	P	-------	P	-------	P	-------
Chinkota elm	G	22–24	G	24–26	G	23–25	G	23–27	F	10–12	F	14–16	P	-------
Colorado blue spruce	P	-------	F	17–19	P	-------	G	18–20	P	-------	P	-------	P	-------
Cottonwood	P	-------	P	-------	P	-------	F	28–30	P	-------	F	20–24	P	-------
Crab apple	F	11–13	G	11–13	F	10–12	F	11–13	P	-------	P	-------	P	-------
Diamond willow	P	-------	P	-------	P	-------	G	9–10	P	-------	F	8–9	P	-------
Eastern redcedar	G	11–13	G	10–12	G	13–15	G	12–14	F	5–7	P	-------	F	8–10
Golden willow	P	-------	P	-------	P	-------	G	24–26	P	-------	F	14–16	P	-------
Green ash	G	14–16	G	14–16	G	14–16	G	16–18	F	9–11	F	9–11	P	-------
Hackberry	G	16–18	G	12–14	G	12–14	G	12–14	P	-------	P	-------	P	-------
Harbin pear	G	11–13	G	11–13	F	9–11	G	10–12	F	4–6	P	-------	P	-------
Honeylocust	F	20–22	F	18–20	G	24–26	G	20–22	P	-------	F	14–16	P	-------
Ponderosa pine	G	18–20	G	18–20	G	15–17	G	16–18	F	9–11	P	-------	F	12–14
Purple-osier willow	P	-------	P	-------	P	-------	G	9–10	P	-------	F	8–9	P	-------
Rocky Mountain cedar	G	11–13	G	10–12	G	13–15	G	12–14	F	5–7	P	-------	F	8–10
Siberian elm	G	22–24	G	24–26	G	23–25	G	23–27	F	10–12	F	14–16	P	-------
White willow	P	-------	P	-------	P	-------	G	24–26	P	-------	F	14–16	P	-------
Shrubs:														
American plum	G	5–6	G	7–8	F	4–5	F	4–5	P	-------	P	-------	P	-------
Buffaloberry	F	5–6	F	5–7	G	5–7	F	5–7	F	3–4	F	3–4	P	-------
Caragana	G	8–10	G	8–9	G	6–8	G	7–9	F	3–4	P	-------	P	-------
Chokecherry	F	8–11	G	8–11	G	8–10	G	8–10	P	-------	P	-------	P	-------
Cotoneaster	G	4–5	G	4–5	G	4–5	G	4–5	P	-------	P	-------	P	-------
Honeysuckle	F	4–6	G	6–8	F	5–7	F	5–7	P	-------	P	-------	P	-------
Lilac	G	4–5	G	6–7	G	4–5	F	4–5	F	3–4	P	-------	P	-------
Nanking cherry	P	-------	F	4–5	F	4–5	F	4–5	P	-------	P	-------	P	-------
Russian-olive	F	15–17	F	15–17	F	12–14	F	12–14	F	8–9	F	8–9	P	-------
Sand cherry	F	3–4	F	3–4	G	4–5	F	3–4	F	3–4	F	3–4	P	-------
Three-leaf sumac	F	4–5	F	4–5	G	5–6	F	4–5	F	4–5	F	4–5	P	-------

Poor. One or more of the following conditions apply: leaves or needles are very abnormal in color and growth; very large amounts of deadwood are within the live crowns; evidence of extensive damage by disease, insects, and climate is obvious; severe suppression, stagnation, or decadence exists; the current year's growth is negligible.

WINDBREAK GROUP 1

This group consists of soils of the Anselmo, Bankard, Dunday, Manter, and Tuthill series. These are deep, moderately coarse-textured soils on uplands and deep, coarse-textured soils on bottom lands. They take in water readily and release it readily to tree roots. In some places the water table is at a depth of about 20 feet. Soil blowing is a hazard. Stubble or vegetation should be left between the rows of trees, and cultivation should be confined to the tree rows.

These soils are good for windbreaks. Suitable broadleaf trees are Siberian elm, Chinkota elm, crab apple, green ash, hackberry, Harbin pear, and honeylocust. Hackberry should be used sparingly because of lack of resistance to drought. Cottonwood, golden willow, and white willow can be used on Bankard soils along the Cheyenne River. Suitable conifers are eastern redcedar, Rocky Mountain cedar, and ponderosa pine. Suitable shrubs are American plum, buffaloberry, caragana, chokecherry, lilac, cotoneaster, honeysuckle, Russian-olive, sand cherry, and three-leaf sumac.

WINDBREAK GROUP 2

This group consists of soils of the Altvan, Buffington, Colby, Goshen, Haverson, Kadoka, Keith, Oglala, Richfield, Rosebud, and Ulysses series and of Loamy land. These are deep and moderately deep, medium-textured, well drained and moderately well drained soils. Permeability is moderately slow to moderately rapid. In most areas of Haverson soils, the depth to the water table is about 20 feet. Haverson soils occasionally receive extra water from floods, and Goshen soils, in upland swales, receive runoff from adjacent slopes. Contour cultivation and terraces help to conserve moisture and to control erosion in sloping areas. Clean cultivation between the rows during the first few years helps to eliminate weeds, which compete with the trees for moisture.

These soils are good for windbreaks. Suitable trees are boxelder, Siberian elm, Chinkota elm, crab apple, green ash, hackberry, honeylocust, eastern redcedar, Rocky Mountain cedar, ponderosa pine, Black Hills spruce, and Colorado blue spruce. Cottonwood, golden willow, and white willow can be used on Haverson soils. Hackberry should be used sparingly because of lack of resistance to drought. Spruce trees require special management. Suitable shrubs are American plum, buffaloberry, caragana, cotoneaster, chokecherry, lilac, honeysuckle, Nanking cherry, Russian-olive, sand cherry, and three-leaf sumac.

WINDBREAK GROUP 3

This group consists of soils of the Dawes, Kyle, Manvel, Minnequa, and Pierre series and of Clayey land. These are deep and moderately deep, moderately fine textured and fine textured soils on uplands and stream terraces. Permeability is moderately slow to slow. These soils take in water slowly and release it slowly to tree roots. Clean cultivation and careful management are needed if trees are grown for windbreaks. On sloping sites, contour planting and terraces help to conserve moisture and stimulate tree growth.

Suitable trees are Siberian elm, Chinkota elm, crab apple, Harbin pear, honeylocust, green ash, eastern redcedar, Rocky Mountain cedar, and ponderosa pine. Suitable shrubs are buffaloberry, caragana, chokecherry, cotoneaster, lilac, honeysuckle, American plum, Nanking cherry, Russian-olive, sand cherry, and three-leaf sumac.

WINDBREAK GROUP 4

This group consists of soils of the Elsmere, Lamo, and Loup series and of Alluvial land. These are somewhat poorly drained to poorly drained, coarse-textured to fine-textured soils on bottom lands and in subirrigated basins and valleys. Some of the soils have a water table high enough to limit the selection of trees. Alluvial land is subject to floods of short duration, and the water table generally is at a depth below 10 feet.

Cottonwood, golden willow, white willow, ponderosa pine, Black Hills spruce, and Colorado blue spruce are suitable for windbreaks on all of the soils of this group. Except for the wetter areas, suitable trees also include boxelder, Chinkota elm, Siberian elm, crab apple, green ash, hackberry, Harbin pear, honeylocust, eastern redcedar, and Rocky Mountain cedar. Suitable shrubs are American plum, buffaloberry, caragana, chokecherry, cotoneaster, honeysuckle, lilac, Nanking cherry, and Russian-olive.

WINDBREAK GROUP 5

This group consists of soils of the Mosher and Wortman series. These are deep soils that have a moderately thick silt loam surface layer and a dense clay subsoil that contains moderate amounts of sodium and other salts in the lower part. Permeability is very slow. The claypan restricts the movement of water and the development of plant roots.

Suitable trees for windbreaks are Siberian elm, Chinkota elm, green ash, Harbin pear, eastern redcedar, Rocky Mountain cedar, and ponderosa pine. Suitable shrubs are buffaloberry, caragana, lilac, Russian-olive, and three-leaf sumac.

WINDBREAK GROUP 6

Minatare soils (0 to 2 percent slopes) are the only soils in this group. These are saline-alkali soils that are moderately wet because the water table is high. Permeability is slow to very slow.

Minatare soils are strongly saline and are marginal for tree planting. Suitable trees for windbreaks are cottonwood, Siberian elm, Chinkota elm, green ash, and honeylocust. Suitable shrubs are buffaloberry, diamond willow, purple-osier willow, Russian-olive, and three-leaf sumac.

WINDBREAK GROUP 7

This group consists of soils of the Valentine series. These are deep, light-colored, loose, coarse-textured soils on uplands. Water enters these soils easily and passes rapidly through them to the water table, which is usually at a depth of more than 20 feet. These soils blow easily, so, ordinarily, their grass cover should not be disturbed. If windbreaks are needed to protect winter feedlots and ranch headquarters, the trees should be planted in shallow furrows and should not be cultivated.

Suitable trees for windbreaks are eastern redcedar, Rocky Mountain cedar, and ponderosa pine. Siberian elm, green ash, Russian-olive, American plum, and lilac will grow under intensive care.

Wildlife [6]

Wildlife is an annual crop of the land, and the kinds and numbers of wildlife in any area depend on the nature of the soils and on the use and management of the soils.

Deer, antelopes, grouse, waterfowl, beavers, bobcats, skunks, raccoons, badgers, prairie dogs, coyotes, and songbirds are common in Shannon County. Bison were eliminated by hunting soon after the area was settled. Pheasants were introduced as agriculture developed.

In this section, the distribution of wildlife is discussed in relation to the 14 soil associations, which are shown on the general soil map at the back of the survey and are described in the section "General Soil Map." Additional information on developing and improving wildlife habitat can be obtained from the Soil Conservation Service, the Bureau of Indian Affairs, or the South Dakota Department of Game, Fish, and Parks.

Deer.—White-tailed deer and mule deer occur throughout the county and are most numerous in the wooded draws of the Oglala-Canyon association. The deer population in the Keith-Rosebud association has increased in recent years.

Prairie grouse.—There are large populations of grouse in the Tuthill-Richfield association and moderately large populations in the Oglala-Canyon and Kadoka-Epping associations. Sharp-tailed grouse are the most common. Pinnated grouse are to be found throughout the county but in such small numbers as to be unimportant.

Pheasants.—The Keith-Rosebud association supports a moderate population of pheasants. The cropland areas of this association provide the only suitable habitat for pheasants in the county.

Waterfowl.—Ducks are fairly common throughout the county, wherever water supplies for livestock have been developed, but the Valentine association is the only area that provides an abundance of natural marshes and potholes. Here the spring breeding population is about 15 ducks per square mile. Mallard and blue-winged teal are the most common. Gadwall, shoveler, and pintail ducks also nest in this area.

Antelope.—Antelope number less than 100 in the county. They are mostly in the Pierre-Samsil and Badlands associations.

Furbearers.—The most important furbearers in the county are jackrabbits, cottontails, muskrats, minks, and beavers. The population of jackrabbits and cottontails is highest in the Keith-Rosebud association. Muskrats and minks are in the marshy areas of the Loup soils in the southeastern part of the county, and beavers live mostly along White Clay Creek. Limited numbers of raccoons, skunks, badgers, bobcats, and coyotes occur throughout the county. Predator control programs have reduced the number of coyotes.

Fish.—Natural habitat for fish is scarce in this county. Some farm ponds in the Oglala-Canyon, Kadoka-Epping, and Pierre-Samsil associations have been stocked with bass and bluegills, and a few of the deeper, colder ponds have been stocked with trout. Some fishing is provided in the White Clay Reservoir and the White and Cheyenne Rivers.

Engineering Uses of the Soils [7]

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. In this section are discussed properties of the soils that affect construction and maintenance of roads and airports, building foundations, pipelines, water-storage facilities, erosion control structures, drainage systems, irrigation systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, water-holding capacity, grain-size distribution, plasticity, and reaction. Information concerning these and related soil properties are furnished in three tables. The estimates and interpretations of soil properties in this section can be used to—

1. Make preliminary estimates of engineering properties of the soils, for the purpose of determining the feasibility of and planning the construction of farm ponds, irrigation systems, waterspreading systems, diversions, terraces, and other earthen structures.
2. Make preliminary evaluations of soil conditions that will aid in selecting locations for highways, airports, pipelines, and cables, and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, clay, or rock suitable for use as construction material.
4. Aid in the selection of industrial, business, residential, and recreational sites.
5. Supplement information obtained from other published maps and reports and aerial photographs, for the purpose of making soil maps and reports that engineers can use readily.

Tables 4, 5, and 6 provide soil interpretations useful in engineering.

It should be emphasized, however, that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful in planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Engineering classification systems

The engineering systems now most widely used to classify soils are the Unified system (*16*), and the system developed by the American Association of State Highway Officials (AASHO) (*2*).

The Unified soil classification system was established by the Waterways Experiment Station, Corps of Engi-

[6] By LeRoy A. Shearer, biologist, Soil Conservation Service.

[7] By Odell A. Aldrich, agricultural engineer, Soil Conservation Service.

