SOIL SURVEY OF

Union County, South Dakota

United States Department of Agriculture
Soil Conservation Service
In cooperation with
South Dakota Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1971 to 1974. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1974. This survey was made cooperatively by the Soil Conservation Service and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Union County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

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

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

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

Community planners and others can read about soil properties that affect the choice of sites for nonindustrial buildings and for recreation areas in the section "Land Use Planning."

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

Scientists and others can read about the soils in the section "Formation and Classification of the Soils."

Newcomers in Union County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: **Typical scene on Moody-Nora-Alcester association.**

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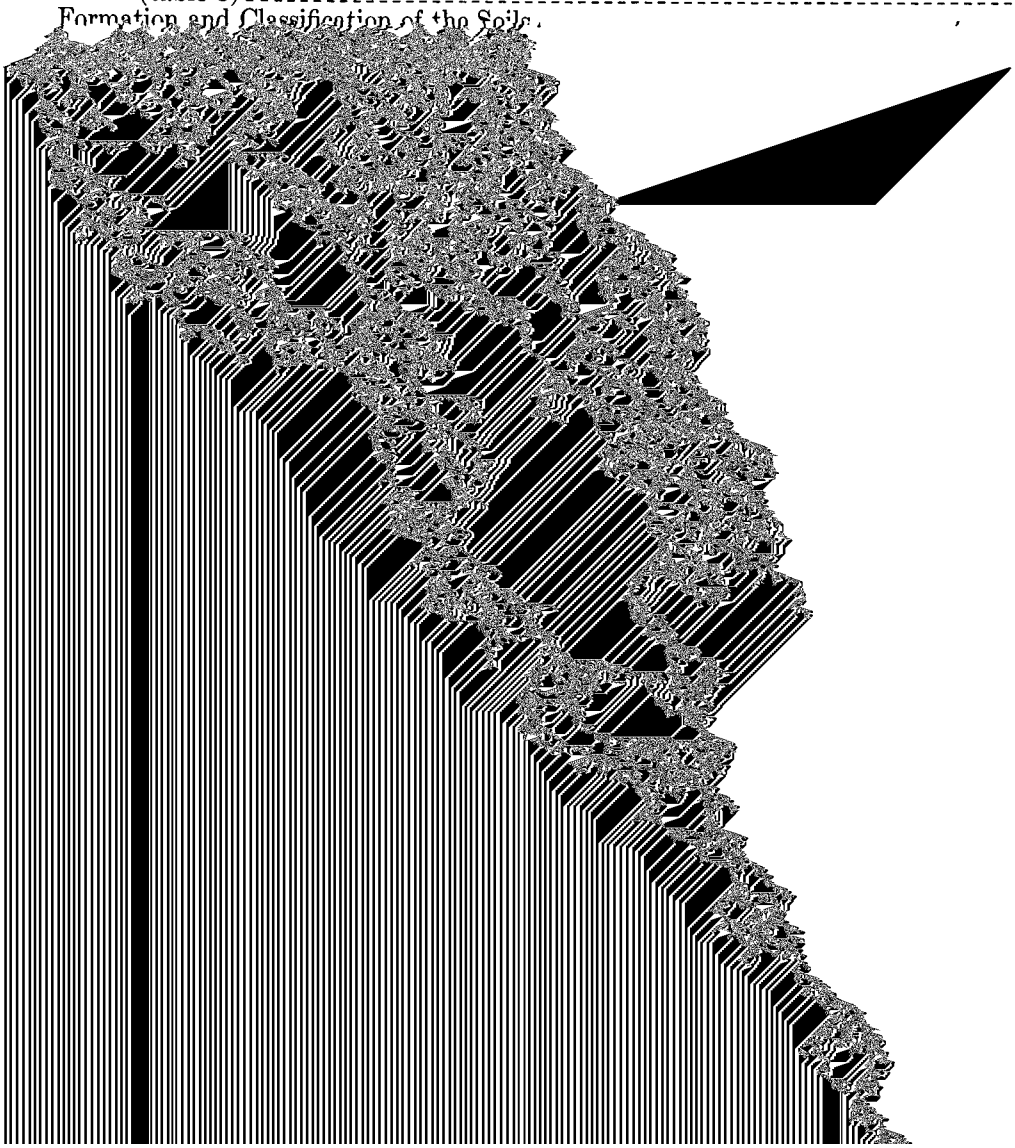
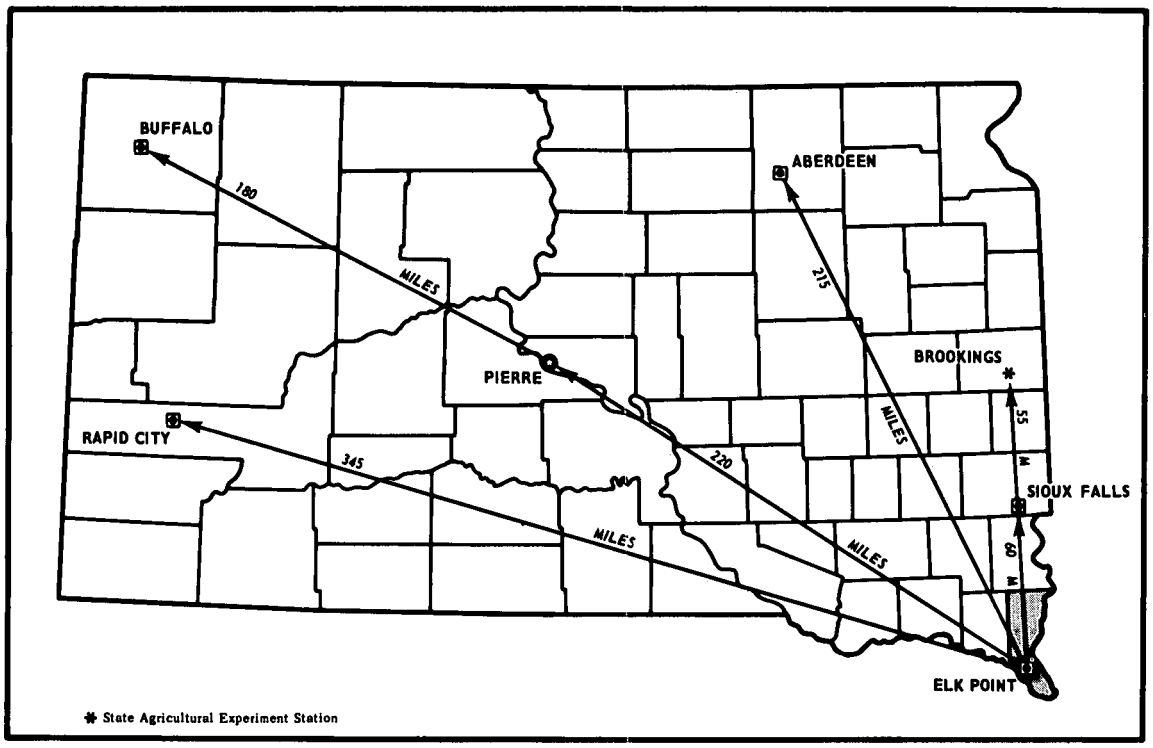