TABLE 4.—*Engineering test data*

[Tests performed by the South Dakota Department of Highways in cooperation with the U.S. Department of Commerce, Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway Officials (AASHO)]

Soil name and location	Underlying material	Depth	Mechanical analysis,[1] percentage passing sieve—					Liquid limit	Plasticity index	Classification	
			3/8-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)			AASHO	Unified [2]
		In.						*Pct.*			
Kadoka silt loam: SE¼ of sec. 20, T. 40 N., R. 41 W., 0.8 mile W. of road junction W. of Kyle, 200 feet S. of road.	Bedded silt and siltstone.	0–3	------	------	------	100	93	46	13	A–7–5(10)	ML
		3–8	------	------	------	100	94	50	24	A–7–6(16)	ML–CL
		8–14	------	------	100	99	85	48	21	A–7–6(14)	ML–CL
		14–21	------	------	100	98	84	42	25	A–7–6(14)	CL
		21–30	------	------	100	99	81	43	12	A–7–5(10)	ML
Keith silt loam: 0.15 mile N. and 115 feet W. of SE. corner of sec. 26, T. 36 N., R. 42 W.	Loess.	0–7	------	------	------	100	86	33	11	A–6(8)	ML–CL
		7–10	------	------	------	100	87	36	16	A–6(10)	CL
		10–15	------	------	------	100	87	40	20	A–6(12)	CL
		15–19	------	------	------	100	86	40	20	A–6(12)	CL
		19–25	------	------	------	100	89	34	12	A–6(9)	ML–CL
		25–32	------	------	------	100	91	30	7	A–4(8)	ML–CL
		32–40	------	------	------	100	79	29	6	A–4(8)	ML–CL
		40–48	------	------	------	100	68	29	6	A–4(7)	ML–CL
		48–65	------	------	------	100	72	27	6	A–4(7)	ML–CL
Keith silt loam: 2,000 feet S. and 350 feet W. of NE. corner of sec. 30, T. 38 N., R. 46 W.	Loess.	0–2	------	------	------	100	97	45	14	A–7–5(11)	ML
		2–9	------	------	------	100	95	41	19	A–7–6(12)	CL
		9–17	------	------	------	100	94	38	18	A–6(11)	CL
		17–22	------	------	------	100	94	36	15	A–6(10)	CL
		22–28	------	------	------	100	93	34	14	A–6(10)	CL
		28–39	------	------	------	100	93	31	11	A–6(8)	CL
		39–50	------	------	------	100	90	28	8	A–4(8)	CL
		50–60	------	------	------	100	90	29	9	A–4(8)	CL
Kyle clay, alkali: SW¼ of sec. 18, T. 37 N., R. 46 W.	Clay alluvium over shale.	0–2	------	------	------	100	99	58	32	A–7–6(20)	CH
		2–7	------	------	------	100	99	67	38	A–7–6(20	CH
		7–13	------	------	------	100	99	69	43	A–7–6(20)	CH
		13–18	------	------	------	100	99	72	45	A–7–6(20)	CH
		18–25	------	------	------	------	100	74	46	A–7–6(20)	CH
		25–38	------	------	------	100	98	75	46	A–7–6(20)	CH
		38–44	------	------	------	100	98	80	51	A–7–6(20)	CH
		44–57	------	------	------	100	99	74	48	A–7–6(20)	CH
Pierre clay: 0.25 mile E. and 295 feet S. of NW. corner of sec. 15, T. 37 W., R. 48 W.	Clay shale.	0–3	------	------	100	99	98	60	34	A–7–6(20)	CH
		3–6	------	------	------	100	99	64	40	A–7–6(20)	CH
		6–11	------	------	------	100	99	62	42	A–7–6(20)	CH
		11–17	------	------	------	100	99	66	42	A–7–6(20)	CH
		17–26	------	------	100	99	96	64	40	A–7–6(20)	CH
		26–33	------	------	100	99	96	63	37	A–7–6(20)	CH
		33–37	95	95	95	91	88	64	38	A–7–6(20)	CH
		37–45	------	------	------	100	98	66	39	A–7–6(20)	CH
Rosebud loam: 0.3 mile W. and 0.25 mile S. of NE. corner of sec. 5, T. 35 N., R. 41 W.	Bedded sandstone.	0–5	------	------	100	98	72	29	7	A–4(7)	ML–CL
		5–9	------	------	100	98	69	29	9	A–4(7)	CL
		9–13	------	------	100	98	67	28	10	A–4(6)	CL
		13–17	------	------	100	97	65	30	10	A–4(6)	CL
		17–21	98	96	95	84	55	33	10	A–4(4)	ML–CL
		21–28	100	99	99	87	55	32	6	A–4(4)	ML
		28–35	------	------	100	94	55	28	4	A–4(4)	ML–CL

[1] Mechanical analysis according to the AASHO Designation: T 88. 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 than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[2] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. An example of a borderline classification obtained by this use is ML–CL.

neers. This system is based on the identification of soils according to particle-size distribution, plasticity, and liquid limit. In this system SW and SP are symbols for clean sands; SM and SC, for sands with nonplastic or plastic fines (G replaces S if the major coarse fraction is gravel); ML and CL, for nonplastic or plastic, fine-grained materials of low liquid limit; and MH and CH, for nonplastic or plastic, fine-grained materials of high liquid limit. Some soils are on the borderline between two of these groups and are given a dual classification, for example, SM–SC or ML–CL.

The system developed by the American Association of State Highway Officials is based on the performance of soils in highways. It groups soils of about the same general load-carrying capacity and service. All materials are classified in seven basic groups, A–1 through A–7. The best soils for road subgrade are classified as A–1; the poorest are classified as A–7.

Agricultural scientists classify soils according to the textural classification of the U.S. Department of Agriculture. In this system the soil particles 2 millimeters or less in diameter are divided into three groups: sand (2 millimeters to 0.05 millimeter), silt (0.05 to 0.002 millimeter), and clay (less than 0.002 millimeter). The textural classification of a soil depends on the relative proportions of sand, silt, and clay particles.

Engineering test data

Table 4 presents data obtained by laboratory tests of samples taken from six soil profiles. These tests were performed by the South Dakota Department of Highways in cooperation with the U.S. Bureau of Public Roads. They were conducted in accordance with standard procedures of the American Association of State Highway Officials. Some of the terms used in table 4 are explained in the following paragraphs.

In mechanical analysis, the soil particles are sorted by size. Sand and other granular material are retained on a No. 200 sieve, but finer particles pass through the openings. Clay particles are less than 0.002 millimeter in diameter. The material intermediate in size between that held on the No. 200 sieve and that having a diameter of 0.002 millimeter is mostly silt.

The tests for liquid limit measure the effect of water on the consistence of the 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 a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. A high liquid limit indicates that the soil has a high content of clay and a low capacity for supporting loads. 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.

Estimated properties of the soils

Table 5 lists the soil series and mapping units in Shannon County and gives estimates of some of the soil properties that affect engineering work. These estimates are based on test data shown in table 4 and on knowledge of the soils gained during the course of the soil survey. A more complete description of each soil can be found in the section "Descriptions of the Soils."

The percentage of material passing the number 10, number 40, and number 200 sieves reflects the normal range for a specified soil. Most samples of a given soil fall within the range listed in table 5, but it should not be assumed that all will.

Permeability relates only to the movement of water downward through an undisturbed soil. The estimates are based on soil structure and texture.

Available water holding capacity relates to the amount held by a soil, in a form available to plants, after the free water has drained out.

Reaction, which indicates the degree of acidity or alkalinity of a soil, is expressed as a pH value. The determinations were made by using a glass electrode or color-indicator tests.

The shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content.

Engineering interpretations

Table 6 gives the suitability of the soils for certain uses and shows specific characteristics that affect the design and construction of highways and structures.

The suitability of a soil for topsoil depends largely on thickness, texture, organic-matter content, and natural fertility. Eroded soils, for example, generally are not thick enough, and clayey soils tend to be difficult to work.

No interpretations are shown in table 6 for suitability as a source of gravel and sand, or for drainage structures, irrigation structures, or waterways. Sand and gravel suitable for construction purposes generally are not available in this county. Drainage is only a minor problem. Wet areas of Hoven soils, for example, can be drained by open ditches if suitable outlets are present, or the water can be diverted by terracing the adjacent slopes. Elsmere, Lamo, Loup, Minatare, and Mosher soils are the only soils with a water table within 5 feet of the surface. These soils are well suited to native hay and grazing, and the high water table is considered a favorable feature for these uses. Most of the constructed waterways in the county are in the southeastern part, where most of the cropland is. Care must be taken in reshaping waterways, since the soils are susceptible to water erosion until vegetation is well established.

Engineers and others should not apply specific values to the estimates of bearing capacity given in the last column of table 6, which shows the limitations of the soils as foundation material for low buildings.

Formation and Classification of the Soils

This section consists of four parts. The first part relates the five factors of soil formation to the formation of soils in Shannon County. The second part discusses some of the processes that lead to the formation of soil horizons. The third part describes the system of classifying soils and shows the placement of the soils of this

TABLE 5.—*Estimated engineering*

[Estimates are not shown for the miscellaneous land types: Alluvial land (Aa), Badlands (Ba), Barren badlands (Br),

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification
			USDA texture
	In.	*In.*	
Altvan.	>60	0–9	Silt loam
		9–39	Sandy clay loam to clay loam
		39–60	Stratified sand and gravel
Anselmo: AsB, AsC, AvE. For properties of Valentine component of AvE, see Valentine series in this table.	>60	0–14	Sandy loam to fine sandy loam
		14–60	Sandy loam to sand
Bankard: Bk.	>120	0–60	Loamy sand to sand (Stratified below a depth of about 10 inches).
Buffington: Bu.	>120	0–36	Silty clay loam
		36–65	Silt loam to silty clay
Canyon: CaF, Cc.	6–20	0–10	Loam
		10	Weakly cemented sandstone.
Colby.	>60	0–60	Silt loam to very fine sandy loam
Dawes.[1]	>120	0–8	Silt loam
		8–25	Silty clay to silty clay loam
		25–60	Silt loam to sandy loam
Dunday: DvB. For properties of Valentine component, see Valentine series in this table.	>120	0–60	Loamy fine sand to fine sand
Elsmere: Ef.[2] For properties of Loup component, see Loup series in this table.	>120	0–60	Loamy fine sand to fine sand
Epping: EhF, EkE, Er. For properties of Kadoka component of EkE, see Kadoka series in this table.	5–20	0–6	Silt loam
		6	Bedded silts and siltstone.
Goshen: GoA.	>60	0–14	Silt loam
		14–40	Silty clay loam to silt loam
		40–60	Silt loam to sandy loam
Haverson:			
Loam HhA, HlA.	>120	0–60	Stratified loam to very fine sand
Silty clay loam HoA.	>120	0–15	Silty clay loam
		15–60	Stratified silty clay to very fine sand
Hisle: Hs, Ht.[3,4] For properties of Swanboy component of Ht, see Swanboy series in this table.	10–40	0–20	Clay
		20	Shale.
Hoven: Hv.[3]	>60	0–6	Silt loam
		6–38	Clay to silty clay loam
		38–60	Silt loam to fine sand
Kadoka: KaA, KaB, KaC, KbC. For properties of Epping component of KbC, see Epping series in this table.	20–40	0–3	Silt loam
		3–21	Silty clay loam to silt loam
		21–30	Silt loam
		30	Bedded siltstone.
Keith: KeA, KeB, KhD, KhE, KrA, KuC. For properties of Colby component of KhD and KhE, for properties of Rosebud component of KrA, and for properties of Ulysses component of KuC, see those series in this table.	>60	0–7	Silt loam to loam
		7–25	Silty clay loam to loam
		25–60	Silt loam to loam
Kyle: KyA, KyB, KzA.[1]	60–120+	0–60	Clay to silt loam

See footnotes at end of table.

properties of the soils

Clayey land (Cy), Gravelly land (Gr), Loamy land (Lm), Rock outcrop, Shale outcrop, and Terrace escarpments (Te)]

Classification—Continued		Percentage passing sieve—			Permeability	Available water holding capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10	No. 40	No. 200				
					In./hr.	*In./in. of soil*	*pH*	
ML	A-4	95-100	95-100	65-85	0. 63-2. 0	0. 15-0. 17	6. 6-7. 3	Low.
SC to CL	A-6 to A-7	90-100	80-100	45-75	0. 20-0. 8	0. 16-0. 18	7. 4-7. 8	Moderate.
SM to GM	A-2 to A-1	20-40	5-20	0-15	>6. 3	0. 05-0. 10	7. 9-8. 4	Low.
SM	A-2 to A-4	100	65-85	30-50	2. 00-6. 3	0. 10-0. 14	6. 6-7. 3	Low.
SM to SP-SM	A-2 to A-3	100	50-70	10-35	2. 00-10. 0	0. 05-0. 10	6. 6-7. 8	Low.
SM to SP	A-2 to A-3	95-100	35-75	5-30	>6. 3	0. 05-0. 10	7. 9-8. 4	Low.
ML-CL to CL	A-6 to A-7	100	95-100	85-95	0. 20-0. 8	0. 16-0. 18	7. 9-8. 4	Moderate.
ML to CL	A-4 to A-7	100	90-100	70-95	0. 05-2. 5	0. 10-0. 18	7. 9-8. 4	Moderate.
ML	A-4	90-95	70-95	50-70	1. 2-2. 5	0. 15-0. 17	7. 9-8. 4	Low.
ML to ML-CL	A-4	100	85-95	50-75	0. 80-3. 0	0. 15-0. 17	7. 9-8. 4	Low to moderate.
ML-CL to CL	A-4 to A-6	100	90-100	70-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Low to moderate.
CH to CL	A-7 to A-6	100	95-100	85-95	0. 05-0. 8	0. 17-0. 19	7. 4-7. 8	High.
SM, ML to ML-CL	A-2 to A-4	95-100	60-100	30-85	0. 80-5. 0	0. 15-0. 17	7. 8-8. 4	Low to moderate.
SM to SP-SM	A-2, A-3, A-4	100	65-95	25-50	5. 00-10. 0	0. 05-0. 10	6. 6-7. 3	Low.
SM to SP-SM	A-2 to A-3	100	65-95	5-30	5. 00-10. 0	0. 05-0. 10	6. 6-8. 4	Low.
ML to ML-CL	A-4	90-100	85-100	60-90	0. 80-2. 0	0. 15-0. 17	7. 9-8. 4	Moderate.
ML to CL	A-4 to A-6	100	90-100	70-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
CL to ML-CL	A-7 to A-4	100	90-100	70-95	0. 20-2. 0	0. 16-0. 18	7. 4-7. 8	Moderate.
SM, ML to CL	A-2, A-4, A-6	95-100	60-95	30-75	0. 80-5. 0	0. 15-0. 17	7. 9-8. 4	Moderate.
ML to SM	A-4	95-100	75-100	40-80	1. 2-6. 3	0. 10-0. 16	7. 9-8. 4	Low.
CL to ML-CL	A-7	100	95-100	85-95	0. 20-0. 8	0. 16-0. 18	7. 9-8. 4	Moderate.
CH to SM	A-7 to A-4	95-100	75-100	40-95	0. 20-6. 3	0. 10-0. 18	7. 9-8. 4	Moderate.
CH to MH	A-7	95-100	90-100	70-95	<0. 05	0. 17-0. 19	8. 5-9. 0	High.
ML to ML-CL	A-4	100	90-100	70-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
CH to MH	A-7	100	90-100	75-95	<0. 0	0. 17-0. 19	7. 9-9. 0	High.
ML-CL to SM	A-4 to A-2	100	65-100	20-90	0. 80-6. 35	0. 10-0. 16	7. 4-9. 0	Moderate to low.
ML	A-7 to A-4	100	90-100	70-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
ML-CL to CL	A-7 to A-4	100	90-100	80-95	0. 20-2. 0	0. 16-0. 18	7. 4-8. 4	Moderate.
ML	A-7 to A-4	100	90-100	75-90	0. 80-2. 0	0. 15-0. 17	8. 5-9. 0	Moderate.
ML-CL to ML	A-4 to A-7	100	85-100	60-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
CL	A-6 to A-7	100	85-100	60-95	0. 20-2. 0	0. 15-0. 17	6. 6-7. 8	Moderate.
CL to ML	A-4 to A-6	100	85-100	60-95	0. 80-2. 0	0. 14-0. 16	7. 9-8. 4	Moderate.
CH-CL	A-7 to A-6	100	95-100	70-95	0. 05-0. 2	0. 17-0. 19	7. 4-8. 4	High.

TABLE 5.—*Estimated engineering*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification
			USDA texture
	In.	*In.*	
Lamo: Le.[5] For properties of Elsmere component, see Elsmere series in this table.	>120	0–34	Silt loam to silty clay loam
		34–65	Silt loam to sand
Loup: Ls.[6]	>120	0–14	Very fine sandy loam to loamy fine sand
		14–60	Loam to fine sand
Manter.	>60	0–4	Fine sandy loam to loam
		4–22	Sandy loam
		22–60	Sandy loam to loamy sand
Manvel: McB.[7]	48–60+	0–6	Silty clay loam
		6–60	Silty clay loam
Minatare: Me.[3, 4, 5]	>60	0–3	Loam
		3–10	Clay to clay loam
		10–60	Loam to sandy loam
Minnequa: MgD.	20–36	0–20	Silty clay loam
		20	Shale and chalk.
Mosher: Mm.[4, 7, 8] For properties of Minatare component, see Minatare series in this table.	>60	0–10	Silt loam to loam
		10–44	Clay loam to clay
		44–60	Clay loam to loamy sand
Oglala: OcE. For properties of Canyon component, see Canyon series in this table.	>40	0–28	Silt loam to very fine sandy loam
		28–48	Silt loam to very fine sandy loam
Orella: OeC, Os.	6–24	0–14	Clay to silty clay loam
		14	Bedded clay shales.
Penrose: PcE, Pd. For properties of Minnequa component of PcE, see Minnequa series in this table.	5–27	0–13	Silty clay loam
		13	Chalky shale.
Pierre: PeC, PsE. For properties of Samsil component of PsE, see Samsil series in this table.	20–40	0–36	Clay to silty clay
Richfield: RaA, RaB, RdA. For properties of Altvan components of RaA and RaB, and for properties of Dawes component of RdA, see those series in this table.	>60	0–9	Silt loam
		9–23	Silty clay loam
		23–60	Silt loam to very fine sandy loam
Rosebud: ReB, RkC. For properties of Canyon component of ReB, and for properties of Keith component of RkC, see those series in this table.	14–40	0–4	Silt loam to very fine sandy loam
		4–20	Loam to clay loam
		20–31	Loam to sandy loam
		31	Bedded fine sands.
Samsil: Ss.	5–20	0–10	Clay
		10	Bedded shale.
Swanboy: Sw,[1,4]	>60	0–60	Clay
Tassel: TaF. For properties of Anselmo component, see Anselmo series in this table.	6–25	0–12	Fine sandy loam to sandy loam
		12	Bedded sandstone.
Tuthill: TnA, TnC, TuA, TuB, TuC. For properties of Anselmo components of TnA and TnC, and for properties of Manter components of TuA, TuB, and TuC, see those series in this table.	>48	0–6	Loam to fine sandy loam
		6–26	Sandy clay loam
		26–64	Sandy loam to sand (gravelly locally)
Ulysses: UcC. For properties of Colby component, see Colby series in this table.	>60	0–10	Silt loam to very fine sandy loam
		10–60	Silt loam to very fine sandy loam

See footnotes at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water holding capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10	No. 40	No. 200				
					In./hr.	In./in. of soil	pH	
ML-CL to CL	A-4 to A-7	100	90-100	70-95	0. 20-2. 0	0. 16-0. 18	7. 9-8. 4	Moderate.
ML-CL to SP	A-4 to A-3	100	50-90	5-70	0. 80-10. 0	0. 05-0. 16	7. 4-8. 4	Moderate to low.
SM	A-4 to A-2	100	70-95	30-50	2. 00-6. 3	0. 05-0. 10	7. 9-8. 4	Low.
SM	A-4 to A-2	100	50-85	5-50	1. 2-10. 0	0. 05-0. 10	7. 4-8. 4	Low.
SM to ML	A-4	100	70-95	40-75	1. 2-5. 0	0. 10-0. 16	6. 6-7. 3	Low.
SM	A-2 to A-4	100	60-70	30-40	0. 63-4. 0	0. 10-0. 16	6. 6-7. 8	Low.
SM	A-2	100	50-75	20-35	2. 00-6. 3	0. 05-0. 14	7. 9-8. 4	Low.
ML-CL to CL	A-7	100	95-100	85-95	0. 20-0. 8	0. 15-0. 17	7. 4-8. 4	Moderate.
ML-CL	A-7	100	95-100	85-95	0. 20-0. 8	0. 16-0. 18	7. 9-9. 0	Moderate.
ML	A-4	100	85-100	60-75	1. 20-2. 5	0. 14-0. 16	7. 4-7. 8	Moderate.
CH	A-7	100	90-100	70-95	<0. 05	0. 17-0. 19	8. 5-9. 0	High.
ML to SM	A-4 to A-2	100	60-100	30-75	1. 20-6. 3	0. 10-0. 16	7. 9-8. 4	Moderate.
ML-CL to CL	A-7	100	95-100	85-95	0. 20-1. 2	0. 16-0. 18	7. 9-8. 4	Moderate.
ML to ML-CL	A-4	100	85-100	70-90	0. 80-2. 0	0. 14-0. 16	6. 6-7. 3	Moderate.
CH	A-7	100	90-100	70-95	0. 05-0. 2	0. 17-0. 19	7. 9-9. 0	High.
CH to SM	A-7 to A-2	100	50-100	15-75	2. 50-6. 3	0. 05-0. 14	7. 9-9. 0	Moderate to low.
ML	A-4	100	85-95	50-75	0. 80-3. 0	0. 15-0. 17	6. 6-7. 8	Moderate.
ML	A-4	100	85-100	50-90	1. 20-3. 0	0. 15-0. 17	7. 9-8. 4	Moderate to low.
CH to CL	A-7	100	90-100	75-95	0. 05-0. 2	0. 17-0. 19	7. 9-8. 4	High.
ML-CL to CL	A-7	95-100	90-100	80-95	0. 20-0. 8	0. 16-0. 18	7. 9-8. 4	Moderate.
CH	A-7	100	90-100	75-95	0. 05-0. 2	0. 17-0. 19	7. 9-8. 4	High.
ML-CL	A-4	100	90-100	70-90	0. 80-2. 0	0. 15-0. 17	6. 6-7. 3	Low.
CL	A-7	100	95-100	85-95	0. 20-0. 8	0. 16-0. 18	7. 4-7. 8	Moderate.
ML-CL to ML	A-4	100	85-100	50-90	0. 80-3. 0	0. 15-0. 17	7. 9-8. 4	Moderate.
ML to ML-CL	A-4	100	85-95	50-75	0. 80-3. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
CL to ML-CL	A-4 to A-6	100	85-100	50-75	0. 20-2. 5	0. 15-0. 17	7. 4-8. 4	Moderate.
ML-CL to SM	A-4 to A-2	90-100	50-85	25-65	1. 20-6. 3	0. 10-0. 16	7. 9-8. 4	Low.
CH	A-7	100	90-100	65-85	0. 05-0. 2	0. 17-0. 19	7. 9-8. 4	High.
CH	A-7	100	90-100	90-95	<0. 05	0. 17-0. 19	7. 9-9. 0	Very high.
SM	A-4 to A-2	85-100	50-75	20-40	2. 00-6. 3	0. 10-0. 15	7. 9-8. 4	Low.
SM to ML	A-4	100	70-95	40-75	1. 20-5. 0	0. 10-0. 15	6. 6-7. 3	Low.
SC to CL	A-6	100	80-90	35-55	0. 63-2. 0	0. 15-0. 17	6. 6-7. 3	Moderate.
SM	A-2, A-3, A-4	80-100	40-60	5-40	2. 00-10. 0	0. 05-0. 10	7. 4-8. 4	Low.
ML	A-4	100	90-100	50-90	0. 80-3. 0	0. 15-0. 17	6. 6-7. 8	Moderate.
ML	A-4	100	90-100	50-90	0. 80-3. 0	0. 12-0. 19	7. 9-8. 4	Moderate to low.

TABLE 5.—*Estimated engineering*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification: USDA texture
	In.	*In.*	
Valentine: VaC, VaD, Vs.	>120	0–60	Loamy fine sand to coarse sand
Wanblee,[3, 4]	16–40	0–3	Silt loam
		3–20	Silty clay
		20–60	Silty clay to silt loam or siltstone
Wortman: Ww.[3] For properties of Wanblee component, see Wanblee series in this table.	25–50+	0–4	Silt loam
		4–21	Silty clay loam to silty clay
		21–60	Silt loam to siltstone

[1] Moderate dispersion.
[2] Water table at depth of 3 to 6 feet.
[3] High dispersion.
[4] Saline.

TABLE 6.—*Engineering*

[Estimates are not shown for the miscellaneous land types: Alluvial land (Aa), Badlands (Ba), Barren lands (Br), Clayey land

Soil series and map symbols	Suitability as a source of—: Topsoil	Suitability as a source of—: Road fill	Soil limitations for sewage disposal: Septic tank filter fields	Soil limitations for sewage disposal: Lagoons
Altvan. Mapped only with soils of Richfield series.	Good	Fair to good	Slight	Severe: rapid permeability in substratum.
Anselmo: AsB, AsC, AvE. For properties of Valentine component of AvE, see Valentine series in this table.	Fair: blows easily.	Good	Slight	Severe: rapid permeability in substratum.
Bankard: Bk	Poor: sandy; low in organic-matter content.	Good	Moderate: subject to flooding.	Severe: rapid permeability.
Buffington: Bu	Good	Poor	Moderate: moderately slow permeability.	Slight
Canyon: CaF, Cc	Poor: thin	Fair	Moderate to severe: 5 to 40 percent slopes; soft sandstone at less than 20 inches.	Severe: 5 to 40 percent slopes; moderately rapid permeability above sandstone.
Colby. Mapped only with soils of Keith and Ulysses series.	Fair if fertilized; high in lime content.	Fair to poor	Moderate to severe: 3 to 18 percent slopes.	Moderate to severe: 3 to 18 percent slopes.
Dawes. Mapped only with soils of Richfield series.	Good	Poor	Moderate: moderately slow to slow permeability.	Slight to moderate: unstable material.
Dunday: DvB. For properties of Valentine component, see Valentine series in this table.	Fair: blows easily.	Good	Slight	Severe: rapid permeability.
Elsmere: Ef. For properties of Loup component, see Loup series in this table.	Fair: blows easily.	Fair	Moderate: water table at depth of 3 to 6 feet.	Severe: rapid permeability.
Epping: EhF, EkE, Er. For properties of Kadoka component of EkE, see Kadoka series in this table.	Poor: thin	Poor	Severe: siltstone at depth of 5 to 20 inches; 3 to 40 percent slopes.	Severe: 3 to 40 percent slopes.