Location of Union County in South Dakota.

SOIL SURVEY OF UNION COUNTY, SOUTH DAKOTA

By James L. Driessen

Fieldwork by James L. Driessen and Regis Vialle, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with the South Dakota Agricultural Experiment Station

UNION COUNTY is in the extreme southeastern corner of South Dakota in the fork of the Big Sioux and Missouri Rivers (see facing page). It has a land area of 289,216 acres and a total area of 298,240 acres. Beresford is the largest town, and Elk Point is the county seat. Other towns are Alcester, Jefferson, and North Sioux City. North Sioux City is an extension of Sioux City, Iowa.

Elevation ranges from less than 1,100 feet along the two rivers in the southeastern tip of the county to about 1,500 feet in the northwest. About half the acreage of the county is bottom land of the Big Sioux and Missouri Rivers. Relief in this part of the county is level to nearly level. Relief is rolling in much of the northern part of the county, nearly level to gently undulating on the uplands in the west, and hilly to steep in areas adjacent to the valleys of the Big Sioux River and its tributaries.

General livestock farming is the main enterprise and the main source of income. About 93 percent of the acreage is in farms, and about 82 percent of it is cropped. Corn, soybeans, oats, and alfalfa are the main crops. Barley, sorghum, and wheat are also grown. Beef cattle and swine are the main types of livestock.

Controlling erosion is a major concern in the management of cropland on uplands. Providing adequate drainage is a major concern on bottom lands. Maintaining fertility and tilth is a concern on all soils used for crops. Interest in irrigating some of the better drained soils on bottom lands is increasing. The southeastern tip of the county is subject to urbanization as the urban area around Sioux City, Iowa, expands.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Union County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Alcester and Worthing, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Moody silty clay loam, 0 to 2 percent slopes, is one of several phases within the Moody series.

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

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

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

A soil complex consists of areas of two or more soils so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all

areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Egan-Shindler complex, 2 to 6 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of

The boundaries of the soil associations in Union County match those of the previously published survey of Lincoln County, but there are some differences in the names because of differences in the extent of soils observed in mapping and classification. These differences do not significantly alter interpretations.