See footnote at end of table.

properties of the soils—Continued

Classification—Continued		Percentage passing sieve—			Permeability	Available water holding capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 10	No. 40	No. 200				
					In./hr.	*In./in. of soil*	*pH*	
SM to SP	A–2 to A–1	100	50–70	5–30	>6. 3	0. 03–0. 07	6. 6–7. 3	Low.
ML–CL	A–4	100	90–100	70–90	0. 80–2. 0	0. 15–0. 17	7. 9–8. 4	Moderate.
CH	A–7	100	95–100	90–95	<0. 05	0. 17–0. 19	8. 5–9. 0	High.
CH to ML–CL	A–7 to A–4	100	90–100	75–95	0. 05–0. 63	0. 15–0. 19	8. 5–9. 0	Moderate.
ML–CL	A–4	100	90–100	70–90	0. 80–2. 0	0. 15–0. 17	6. 6–7. 3	Moderate.
CH	A–7	100	95–100	85–95	0. 05–0. 1	0. 17–0. 19	7. 9–9. 0	High.
ML–CL to CL	A–6 to A–4	100	90–100	70–95	0. 20–2. 0	0. 15–0. 17	7. 9–9. 0	Moderate.

[5] Water table at depth of 2 to 5 feet.
[6] Water table at depth of 2 to 4 feet.
[7] Saline in lower part.
[8] Water table at depth of 3 to 7 feet.

interpretations

(Cy), Gravelly land (Gr), Loamy land (Lm), Rock outcrop, Shale outcrop, and Terrace escarpments (Te)]

Soil features affecting—				
Highways	Farm Ponds		Terraces and diversions	Foundations for low buildings [1]
	Reservoir areas	Embankments		
Moderate susceptibility to frost heaving.	Substratum generally too porous to hold water.	Fair stability	Sand and gravel at depth of 20 to 40 inches.	Fair shear strength.
Susceptibility to soil blowing.	Usually too porous to hold water.	Sandy material; rapid seepage.	Sandy substratum; erodible material.	Fair shear strength.
Susceptibility to soil blowing; loose sand hinders hauling.	Too porous to hold water.	Sandy material; rapid seepage.	Sandy material; erodible material; difficult to establish vegetation.	Features favorable.
Susceptibility to frost heaving.	Pervious substratum may require seal blanket.	Fair to poor stability	Features favorable	Fair bearing capacity.
5 to 40 percent slopes; erodible material.	Pervious substratum requires compacted seal blanket.	Poor stability; poor compaction; susceptibility to piping.	Soft sandstone at depth of less than 20 inches; erodible material; difficult to establish vegetation.	Fair to poor bearing capacity.
3 to 18 percent slopes; erodible material.	Pervious substratum requires compacted seal blanket.	Poor stability; poor compaction; susceptibility to piping.	Erodible material	Poor bearing capacity.
Susceptibility to frost heaving; unstable material.	Pervious substratum may require seal blanket.	Fair stability; medium to high compressibility.	Slow permeability in subsoil.	Poor to fair bearing capacity.
Susceptibility to soil blowing; loose sand hinders hauling.	Too porous to hold water.	Sandy material; rapid seepage.	Sandy material; subject to soil blowing.	Features favorable.
Fluctuating water table at depth of 3 to 6 feet.	Water table at depth of 3 to 6 feet; suitable for dug ponds.	Sandy material; rapid seepage.	Sandy material; subject to soil blowing.	Water table at depth of 3 to 6 feet.
3 to 40 percent slopes; erodible material.	Usually favorable; may require seal blanket in places.	Limited material; poor stability.	Bedded silts and siltstones; difficult to establish vegetation.	Poor bearing capacity.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil limitations for sewage disposal	
	Topsoil	Road fill	Septic tank filter fields	Lagoons
Goshen: GoA	Good	Fair to poor	Moderate: moderate permeability; some flooding.	Moderate: moderate permeability.
Haverson: HhA, HIA, HoA	Fair if fertilized: high in lime content.	Poor to good	Moderate: some flooding; moderately slow to moderately rapid permeability.	Severe: moderately slow to moderately rapid permeability.
Hisle: Hs, Ht For properties of Swanboy component of Ht, see Swanboy series in this table.	Not suitable	Very poor	Severe: very slow permeability.	Moderate: unstable material.
Hoven: Hv	Not suitable	Very poor	Severe: flooding; slow to very slow permeability.	Slight to severe: variable substratum.
Kadoka: KaA, KaB, KaC, KbC For properties of Epping component of KbC, see Epping series in this table.	Good	Poor	Moderate: moderate permeability; 0 to 18 percent slopes; bedded siltstone and silts at depth of 20 to 40 inches.	Moderate to severe: moderate permeability; 0 to 18 percent slopes.
Keith: KeA, KeB, KhD, KhE, KrA, KuC For properties of Colby component of KhD and KhE, for properties of Rosebud component of KrA, and for properties of Ulysses component of KuC, see those series in this table.	Good	Fair to poor	Moderate: moderate permeability; 0 to 18 percent slopes.	Moderate to severe: moderate permeability; 0 to 18 percent slopes.
Kyle: KyA, KyB, KzA	Poor: high in clay content.	Very poor	Severe: slow permeability.	Slight
Lamo: Le For properties of Elsmere component, see Elsmere series in this table.	Good	Poor	Severe: water table at depth of 2 to 5 feet; moderately slow permeability.	Severe: water table at depth of 2 to 5 feet.
Loup: Ls	Fair: blows easily.	Poor	Severe: high water table.	Severe: high water table.
Manter Mapped only with soils of Tuthill series.	Fair to good	Good	Slight	Severe: rapid permeability in substratum.
Manvel: McB	Fair: high in lime content.	Poor	Severe: moderately slow permeability.	Moderate: unstable material.
Minatare: Me	Not suitable	Very poor	Severe: water table at depth of 2 to 5 feet, and seasonally higher; slow to very slow permeability.	Severe: water table at depth of 2 to 5 feet, and seasonally higher; unstable material.
Minnequa: MgD	Fair: high in lime content.	Poor	Severe: 5 to 20 percent slopes; chalk and limestone beds at depth of 20 to 36 inches; moderate to moderately slow permeability.	Moderate: 5 to 20 percent slopes.
Mosher: Mm For properties of Minatare component, see Minatare series in this table.	Good	Poor	Severe: very slow permeability; water table at depth of 3 to 7 feet, and seasonally higher.	Moderate: unstable fill material.
Oglala: OcE For properties of Canyon component, see Canyon series in this table.	Good	Fair	Moderate: moderate permeability; 9 to 18 percent slopes.	Moderate: moderate permeability; 9 to 18 percent slopes.
Orella: OeC, Os	Not suitable	Very poor	Severe: slow to very slow permeability.	Moderate: unstable material; 0 to 18 percent slopes.

See footnote at end of table.

interpretations—Continued

Soil features affecting—				
Highways	Farm Ponds		Terraces and diversions	Foundations for low buildings[1]
	Reservoir areas	Embankments		
Susceptibility to frost heaving; some flooding.	Pervious substratum may require seal blanket.	Poor stability	Features favorable	Poor to fair bearing capacity.
Some flooding; erodible material on embankments.	Pervious substratum requires seal blanket.	Poor to fair stability; permeable.	Erodible material	Fair to good.
Plastic material; high shrink-swell potential.	Usually satisfactory; some seepage in shale crevices.	Fair to poor stability; low shear strength.	Clay materials; unstable material for embankments.	Poor shear strength; high shrink-swell potential.
Susceptibility to frost heaving and flooding; depressional.	Variable substratum; seal blanket required in places.	Fair to poor stability; low shear strength.	Not applicable	Susceptibility to ponding.
Susceptibility to frost heaving; erodible material on embankments.	Usually satisfactory; seal blanket required in places.	Fair to poor stability	Bedded silts and siltstone at depth of 20 to 40 inches.	Poor bearing capacity.
Susceptibility to frost heaving; erodible material on embankments.	Pervious substratum may require seal blanket.	Fair to poor stability; susceptibility to piping.	Features favorable	Poor bearing capacity.
Plastic material; high shrink-swell potential.	Features satisfactory	Fair to poor stability; high shrink-swell potential.	Clay; slow permeability	Poor shear strength; high shrink-swell potential.
Water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet; suitable for dug ponds.	Poor stability	Not applicable; water table at depth of 2 to 5 feet.	Water table at depth of 2 to 5 feet.
High water table	High water table; suitable for dug ponds.	Sandy material; rapid seepage.	Not applicable; high water table.	High water table.
Susceptibility to soil blowing.	Generally too porous to hold water.	Sandy material; rapid seepage.	Sandy substratum; erodible material.	Features favorable.
Susceptibility to frost heaving; unstable material.	Features satisfactory	Fair to poor stability	Favorable; moderately slow permeability.	Fair bearing capacity; moderate shrink-swell potential.
Susceptibility to frost heaving; water table at depth of 2 to 5 feet, and seasonally higher.	Water table at depth of 2 to 5 feet, and seasonally higher; water may be too brackish for ponds.	Poor stability	Not applicable; water table at depth of 2 to 5 feet, and seasonally higher.	Water table at depth of 2 to 5 feet, and seasonally higher.
Susceptibility to frost heaving; unstable material.	Fractured limestone may require compacted seal blanket.	Limited material; fair to poor stability.	Shale and chalk at depth of 20 to 36 inches.	Fair to poor bearing capacity.
Susceptibility to frost heaving; water table at depth of 3 to 7 feet, and seasonally higher.	Water table at depth of 3 to 7 feet, and seasonally higher; water may be too brackish for ponds.	Poor stability	Not applicable; water table at depth of 3 to 7 feet, and seasonally higher.	Water table at depth of 3 to 7 feet, and seasonally higher.
9 to 18 percent slopes; erodible material.	Pervious substratum requires seal blanket.	Poor stability; susceptibility to piping.	Favorable on slopes up to 12 percent.	Poor to fair bearing capacity.
Plastic material; high shrink-swell potential; erodible material.	Features satisfactory	Fair to poor stability; high compressibility.	Bedded clay at shallow depths.	Poor shear strength; high shrink-swell potential.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil limitations for sewage disposal	
	Topsoil	Road fill	Septic tank filter fields	Lagoons
Penrose: PcE, Pd. For properties of Minnequa component of PcE, see Minnequa series in this table.	Poor: thin.	Poor.	Severe: shallow to chalky shale; moderately slow permeability; 5 to 40 percent slopes.	Moderate to severe: 5 to 40 percent slopes.
Pierre: PeC, PsE. For properties of Samsil component of PsE, see Samsil series in this table.	Poor: high in clay content.	Very poor.	Severe: slow permeability.	Moderate: unstable material; 3 to 25 percent slopes.
Richfield: RaA, RaB, RdA. For properties of Altvan component of RaA and RaB, and for properties of Dawes component of RdA, see those series in this table.	Good.	Poor.	Moderate: moderately slow permeability.	Slight to moderate: unstable material.
Rosebud: ReB, RkC. For properties of Canyon component of ReB, and for properties of Keith component of RkC, see those series in this table.	Good.	Fair.	Moderate: moderate permeability; 3 to 9 percent slopes.	Moderate to severe: moderate permeability; 3 to 9 percent slopes.
Samsil: Ss.	Not suitable.	Very poor.	Severe: slow permeability; shallow to bedded shale; 3 to 40 percent slopes.	Severe: unstable material; 3 to 40 percent slopes; shallow to bedded shale.
Swanboy: Sw.	Not suitable.	Very poor.	Severe: very slow permeability.	Moderate: unstable material.
Tassel: TaF. For properties of Anselmo component, see Anselmo series in this table.	Poor: thin.	Fair to good.	Slight to severe: 10 to 40 percent slopes; shallow to bedded sandstone and fine sands.	Severe: moderately rapid permeability; 10 to 40 percent slopes.
Tuthill: TnA, TnC, TuA, TuB, TuC. For properties of Anselmo component of TnA and TnC, and for properties of Manter component of TuA, TuB, and TuC, see those series in this table.	Good.	Good.	Slight.	Moderate: substratum too porous in places.
Ulysses: UcC. For properties of Colby component, see Colby series in this table.	Good.	Fair to poor.	Moderate: moderate permeability.	Moderate to severe: 3 to 9 percent slopes; moderate permeability.
Valentine: VaC, VaD, Vs.	Not suitable.	Good.	Slight.	Severe: very rapid permeability.
Wanblee. Mapped only with soils of Wortman series.	Not suitable.	Very poor.	Severe: slow permeability.	Moderate: unstable material.
Wortman: Ww. For properties of Wanblee component, see Wanblee series in this table.	Fair to depth of 4 to 10 inches.	Poor.	Severe: slow to very slow permeability.	Moderate: unstable material.

[1] Engineers and others should not apply specific values to the estimates of bearing capacity.

interpretations—Continued

Soil features affecting—				
Highways	Farm Ponds		Terraces and diversions	Foundations for low buildings [1]
	Reservoir areas	Embankments		
5 to 40 percent slopes; erodible material.	Fractured limestone may require compacted seal blanket.	Limited material; fair stability.	Shallow to chalky shale	Fair to poor bearing capacity; shallow to chalky shale.
Plastic material; high shrink-swell potential.	Features satisfactory	Fair to poor stability; high compressibility.	Shale at depth of 18 to 40 inches; slow permeability.	Poor shear strength; high shrink-swell potential.
Susceptibility to frost heaving.	Variable substratum may require seal blanket.	Fair to poor stability	Features favorable	Poor bearing capacity.
Moderate susceptibility to frost heaving; erodible material.	Pervious substratum requires seal blanket.	Poor stability; poor compaction; susceptibility to piping.	Sandstone or caliche at depth of 14 to 40 inches.	Fair bearing capacity.
Plastic material; high shrink-swell potential; erodible material.	Usually satisfactory; some seepage in shale crevices.	Limited material; high compressibility.	Shallow to bedded shale.	Shallow to bedded shale; high shrink-swell potential; low shear strength.
Very plastic material; very high shrink-swell potential.	Features satisfactory	Poor stability; high compressibility.	Unstable embankments; very dense clay; difficult to establish vegetation.	Very high shrink-swell potential; low shear strength.
10 to 40 percent slopes; erodible material.	Pervious substratum requires seal blanket.	Fair stability; sandy material; susceptibility to seepage.	Shallow to bedded sandstone and fine sands.	Features favorable.
Fair to good locally	In places too porous to hold water.	Fair stability; susceptibility to seepage.	Features favorable	Features favorable.
Susceptibility to frost heaving; erodible material.	Pervious substratum requires seal blanket.	Poor stability; susceptibility to piping.	Features favorable	Poor to good bearing capacity.
Loose sand hinders hauling; erodible material.	Too porous to hold water	Sandy material; rapid seepage.	Sandy, erodible material	Features favorable.
High susceptibility to frost heaving; unstable material.	Usually satisfactory	Poor stability	Unstable material for embankments.	Poor bearing capacity.
High susceptibility to frost heaving; unstable material.	Usually satisfactory	Poor stability	Unstable material for embankments.	Poor bearing capacity.

county in the classification system. The fourth part gives the results of chemical and physical analyses of selected soils.

Formation of the Soils

The characteristics of the soil at any given point are determined by the interaction of the five major factors of soil formation. These factors are climate, plant and animal life, parent material, relief, and time.

Climate

The climate of Shannon County is semiarid and continental. Seasonal variations in precipitation and temperature are wide. Precipitation also varies from one year to another. In this kind of climate, soil forming is moderately slow. Climatic data are given in the section "General Nature of the County."

The climate is relatively uniform throughout the county, and presumably the characteristics of most soils reflect the kind of climate the county has now. Thus, climate alone does not account for the differences among the soils, but rather the combination of climate with the other four factors.

Plant and animal life

Plants, animals, insects, bacteria, fungi, and earthworms are important in the formation of soils. Among the changes they cause are gains in organic matter, gains or losses in plant nutrients, and changes in structure and porosity. In turn, the kinds of plants and animal life present in a soil or soil material are influenced by climate, parent material, relief, and other factors of biologic environment.

The well-drained, gently sloping soils on uplands have a cover of mid and short grasses. The kinds of grasses vary according to the texture of the soils, but the density is about the same. As a result, the horizons of organic-matter accumulation are of about the same thickness.

The steeper soils on uplands lose more water through runoff. They have a less dense grass cover and a higher proportion of short grasses. Consequently, they have thinner horizons of organic-matter accumulation. The Canyon and Colby soils are examples.

Nearly level soils, and especially the concave soils, often receive runoff. The extra moisture results in dense stands of grass, a larger proportion of mid grasses, and usually some tall grasses. Such soils, of which the Goshen soils are examples, have relatively thick horizons of organic-matter accumulation.

Tall and mid grasses are dominant on the nearly level sites that have a high water table. These sites generally have the greatest accumulation of organic matter, both as to thickness and as to amount.

There are scattered, thin stands of stunted ponderosa pines, generally with an understory of grass. This kind of vegetation appears to have had little or no effect on the formation of the soils.

Some forms of animal life are selective as to the kinds of soil or soil material they inhabit. Earthworm activity is evident in friable, medium-textured soils, such as those of the Goshen, Keith, and Oglala series; but earthworms are rare in excessively drained soils, such as Colby and Canyon soils, which formed in similar materials. No evidence of earthworm activity has been found in fine-textured soils, such as those of the Pierre series, or in coarse-textured soils, such as those of the Valentine series. Burrowing rodents, such as prairie dogs, have been active in areas of Altvan, Goshen, Keith, and Richfield soils.

Man also has altered soils, mainly by cultivating them. In some fields, the A and B horizons have been mixed by tillage, or erosion resulting from tillage has thinned the A horizon. Small cultivated areas of Canyon, Colby, and Epping soils, for example, have lost their thin A horizon or have been mixed with the underlying material to the extent that the A horizon cannot be identified.

Parent material [8]

Parent material is the disintegrated and partly weathered rock from which soil has formed. It determines the limits of the chemical and physical characteristics of soil. Some of the soils of Shannon County formed in material weathered from the underlying geologic formations. Some formed in material transported by wind and water. The parent material influences the soil in several ways. Some kinds of parent material are slow to show the effects of the soil-forming factors of climate, time, and biologic activity. Soils formed in such material inherit from the parent material such characteristics as color, texture, consistence, and sometimes structure. Soil formation progresses somewhat faster in friable, loamy and silty parent material. More change takes place, and soil horizons are more distinct.

Gently sloping to rolling soils that formed in materials weathered from Cretaceous shale occur in the western part of the county. The shale was laid down when a vast sea covered the area. It was covered by later deposits and subsequently exposed as a result of erosion.

The oldest exposed shale in the county is the Carlile Formation. It occurs only as a few eroded exposures; the rest is covered by alluvium.

The Niobrara Formation is in the southwestern part of the county. It consists of silty to clayey chalky shale, marl, and chalk that contains very thin layers of brittle limestone. The weathered materials are calcareous and contain a considerable amount of soft gypsum and varying amounts of selenium (7). Soils form slowly in these materials. The Manvel, Minnequa, and Penrose soils are examples of soils that have inherited characteristics from the Niobrara Formation.

The Pierre Formation, the most extensive of the Cretaceous shale formations in the county, is a dark-gray fissile shale that contains beds of bentonite and seams of limestone, iron, and manganese concretions. Near the White River badlands, the formation is highly weathered and is yellowish brown in color. The Kyle, Pierre, and Samsil soils are examples of soils that have inherited many of their characteristics from the Pierre Formation.

About four-fifths of the county is underlain by formations of the Tertiary System. These formations are of later origin than the Cretaceous. The Tertiary forma-

[8] The assistance of JOHN A. WILSON, geologist, Soil Conservation Service, is acknowledged for the discussion on geologic formations.

tions in this county are the White River Group, the Arikaree Group, the Rosebud Formation, which belongs to an unnamed group, and the Ash Hollow Formation.

The White River Group consists of a succession of clay and silt beds. The lower formation, the Chadron, is mainly greenish-gray, bentonitic silty clay that typically weathers into rounded humps (*1*). Orella soils are an example of soils that formed in materials weathered from the Chadron Formation. The Brule Formation consists of bands of pinkish and grayish siltstone and sandstone interbedded with silty bentonitic claystone (*1*). Kadoka and Epping soils are examples of soils that formed in material weathered from the Brule Formation. The Badlands soil association is made up of eroded beds of the White River Group.

The Arikaree Group is above the White River Group and consists of three formations—the Sharps, the Monroe Creek, and the Harrison. The Sharps Formation is pinkish-tan silt that has many small, calcareous potatoball concretions and a zone of volcanic ash at its base (*4*). The Monroe Creek Formation consists of compact, massive, grayish-buff, sandy silt that has many calcareous, nodular concretions at its base and tends to form vertical escarpments when it is exposed (*4*). The Harrison Formation consists of gray, massive very fine sand and distinct lime-cemented layers.

The Rosebud Formation consists of interbedded pinkish sand, silt, and clay. Concretions and beds of reddish-buff silty clay cemented with silica occur throughout the formation (*4*).

The Ash Hollow Formation represents the Ogallala Group in Shannon County. It occurs only as a prominent, highly dissected caprock and consists of cross-bedded, gritty marl that contains some volcanic ash (*4*).

Canyon, Oglala, Rosebud, and Tassel soils are the main soils that formed in materials weathered from the Arikaree Group, the Rosebud Formation, and the Ash Hollow Formation.

Loess occurs in many parts of the county. The deposits range up to 15 feet in thickness. Most of them mantle the Tertiary formations, but outliers are to be found in the western part of the county. These silty materials furnished the parent material for Colby, Keith, Richfield, and Ulysses soils.

The Pleistocene System is represented by sandhills in the southeastern part of the county. This formation consists of unconsolidated, windblown fine sand. Dunday and Valentine soils are examples of soils that formed in these deposits. Anselmo soils formed in sandy material that contained some silt.

The high terraces and tablelands in the northern part of the county are mantled with alluvium of the late Tertiary to Pleistocene periods. The alluvium consists of stratified layers of sand, gravel, and loamy material. Locally, the surface has been reworked by wind, and in places there is a thin mantle of silty material. Altvan, Anselmo, Manter, Tuthill, and Valentine soils are the main examples of soils that formed in these materials. Alluvial deposits of the Recent period consist of silt, clay, sand, and gravel on bottom lands and low terraces. Bankard and Haverson soils are examples of soils that formed in recent alluvium.

Relief

Relief influences soil formation through its effect on drainage and runoff. Where the slopes are steep, soils form slowly because much of the precipitation is lost in runoff and consequently erosion is active and leaching is slow. Canyon, Colby, Epping, and Samsil soils are examples of soils formed under these conditions. Where the slopes are gentle and runoff is slower, more water enters the soils and soil formation progresses more rapidly. Rosebud, Keith, Kadoka, and Pierre soils formed under such conditions. Deeper soils of more advanced development form on nearly level concave slopes that receive runoff water. Goshen and Dawes soils are examples. Where runoff ponds, soil-forming processes are altered and soils such as those of the Hoven series form.

Time

The length of time that soil material has been exposed to the other four factors of soil formation is reflected in the soils. Some landscapes in this county have been stable for a long time, and the soils on these sites have well-developed genetic horizons. Richfield and Tuthill soils, which are on the high tablelands in the northern part of the county, are good examples. The youngest soils are those that formed in recent alluvium.

Formation of Soil Horizons

The processes that take place in the formation of soil horizons include (1) the accumulation of organic matter, (2) the leaching of calcium carbonate and bases, (3) the reduction and transfer of iron, and (4) the formation and translocation of silicate clay minerals. One or more of these processes have been active in the formation of horizons in the soils of Shannon County.

Bankard and Valentine soils are examples of soils that are very low in organic-matter content; Canyon, Colby, Epping, and Haverson soils are low; Keith, Richfield, and Rosebud soils are moderate; and Goshen, Lamo, and Loup soils are moderately high.

Most of the well-drained soils that formed in loamy or silty material on uplands are leached of carbonates to a depth of 15 to 30 inches. Keith and Rosebud soils are examples. Moderately well drained soils, such as Goshen soils, have been leached to a depth of 22 to 50 inches. Most of the somewhat excessively drained soils and the young alluvial soils have not been leached.

The reduction and transfer of iron, or gleying, occurs only in poorly drained soils, such as Lamo and Loup soils. The gray color of the subsurface horizons indicates reduction and loss of iron. The reddish-brown and yellowish-brown mottles in the horizons of some of these soils indicate segregation of iron.

Many of the soils on uplands in this county have B horizons in which there is a distinct and easily observed accumulation of clay minerals. It is assumed this material was moved by water. Soil scientists generally agree that the leaching of bases usually precedes the formation of a horizon of clay accumulation. Exactly how clay movement proceeds is not clear, but some of the factors associated with the process exist in the parent material in which the soils of this county formed. Among these factors are (1) sufficient clay in the parent material,

(2) the presence of bases as flocculating agents, (3) the presence of dispersion agents, such as sodium, (4) the alternate wetting and drying of the soils, and (5) landscapes that are old enough for the factor of time to be significant. Kadoka, Keith, Richfield, and Tuthill soils are examples of soils affected by this process.

If substantial amounts of sodium, which is a dispersion agent, have accumulated in the clay horizon, the clay is in poor physical condition. If leaching continues and the soil deepens, the sodium is replaced by hydrogen and soils such as those of the Dawes series form.

Classification of the Soils

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

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*3*) and was revised later (*14*). The system currently used was adopted by the National Cooperative Soil Survey in March 1967. This system is under continual study. Readers interested in the development of the system should refer to the latest literature available (*12*, *15*).

The current system of classification defines the classes in terms of observable and measurable properties of soils. It permits the grouping of soils that are similar in morphology and genesis and is designed to accommodate all soils. It 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. The placement of some soil series in the current system, particularly in families, may change as more precise information becomes available. In table 7 the soils of Shannon County are classified according to the current system. Following are brief descriptions of the six categories.

Order

Ten soil orders are recognized. They are: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties

Table 7.—*Classification of soil series in Shannon County*

[The classifications are those of the period during which this survey was written]

Series	Family	Subgroup	Order
Altvan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aridic Argiustolls	Mollisols.
Anselmo	Coarse-loamy, mixed, mesic	Typic Haplustolls	Mollisols.
Bankard	Sandy, mixed, mesic	Ustic Torripsamments	Entisols.
Buffington	Fine, mixed, mesic	Entic Haplustolls	Mollisols.
Canyon	Loamy, mixed, calcareous, mesic, shallow	Typic Ustorthents	Entisols.
Colby	Fine-silty, mixed, calcareous, mesic	Typic Ustorthents	Entisols.
Dawes	Fine, mixed, mesic	Typic Paleustolls	Mollisols.
Dunday	Sandy, mixed, mesic	Entic Haplustolls	Mollisols.
Elsmere	Sandy, siliceous, mesic	Aquic Haplustolls	Mollisols.
Epping	Loamy, mixed, calcareous, mesic, shallow	Typic Ustorthents	Entisols.
Goshen	Fine-silty, mixed, mesic	Pachic Argiustolls	Mollisols.
Haverson	Fine-loamy, mixed, calcareous, mesic	Ustic Torrifluvents	Entisols.
Hisle	Fine, mixed, mesic	Ustollic Natrargids	Aridisols.
Hoven	Fine, mixed, noncalcareous, mesic	Typic Natraquolls	Mollisols.
Kadoka	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Keith	Fine-silty, mixed, mesic	Typic Argiustolls	Mollisols.
Kyle	Very fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Lamo	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Loup	Sandy, mixed, nonacid, mesic	Mollic Psammaquents	Entisols.
Manter	Coarse-loamy, mixed, mesic	Aridic Argiustolls	Mollisols.
Manvel	Fine-carbonatic	Ustic Torriorthents	Entisols.
Minatare	Fine, mixed, mesic	Aquic Natrargids	Aridisols.
Minnequa	Fine-carbonatic, mesic	Ustic Torriorthents	Entisols.
Mosher	Fine, mixed, mesic	Typic Natrustolls	Mollisols.
Oglala	Coarse-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Orella	Clayey, mixed, calcareous, mesic, shallow	Typic Ustorthents	Entisols.
Penrose	Fine-carbonatic, mesic	Lithic Ustic Torriorthents	Entisols.
Pierre	Very fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Richfield	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Rosebud	Fine-loamy, mixed, mesic	Typic Argiustolls	Mollisols.
Samsil	Clayey, mixed, calcareous, mesic, shallow	Typic Ustorthents	Entisols.
Swanboy	Very fine, mixed, mesic	Ustertic Camborthids	Aridisols.
Tassel	Loamy, mixed, calcareous, mesic, shallow	Typic Ustorthents	Entisols.
Tuthill	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Argiustolls	Mollisols.
Ulysses	Fine-silty, mixed, mesic	Typic Haplustolls	Mollisols.
Valentine	Sandy, mixed, mesic	Typic Ustipsamments	Entisols.
Wanblee	Fine, mixed, mesic	Ustollic Natrargids	Aridisols.
Wortman	Fine, mixed, mesic	Typic Natrustolls	Mollisols.

used to differentiate among the soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and the Histosols, which occur in many different climates.

Three soil orders are represented in Shannon County: Entisols, Aridisols, and Mollisols.

Entisols either lack genetic horizons or have only the beginnings of such horizons. Soils of this order in Shannon County were classified as Alluvial soils, Regosols, and Lithosols under the 1938 system.

Aridisols are soils of dry places. They have not had a sufficient accumulation of organic matter to produce a dark color in the uppermost 7 inches. Soils of this order in Shannon County were classified as Brown soils and Solonetz soils under the 1938 system.

Mollisols are friable soils that are high in bases and have a sufficient accumulation of organic matter to be dark colored in the uppermost 7 inches or more. Soils of this order in Shannon County were classified as Chestnut, Solonetz, Planosol, and Humic Gley soils under the 1938 system.

Suborder

Each order is divided into suborders, which are based primarily on soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range allowed in the orders. The soil properties used to separate suborders are those that reflect either the presence or the absence of waterlogging, or those that reflect soil differences resulting from climate or vegetation. (The suborders are not shown separately in table 7, because they are identified by the last part of the second word in the name of the subgroup.)

Great Group

Each suborder is divided into great groups on the basis of similarity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated, or those that have pans that interfere with the growth of roots or the movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition, and the like. (The great groups are not shown separately in table 7, because they are identified by the last word in the name of the subgroup.)

Subgroup

Each great group is divided into subgroups. The soils in one of the subgroups represent the central, or typic, segment of the group; those in the others, called intergrades, have mainly the properties of one group but also one or more properties of another great group, suborder, or order. Some subgroups are made up of soils whose properties intergrade outside the range of any recognized great group, suborder, or order.

Family

Families are established within a subgroup primarily on the basis of properties important in the growth of plants or in the behavior of soils when they are used for engineering. These properties include texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

Series

The series, the lowest category, is a group of soils that have major horizons similar in important characteristics and in sequence in the profile. Soils within a series may differ in the texture of the surface layer.

Laboratory Data

Data obtained by physical and chemical measurements of selected soils in Shannon County are given in table 8.[9] The profiles of the selected soils are described in the section "Descriptions of the Soils." The data in table 8 are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful in estimating water-holding capacity, hazard of soil blowing, fertility, tilth, and other practical aspects of soil management. The data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali areas.

Field and laboratory methods

Samples were collected from carefully selected pits. The samples are considered representative of the soil material that is made up of particles less than three-fourths of an inch in diameter. Estimates of the fraction of the sample consisting of particles more than three-fourths of an inch were made during the sampling. If necessary, the sample was sieved after it was dried and rock fragments more than three-fourths of an inch in diameter were discarded. Then the material made up of particles less than three-fourths of an inch was rolled, crushed, and sieved by hand to remove rock fragments more than 2 millimeters in diameter. The fraction that consists of particles between 2 millimeters and three-fourths of an inch in diameter is recorded on the data sheets as the percentage greater than 2 millimeters. This value is calculated from the total weight of the particles less than three-fourths of an inch in diameter.

The proportions of particles more than three-fourths of an inch and of those between 2 millimeters and three-fourths of an inch are somewhat arbitrary. The accuracy of the data depends on the extent of the preparations, and this varies with the objectives of the study. Both fractions contain relatively unaltered rock fragments more than 2 millimeters in diameter. They do not contain slakable clods of earthy material.

Unless otherwise noted, all laboratory analysis was made on material that passed the 2-millimeter sieve and was ovendry. The values given in table 8 for exchangeable sodium and potassium represent the amounts of sodium and potassium that have been extracted by the ammonium acetate method, minus the amounts that were soluble in the saturation extract.

Methods of the Soil Survey Laboratory were used to obtain most of the data in table 8. Determinations of clay were made by the pipette method (*5*, *6*, *8*). The

[9] Profiles of selected soils in table 8 described by George Buntley, assistant professor of agronomy, South Dakota Agricultural Experiment Station.

TABLE 8.—*Laboratory data*

[Analyses made at Soil Survey Laboratory, Soil Conservation Service, Lincoln,

Soil name, location of sample site, sample number, and laboratory number	Horizon	Depth	Particle-size distribution: Coarse sand (2 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Epping silt loam: 0.8 mi. W. of old road junction and 300 ft. S. of road, SE¼ sec. 20, T. 40 N., R. 41 W. Sample No. S57SD-57-7-(1-3) Laboratory No. 6613-6615	A1	0-2	0.5	0.3	1.8	17.3	60.3	19.8
	C	2-6	.9	.7	2.8	19.3	67.7	8.6
	R	6-20	.7	.8	3.5	25.6	64.3	5.1
Kadoka silt loam: 0.8 mi. W. of old road junction and 200 ft. S. of road, SE¼ sec. 20, T. 40 N., R. 41 W. Sample No. S57SD-57-6-(1-5) Laboratory No. 6608-6612	A1	0-3	.3	.3	1.9	19.0	55.5	23.0
	B21t	3-8	.4	.1	1.1	15.4	49.7	33.3
	B22	8-14	.3	.5	2.6	20.3	59.3	17.0
	B3ca	14-21	.6	.7	3.1	21.2	62.4	12.0
	C&R	21-30	.5	.6	2.8	20.6	66.4	9.1
Keith silt loam: 0.55 mi. W. and 90 ft. S. of fence corner in the NE. corner sec. 15, T. 37 N., R. 48 W. Sample No. S57SD-57-10-(1-10) Laboratory No. 6631-6640	Ap1	0-4	.3	.2	2.7	20.2	55.4	21.2
	Ap2	4-7	.2	.1	2.2	20.2	54.6	22.7
	B21t	7-11	.1	.1	1.9	17.2	53.0	27.7
	B22t	11-15	.1	.1	1.9	18.1	49.8	30.0
	B23t	15-21	.1	----------	1.7	18.8	51.5	27.9
	B24t	21-28	----------	----------	1.2	18.2	52.5	28.1
	B31ca	28-32	----------	----------	1.1	18.1	53.6	27.6
	B32ca	32-39	----------	----------	1.0	13.8	50.3	34.9
	C1ca	39-47	----------	----------	.4	4.5	53.3	41.8
	IIc2ca	47-60	----------	.1	3.6	32.7	49.4	14.2
Kyle clay, alkali: SE¼ sec. 23, T. 38 N., R. 47 W. Sample No. S58SD-57-3-(1-8) Laboratory No. 8869-8876	A1	0-2	.2	.1	.3	2.6	32.1	57.7
	AB	2-6	.2	.1	.2	2.1	36.3	61.1
	B21	6-14	.3	.1	.3	1.9	37.4	60.0
	B22	14-21	.1	(1)	.2	1.9	37.3	60.5
	B31cs	21-27	(1)	(1)	.1	1.5	36.9	61.5
	B32cs	27-38	(1)	(1)	(1)	.9	33.7	65.4
	C1cs	38-44	(1)	(1)	(1)	(1)	35.0	65.0
	C2	44-53	(1)	(1)	(1)	.7	43.9	55.4
Pierre clay: 0.2 mi. S. and 285 ft. E. of NW. corner sec. 13, T. 37 N., R. 48 W. Sample No. S57SD-57-9-(1-7) Laboratory No. 6624-6630	A1	0-3	1.7	.6	1.7	11.5	40.9	43.6
	B21	3-6	.6	.3	.9	8.3	38.9	51.0
	B22	6-11	.4	.2	.7	7.8	39.9	51.0
	B23ca	11-17	.3	.2	.7	7.0	40.1	51.7
	B3ca	17-25	.2	.1	.7	7.8	40.9	50.3
	Ccs	25-36	----------	----------	.5	5.9	44.6	49.0
	R	36-44	.5	----------	.7	8.0	43.5	47.3
Rosebud loam: 780 ft. E. and 65 ft. S. of NW. fence corner sec. 6, T. 35 N., R. 41 W. Sample No. S57SD-57-3-(1-7) Laboratory No. 6592-6598	Ap	0-4	1.0	2.6	13.2	25.4	41.0	16.8
	B1	4-7	.6	2.3	12.0	24.3	37.8	23.0
	B21t	7-10	.7	1.9	9.3	24.1	37.5	26.5
	B22t	10-14	.9	1.9	8.7	27.6	39.0	21.9
	B3ca	14-20	3.3	2.5	8.4	30.8	38.7	16.3
	C1ca	20-25	21.1	12.4	20.2	13.3	15.4	17.6
	C2ca	25-31	28.6	8.3	16.4	14.0	19.5	13.2

[1] Trace.

for selected soil profiles

Nebraska. Dashes indicate values were not determined or do not apply]

Reaction (1:1)	Organic carbon	Electrical conductivity $(Ec \times 10^3)$	$CACO_3$ equivalent	Moisture held at tension of 1/3 atmosphere	Cation exchange capacity (NH_4AC)	Extractable cations (meq. per 100 gm. of soil)					Exchangeable sodium
						Ca	Mg	H	Na	K	
pH	*Pct.*	*Mmho./cm. at 25° C.*	*Pct.*	*Pct.*	*(Meq./100 gm.)*						*Pct.*
7. 3	2. 80	0. 7	1	33. 9	32. 4	------	------	------	0. 1	1. 9	------------
7. 9	. 94	. 5	12	40. 4	30. 3	------	------	------	. 1	2. 0	------------
8. 0	. 13	. 5	8	39. 2	29. 2	------	------	------	. 6	2. 6	2
7. 1	2. 97	. 6	------------	32. 4	28. 0	22. 8	3. 1	3. 3	------	2. 3	------------
7. 0	1. 47	. 4	------------	36. 2	37. 6	29. 9	4. 5	3. 0	. 1	2. 9	------------
7. 5	. 65	. 5	1	39. 1	41. 0	------	------	------	. 2	3. 0	------------
8. 2	. 30	. 6	6	40. 6	37. 2	------	------	------	. 7	3. 3	2
8. 7	. 08	. 6	4	40. 9	37. 2	------	------	------	1. 9	3. 6	4
7. 4	1. 85	. 8	------------	27. 2	24. 4	18. 3	3. 9	2. 1	. 1	3. 7	------------
7. 1	1. 69	. 4	------------	19. 5	24. 0	17. 9	3. 3	2. 9	------	2. 6	------------
7. 2	1. 13	. 4	------------	31. 0	25. 4	18. 3	4. 0	2. 9	. 1	2. 3	------------
7. 2	. 78	. 4	------------	32. 8	27. 2	19. 4	4. 0	2. 5	. 1	2. 4	------------
7. 4	. 74	. 4	------------	34. 7	26. 8	19. 2	5. 2	2. 1	. 2	2. 8	1
7. 5	. 73	. 6	------------	35. 8	28. 0	19. 8	5. 9	1. 7	. 5	3. 6	1
8. 0	. 50	. 7	2	37. 0	28. 9	------	------	------	1. 1	4. 4	3
8. 0	. 37	. 7	8	39. 6	32. 6	------	------	------	2. 0	4. 8	6
8. 1	. 34	. 8	13	46. 3	38. 7	------	------	------	3. 0	5. 7	7
8. 6	. 13	. 8	5	28. 1	22. 9	------	------	------	2. 0	3. 8	8
7. 8	1. 47	. 9	2	39. 4	38. 7	------	------	------	. 8	3. 0	1
8. 0	. 98	. 7	3	44. 5	39. 4	------	------	------	2. 7	1. 8	6
8. 2	. 93	. 8	3	48. 3	38. 0	------	------	------	5. 3	1. 4	12
8. 1	. 91	1. 3	3	49. 2	38. 3	------	------	------	7. 1	1. 5	15
7. 7	. 62	5. 0	3	45. 5	38. 4	------	------	------	8. 0	1. 5	12
7. 7	. 40	5. 0	2	46. 5	40. 9	------	------	------	8. 4	1. 6	13
7. 6	. 30	5. 0	2	47. 1	40. 3	------	------	------	7. 9	1. 6	11
7. 8	. 26	4. 4	2	42. 2	34. 4	------	------	------	6. 8	1. 5	12
7. 3	2. 08	. 7	1	29. 6	30. 3	21. 9	8. 2	2. 5	. 2	1. 4	1
7. 9	1. 24	. 6	4	28. 5	30. 8	------	------	------	. 3	1. 1	1
8. 3	. 75	. 6	5	28. 1	29. 2	------	------	------	1. 0	. 8	3
8. 4	. 52	. 7	5	31. 0	28. 4	------	------	------	2. 2	. 7	6
8. 2	. 42	1. 6	4	32. 0	27. 7	------	------	------	3. 5	. 7	9
7. 5	. 23	5. 5	3	33. 6	27. 9	------	------	------	4. 2	. 8	7
7. 5	. 19	5. 0	2	33. 2	27. 7	------	------	------	4. 0	. 8	8
6. 9	1. 24	. 9	1	18. 3	16. 9	12. 2	2. 3	3. 3	------	1. 9	------------
7. 1	. 97	. 9	------------	21. 6	20. 1	16. 1	2. 6	2. 9	------	1. 5	------------
7. 6	. 61	. 6	------------	23. 7	23. 8	19. 7	3. 1	2. 1	------	1. 3	------------
7. 8	. 67	. 6	1	21. 6	23. 0	22. 1	3. 2	. 8	------	1. 1	------------
8. 1	. 52	. 6	9	21. 4	18. 5	------	------	------	------	1. 0	------------
8. 2	. 30	. 7	15	17. 9	14. 1	------	------	------	------	1. 0	------------
8. 3	. 21	. 8	27	22. 4	10. 9	------	------	------	. 1	1. 2	1

reaction of the saturated paste and that of a 1:1 water suspension were measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*9*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of adsorbed ammonia (*9*). To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate and magnesium as magnesium ammonium phosphate (*9*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*10*). Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

General Nature of the County

Shannon County was established in 1875. In 1883 the county was divided and the northern part was established as Washington County; but in 1943 the two counties were combined, and the present boundary is essentially the same as it was in 1875.

The development of the county has been closely related to the history of the Oglala Sioux Indians. The Bureau of Indian Affairs agency headquarters for the Oglala has been located at Pine Ridge since 1878.

Fur traders, trappers, and missionaries were the first white settlers. By an act of Congress in 1910, nonalloted land was opened to homesteaders. Most of the non-Indian land was acquired after 1920 through purchases of Indian allotments.

In 1960 the population was 6,000, predominantly Indian. The Indian population is larger than that of any other county in the State, both as to number and as to percentage (*11*).

No railroad passes through this county. U.S. Highway 18 crosses the southern part from east to west, and State Highway 75 branches off to Gordon, Nebraska. State highways also connect Pine Ridge with Rushville, Nebraska. These are the main routes to markets outside the county. Hard-surfaced and gravelled secondary roads connect Indian villages, schools, and trading stores.

All agricultural products are marketed outside the county. Much of the livestock is sold through barns in adjacent counties, but some is shipped by truck to central markets at Omaha or Sioux City or is shipped on direct consignment to corn-belt feeders. Most of the wheat and other grain is marketed at elevators at Gordon, Rushville, and Chadron, Nebraska.

Shannon County has elementary schools at Batesland, Denby, Sharps Corner, and Pine Ridge. Most of the Indian children attend Federal schools operated by the Bureau of Indian Affairs. These include a high school at Pine Ridge and elementary schools at Oglala, Pine Ridge, Manderson, Wounded Knee, Porcupine, and Kyle.

Churches of several faiths are at Batesland, Pine Ridge, Wounded Knee, Manderson, Porcupine, and Kyle. The community life of much of the Indian population centers around the reservation headquarters, schools, and church missions at Pine Ridge, Wounded Knee, Manderson, Porcupine, and Kyle. In August of each year, the Oglala tribe sponsors the Sun Dance. The community life of the farm population in the southeastern part of the county centers on church, school, and farm organization activities at Batesland.

Local rodeos, amateur baseball, hunting, fishing, golf, and swimming provide most of the recreation. A golf course and swimming pool are at Pine Ridge. Agates and fossils can be found in areas of Badlands. The site of the battle of Wounded Knee is a well-known historical site.

Ground water of good quality occurs in much of the county, except in associations 6, 7, 8, and 11. (See the General Soil Map at the back of this publication for the location of these associations.) In these areas it is necessary to collect surface water for livestock. The Cheyenne River and the White River are flowing streams, but the potential for pump irrigation along the White River is limited by low summer flow. Some of the tributary creeks flow enough in most years to provide water for livestock.

Climate [10]

Shannon County, located in southwestern South Dakota and immediately to the lee of the Black Hills, has a semiarid climate characterized by cold winters and hot summers. Normally, precipitation is light in winter and is marginal for crops during the growing season. No large bodies of water are near enough to affect the climate.

Table 9 gives data on temperature and precipitation recorded at the U.S. Weather Bureau at Pine Ridge, which is in the extreme south-central part of the county.

Table 10 shows the probabilities of specified temperatures after certain dates in spring and before certain dates in fall.

This county has wide seasonal and daily variations in temperature. Temperatures of 100°F. or more can be expected about 2 years out of 3 in June, 4 days each year in July, and 3 days each year in August. The temperature falls to 30° below zero or lower about once in 2 years, and to 20° below zero or lower on an average of about 3 days each year. On the average, the temperature falls to zero or lower on 19 days each year and fails to climb above zero 1 day each year.

The average annual precipitation at Pine Ridge is 16.33 inches. Of this amount, 12.68 inches, or about 78 percent, falls during the growing season, April through September. The amount of precipitation during the growing season has ranged from 9.60 inches, in 1936, to 27.78 inches, in 1942. Thunderstorms of widely varying intensity are the main source of rainfall during the growing season. About once in 2 years, 1 inch or more of rain falls in 1 hour; about once in 20 years, 2 inches or more falls in 1 hour; about once in 2 years, 2 inches or more falls in a 24-hour period; and about once in 15 years, 3 inches or more falls in a 24-hour period.

Snow cover effectively protects pastures and fall-seeded crops, but too heavy a cover hinders farmwork

[10] By WALTER SPUHLER, State climatologist, U.S. Weather Bureau, Brookings, S. Dak.

TABLE 9.—*Temperature and precipitation*

[All data obtained from records at Pine Ridge for the period 1933–63. Elevation 3,210 feet]

Month	Temperature				Precipitation						Average number of days with—	
	Average daily maximum	Average daily minimum	Two years in 10 will have— Maximum temperature equal to or higher than—	Two years in 10 will have— Minimum temperature equal to or lower than—	Average total	Maximum total	Minimum total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Average total snowfall	Snowfall of 1 inch or more	Depth of snow cover 1 inch or more
	°F.	°F.	°F.	°F.	In.	In.	In.	In.	In.	In.		
January	36.9	9.0	42.4	3.1	0.44	1.81	0	0.35	1.51	5.3	2	8
February	40.5	12.8	47.2	7.1	.47	1.44	0	.38	.95	5.4	2	7
March	48.2	21.1	54.1	16.3	.97	2.55	.26	.37	1.94	7.5	3	5
April	61.0	31.8	65.9	29.0	1.77	5.28	.34	.49	3.46	3.6	1	1
May	71.3	42.7	75.2	40.1	3.09	10.03	.37	1.02	4.00	.9	(1)	(1)
June	81.2	51.9	84.8	48.8	3.13	10.90	.23	1.12	4.43	0	0	0
July	90.9	58.1	98.2	54.4	2.00	5.39	.34	.69	4.38	0	0	0
August	89.6	56.4	93.6	53.1	1.51	6.32	.06	.21	3.13	0	0	0
September	79.9	45.0	83.6	42.0	1.18	3.65	.05	.38	2.66	0	0	0
October	67.9	34.2	72.5	30.0	.88	2.71	0	.13	1.88	.6	(1)	(1)
November	50.4	21.1	55.6	17.8	.56	2.90	0	.24	1.12	3.9	1	3
December	40.9	14.5	44.2	11.3	.33	.76	0	.14	.62	3.6	2	7
Year	63.2	33.2			16.33	27.78	9.60	12.00	20.82	30.8	11	31

[1] Less than 0.5 day.

TABLE 10.—*Probabilities of specified temperatures after specified dates in spring and before specified dates in fall*

[Data obtained from records at Pine Ridge, 1933–63. Table prepared by WILLIAM F. LYTLE, South Dakota State University]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
After specified dates in spring:						
90 percent	March 13	March 23	April 3	April 13	April 22	May 7
70 percent	March 18	March 29	April 8	April 18	April 28	May 12
50 percent	April 5	April 16	April 27	May 5	May 19	May 30
30 percent	April 21	May 3	May 14	May 22	June 8	June 17
10 percent	April 26	May 8	May 20	May 26	June 14	June 22
Before specified dates in fall:						
10 percent	October 10	September 30	September 18	September 7	August 31	August 8
30 percent	October 15	October 5	September 23	September 11	September 4	August 14
50 percent	November 2	October 23	October 12	September 27	September 20	September 8
70 percent	November 19	November 9	October 30	October 13	October 5	October 1
90 percent	November 24	November 14	November 4	October 17	October 9	October 8

in winter. The average annual snowfall at Pine Ridge is about 31 inches; but as much as 54 inches fell in the winter of 1955–56, and as little as 14 inches fell in the winter of 1960–61. The heaviest 1-day snowfall was 14 inches. On the average, 1 inch or more covers the ground 31 days each year. In 1952 there was a snow cover of 1 inch or more on 116 days; in 1934, on no day. Strong winds, which often accompany snowfall, commonly blow snow into or near sheltered areas and leave open areas nearly bare.

In an average year, sunshine can be expected about two-thirds of the daylight hours in the growing season and about three-fourths of the daylight hours in July and August, the sunniest months.

Southeast winds of 10 to 11 miles an hour prevail in summer. Northwest winds of 11 to 12 miles an hour prevail in winter. Winds of 50 miles an hour or more can occur during any month but are most likely in summer, during thunderstorms. Thunderstorms can be expected about 11 times in June, 11 times in July, 9 times in August, 8 times in May, and 4 times in September. They are less frequent in other months. The annual total is about 45.

The relative humidity averages 80 percent early in the morning and 50 percent in the afternoon.

The average annual pan evaporation in Shannon County is about 59 inches. The average from May through October is about 45 inches. The rate of evaporation from small lakes is about 70 percent of that from the pan. Water loss from soil and crops is generally less.

Farming

Livestock raising and dryland farming are the main agricultural enterprises in Shannon County. Mainly because of the mechanization of farm and ranch operations, the trend is toward fewer operating units and larger farms and ranches. According to the 1964 Census of Agriculture, the total land area is 1,344,000 acres, and 99.1 percent of this is in farms. In 1964 there were 200 farms. The average size was 6,656.9 acres. Of the 200 farms, 31 were classified as cash-grain farms, 141 as livestock farms and ranches, 4 as general farms, and 24 as miscellaneous or unclassified. There were 178 commercial farms. The cash-grain farms and many of the livestock farms are in the southeastern part of the county.

Livestock reported in the 1964 census included 36,957 cattle and calves on 178 farms, 1,188 hogs and pigs on 24 farms, 692 sheep and lambs on 6 farms, and 3,567 chickens on 78 farms.

The major crops are winter wheat, alfalfa, barley, corn, and oats. According to the 1964 census, winter wheat was harvested from 16,845 acres, alfalfa and alfalfa mixtures cut for hay from 7,448 acres; barley from 1,827 acres; corn from 1,347 acres; and oats from 4,889 acres. Smaller acreages were in spring wheat, rye, sorghum, and potatoes. Alfalfa seed was harvested from 1,261 acres.

Information about the past history of cropping and livestock raising in Shannon County can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service (*13*).

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Bentonitic. Containing a significant amount of bentonite, a clay mineral with swelling properties when moist.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Calcareous. Containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Carbonate. A compound formed when calcium, magnesium, or another element combines with carbon and oxygen.

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; will 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.

Eolian soil material. Soil material accumulated through wind action; commonly refers to sandy material in dunes.

Erosion. The wearing away of the land surface by wind, 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 (or tilth) of the soil, are favorable.

Gravel. Rounded or angular rock fragments that are not prominently flattened and are up to 3 inches in diameter.

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 the following: 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 A horizon to the C horizon. The B horizon also has distinctive characteristics caused by (1) accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. The A and B horizons combined 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.

Leaching. The removal of soluble materials from soils or soil material by percolating water.

Limy. Calcareous.

Loess. A fine-grained, wind-transported deposit consisting dominantly of silt-sized particles.

Permeability. The quality that enables a 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

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil that contains soluble salts in amounts that impair growth of crop plants but that does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a textural class, soil that 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 (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer beneath the solum, or true soil.

Tablelands. Relatively smooth-surfaced landforms that are at levels generally above surrounding uplands.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, a 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.

Terrace (mechanical). An embankment or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus 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.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of 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-holding capacity. The capacity of a soil to hold water in a form available to plants. Often expressed in either inches of water per inch of soil depth or in inches of water per foot of soil depth. Also referred to as available water holding capacity in this survey.

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.

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Range site		Capability unit		Windbreak group	
			Name	Page	Symbol	Page	Number	Page
PsE	Pierre-Samsil clays, 9 to 25 percent slopes	37	----	--	--	--	--	--
	Pierre part	--	Clayey	50	VIe-1	58	3	62
	Samsil part	--	Shallow	50	VIs-2	58	None	--
RaA	Richfield and Altvan silt loams, 0 to 3 percent slopes	38	----	--	--	--	--	--
	Richfield part	--	Silty	50	IIc-1	55	2	62
	Altvan part	--	Silty	50	IIIs-2	56	2	62
RaB	Richfield and Altvan silt loams, 3 to 5 percent slopes	39	----	--	--	--	--	--
	Richfield part	--	Silty	50	IIe-1	55	2	62
	Altvan part	--	Silty	50	IIIe-1	55	2	62
RdA	Richfield-Dawes silt loams, 0 to 3 percent slopes	39	----	--	--	--	--	--
	Richfield part	--	Silty	50	IIc-1	55	2	62
	Dawes part	--	Silty	50	IIIs-1	56	3	62
ReB	Rosebud-Canyon loams, 5 to 9 percent slopes	40	----	--	--	--	--	--
	Rosebud part	--	Silty	50	IIIe-1	55	2	62
	Canyon part	--	Shallow	50	VIs-2	58	None	--
RkC	Rosebud-Keith silt loams, 3 to 9 percent slopes	41	Silty	50	IIe-1	55	2	62
Ss	Samsil-Shale outcrop complex	42	----	--	--	--	--	--
	Samsil part	--	Shallow	50	VIIs-2	59	None	--
	Shale outcrop part	--	None	--	VIIIs-1	59	None	--
Sw	Swanboy clay	43	Dense Clay	51	VIIs-1	59	None	--
TaF	Tassel-Anselmo complex, 10 to 40 percent slopes	43	----	--	--	--	--	--
	Tassel part	--	Shallow	50	VIs-2	58	None	--
	Anselmo part	--	Sandy	50	VIe-2	58	1	62
Te	Terrace escarpments	43	Shallow	50	VIIs-2	59	None	--
TnA	Tuthill and Anselmo fine sandy loams, 0 to 3 percent slopes	44	Sandy	50	IIIe-2	55	1	62
TnC	Tuthill and Anselmo fine sandy loams, 3 to 9 percent slopes	44	Sandy	50	IVe-3	57	1	62
TuA	Tuthill and Manter soils, 0 to 3 percent slopes	45	----	--	--	--	--	--
	Tuthill part	--	Silty	50	IIIe-2	55	1	62
	Manter part	--	Sandy	50	IIIe-2	55	1	62
TuB	Tuthill and Manter soils, 3 to 5 percent slopes	45	----	--	--	--	--	--
	Tuthill part	--	Silty	50	IIIe-3	55	1	62
	Manter part	--	Sandy	50	IIIe-3	55	1	62
TuC	Tuthill and Manter soils, 5 to 9 percent slopes	45	----	--	--	--	--	--
	Tuthill part	--	Silty	50	IVe-3	57	1	62
	Manter part	--	Sandy	50	IVe-3	57	1	62
UcC	Ulysses-Colby complex, sand substratum, 3 to 9 percent slopes	45	----	--	--	--	--	--
	Ulysses part	--	Silty	50	IIIe-1	55	2	62
	Colby part	--	Thin Upland	51	IVe-5	57	2	62
VaC	Valentine fine sand, rolling	46	Sands	49	VIe-2	58	7	62
VaD	Valentine fine sand, hilly	46	Choppy Sands	50	VIIe-1	59	7	62
Vs	Valentine sand	46	Sands	49	VIe-2	58	7	62
Ww	Wortman-Wanblee complex	48	----	--	--	--	--	--
	Wortman part	--	Claypan	50	IVs-2	58	5	62
	Wanblee part	--	Thin Claypan	51	VIs-1	58	None	--

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Range site Name	Range site Page	Capability unit Symbol	Capability unit Page	Windbreak group Number	Windbreak group Page
KaA	Kadoka silt loam, 0 to 3 percent slopes-----	24	Silty	50	IIIc-1	56	2	62
KaB	Kadoka silt loam, 3 to 5 percent slopes-----	24	Silty	50	IIIe-1	55	2	62
KaC	Kadoka silt loam, 5 to 9 percent slopes-----	24	Silty	50	IVe-2	57	2	62
KbC	Kadoka-Epping silt loams, 3 to 9 percent slopes-------------------------------------	24	----	--	--	--	--	--
	Kadoka part----------------------------	--	Silty	50	IIIe-1	55	2	62
	Epping part----------------------------	--	Shallow	50	VIs-2	58	None	--
KeA	Keith silt loam, 0 to 3 percent slopes------	25	Silty	50	IIc-1	55	2	62
KeB	Keith silt loam, 3 to 5 percent slopes------	26	Silty	50	IIe-1	55	2	62
KhD	Keith-Colby silt loams, 9 to 12 percent slopes-------------------------------------	26	----	--	--	--	--	--
	Keith part-----------------------------	--	Silty	50	IVe-1	56	2	62
	Colby part-----------------------------	--	Thin Upland	51	IVe-5	57	2	62
KhE	Keith-Colby silt loams, 12 to 18 percent slopes-------------------------------------	26	----	--	--	--	--	--
	Keith part-----------------------------	--	Silty	50	VIe-1	58	2	62
	Colby part-----------------------------	--	Thin Upland	51	VIe-1	58	2	62
KrA	Keith-Rosebud silt loams, 0 to 3 percent slopes-------------------------------------	26	Silty	50	IIc-1	55	2	62
KuC	Keith and Ulysses silt loams, 5 to 9 percent slopes-------------------------------------	26	Silty	50	IIIe-1	55	2	62
KyA	Kyle clay, alkali, 0 to 3 percent slopes----	28	Clayey	50	IVs-1	58	None	--
KyB	Kyle clay, alkali, 3 to 5 percent slopes----	28	Clayey	50	VIe-1	58	None	--
KzA	Kyle silty clay, 0 to 3 percent slopes------	28	Clayey	50	IVs-1	58	3	62
Le	Lamo-Elsmere complex-----------------------	29	----	--	--	--	--	--
	Lamo part------------------------------	--	Subirrigated	49	Vw-1	58	4	62
	Elsmere part---------------------------	--	Subirrigated	49	IVw-1	57	4	62
Lm	Loamy land---------------------------------	29	Silty	50	VIe-1	58	2	62
Ls	Loup soils---------------------------------	30	Subirrigated	49	Vw-1	58	4	62
McB	Manvel silty clay loam, 0 to 5 percent slopes-------------------------------------	31	Thin Upland	51	IVe-5	57	3	62
Me	Minatare soils-----------------------------	32	Saline Low-land	49	VIs-1	58	6	62
MgD	Minnequa silty clay loam, 5 to 12 percent slopes-------------------------------------	33	Thin Upland	51	VIe-1	58	3	62
Mm	Mosher-Minatare complex--------------------	34	----	--	--	--	--	--
	Mosher part----------------------------	--	Claypan	50	IVs-2	58	5	62
	Minatare part--------------------------	--	Thin Claypan	51	VIs-1	58	None	--
OcE	Oglala-Canyon complex, 9 to 18 percent slopes-------------------------------------	34	----	--	--	--	--	--
	Oglala part----------------------------	--	Silty	50	VIe-1	58	2	62
	Canyon part----------------------------	--	Shallow	50	VIs-2	58	None	--
OeC	Orella clay, 0 to 9 percent slopes----------	35	Shallow	50	VIs-2	58	None	--
Os	Orella-Shale outcrop complex---------------	35	----	--	--	--	--	--
	Orella part----------------------------	--	Shallow	50	VIs-2	58	None	--
	Shale outcrop part---------------------	--	None	--	VIIIs-1	59	None	--
PcE	Penrose and Minnequa silty clay loams, 5 to 20 percent slopes------------------------	36	----	--	--	--	--	--
	Penrose part---------------------------	--	Shallow	50	VIs-2	58	None	--
	Minnequa part--------------------------	--	Thin Upland	51	VIe-1	58	3	62
Pd	Penrose-Rock outcrop complex---------------	36	----	--	--	--	--	--
	Penrose part---------------------------	--	Shallow	50	VIIs-2	59	None	--
	Rock outcrop part----------------------	--	None	--	VIIIs-1	59	None	--
PeC	Pierre clay, 3 to 9 percent slopes----------	37	Clayey	50	IVe-6	57	3	62

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in the tables as follows:

Acreage and extent, table 1, p. 11.
Predicted yields, table 2, p. 60.
Windbreaks, table 3, p. 61.
Engineering uses of the soils, table 4, p. 64; table 5, p. 66; and table 6, p. 70.

Map symbol	Mapping unit	Described on page	Range site		Capability unit		Windbreak group	
			Name	Page	Symbol	Page	Number	Page
Aa	Alluvial land	10	Overflow	49	VIw-1	58	4	62
AsB	Anselmo sandy loam, 0 to 5 percent slopes	12	Sandy	50	IIIe-2	55	1	62
AsC	Anselmo sandy loam, 5 to 9 percent slopes	13	Sandy	50	IVe-3	57	1	62
AvE	Anselmo-Valentine complex, 5 to 20 percent slopes	13	---	--	--	--	--	--
	Anselmo part	--	Sandy	50	VIe-2	58	1	62
	Valentine part	--	Sands	49	VIe-2	58	7	62
Ba	Badlands	13	---	--	--	--	--	--
	Barren broken areas	--	None	--	VIIIs-1	59	None	--
	Clayey soils	--	Clayey	50	VIe-1	58	3	62
	Loamy soils	--	Silty	50	VIe-1	58	2	62
Bk	Bankard loamy sand	14	Overflow	49	VIe-2	58	1	62
Br	Barren badlands	14	None	--	VIIIs-1	59	None	--
Bu	Buffington silty clay loam	14	Clayey	50	IIIc-2	56	2	62
CaF	Canyon association, 18 to 40 percent slopes	15	---	--	--	--	--	--
	Canyon part	--	Shallow	50	VIIs-2	59	None	--
	Oglala and Rosebud parts	--	Silty	50	VIe-1	58	2	62
Cc	Canyon-Rock outcrop association	15	---	--	--	--	--	--
	Canyon part	--	Shallow	50	VIIs-2	59	None	--
	Rock outcrop part	--	None	--	VIIIs-1	59	None	--
Cy	Clayey land	15	Clayey	50	VIe-1	58	3	62
DvB	Dunday-Valentine complex, 0 to 5 percent slopes	17	---	--	--	--	--	--
	Dunday part	--	Sandy	50	IVe-4	57	1	62
	Valentine part	--	Sands	49	VIe-2	58	7	62
Ef	Elsmere-Loup loamy fine sands	18	---	--	--	--	--	--
	Elsmere part	--	Subirrigated	49	IVw-1	57	4	62
	Loup part	--	Subirrigated	49	Vw-1	58	4	62
EhF	Epping complex, 9 to 40 percent slopes	19	---	--	--	--	--	--
	Epping part	--	Shallow	50	VIIs-2	59	None	--
	Kadoka part	--	Silty	50	VIe-1	58	2	62
EkE	Epping-Kadoka silt loams, 9 to 18 percent slopes	19	---	--	--	--	--	--
	Epping part	--	Shallow	50	VIs-2	58	None	--
	Kadoka part	--	Silty	50	VIe-1	58	2	62
Er	Epping-Rock outcrop complex	19	---	--	--	--	--	--
	Epping part	--	Shallow	50	VIIs-2	59	None	--
	Rock outcrop part	--	None	--	VIIIs-1	59	None	--
GoA	Goshen silt loam, 0 to 3 percent slopes	20	Overflow	49	IIc-1	55	2	62
Gr	Gravelly land	20	Shallow	50	VIIs-2	59	None	--
HhA	Haverson loam, high, 0 to 3 percent slopes	21	Silty	50	IIIc-2	56	2	62
HlA	Haverson loam, low, 0 to 3 percent slopes	21	Overflow	49	IIIw-1	56	2	62
HoA	Haverson silty clay loam, 0 to 3 percent slopes	21	Overflow	49	IIIw-1	56	2	62
Hs	Hisle clay	22	Thin Claypan	51	VIs-1	58	None	--
Ht	Hisle-Swanboy clays, saline	22	Saline Lowland	49	VIs-1	58	None	--
Hv	Hoven silt loam	23	Closed Depression	49	VIs-1	58	None	--

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