The soil associations in this survey area have been grouped

soils on narrow bottom lands, Chancellor soils in swales, Egan soils intermingled with Wentworth soils on rises, and Wakonda soils on the rim of depressions and on the edge of swales.

The major soils have medium to high fertility and high available water capacity. Permeability is moderate in Wentworth soils and slow in Worthing soils. Shindler soils have moderate permeability in the subsoil and moderately slow permeability in the underlying material. Runoff is slow to medium on Shindler and Wentworth soils, and it ponds on Worthing soils. Controlling erosion and maintaining fertility are the main concerns of management. Controlling wetness and maintaining tilth on Worthing soils are also concerns.

Almost all of this association is cultivated. Corn, oats, soybeans, and alfalfa are the main crops. Pastures are small and commonly near farmsteads. The potential for cultivated crops and pasture and hay plants is high.

2. *Wakonda-Worthing-Chancellor association*

Deep, moderately well drained to poorly drained, nearly level and level, silty soils

This soil association is on a broad upland plain. The areas consist of very slight rises that are 1 to 3 feet above many closed depressions and shallow swales. Slopes are mostly nearly level, but the flat-bottomed depressions are level. The drainage pattern is poorly defined, although the heads of a few drainageways are on the edges of the mapped area.

This association makes up about 5 percent of the county. It is about 35 percent Wakonda soils, 25 percent Worthing soils, 25 percent Chancellor soils (fig. 1), and 15 percent minor soils.

Wakonda soils are moderately well drained and are on very slight rises. The surface layer is calcareous, grayish brown silt loam. The underlying material is calcareous, light yellowish brown silt loam. Spots and streaks of gypsum salts are in the underlying material below a depth of 31 inches.

Worthing soils are poorly drained and are in depressions. The surface layer is dark gray silty clay loam. The subsoil is dark gray and gray silty clay. The underlying material is calcareous, light olive gray and olive yellow silty clay loam.

Chancellor soils are somewhat poorly drained and are in swales and on the rims of depressions. The surface layer is dark gray silty clay loam. The subsoil is dark gray and grayish brown silty clay in the upper part and light olive gray silty clay loam in the lower part. The underlying material is calcareous, light yellowish brown and gray silty clay loam.

The minor soils in this association are nearly level to gently sloping, well drained Egan and Wentworth soils on rises.

Runoff is slow in much of this association and ponds on the Worthing soils. Permeability is moderate in Wakonda

Soils That Formed Mostly in Loess; on Uplands

The two soil associations in this group consist mainly of deep, well drained, silty soils that formed in loess, but there are moderately well drained soils that formed in local alluvium on foot slopes, on fans, and on narrow bottom lands along small streams and drainageways. Slopes are long and smooth. The soils are mostly gently sloping to strongly sloping, but some are nearly level; others are strongly sloping to very steep along drainageways and on the valley sides of the Big Sioux River.

These associations make up 38 percent of the county. The soils are used mostly for crops, but the steeper soils are used for pasture and hay. Some areas are moderately to severely eroded. Controlling erosion is a major management concern.

3. *Moody-Nora-Alcester association*

Deep, well drained and moderately well drained, nearly level to sloping, silty soils

This soil association is on an upland plain that is mantled by silty loess. Slopes are long and smooth and are mostly gently sloping, but some are nearly level or sloping. The drainage pattern is well defined.

This association makes up about 12 percent of the county. It is about 50 percent Moody soils, 15 percent Nora soils, 15 percent Alcester soils, and 20 percent minor soils.

Moody soils are nearly level to sloping and are well drained. They have slightly concave to slightly convex slopes. The surface layer and the upper part of the subsoil are dark grayish brown silty clay loam. The middle of the subsoil is brown and pale brown silty clay loam, and the lower part is pale brown silt loam. The underlying material is calcareous, light yellowish brown silt loam.

Nora soils are mostly sloping and are well drained. They have long, smooth, mostly convex slopes. The surface layer is dark grayish brown silty clay loam. The upper part of the subsoil is brown silt loam. The lower part of the subsoil and the underlying material are calcareous, light yellowish brown silt loam.

Alcester soils are gently sloping and moderately well drained. They are on foot slopes and in narrow drainageways. The surface layer is dark grayish brown silt loam. The subsoil is dark grayish brown and grayish brown silt loam. The underlying material is light brownish gray silty clay loam.

The minor soils in this association are Calco, Kennebec, and McPaul soils on narrow bottoms along creeks and drainageways and Crofton soils on the tops and upper sides of ridges and knolls.

The major soils have medium to high fertility and high available water capacity. Permeability is moderate, and runoff is medium in most areas. Controlling erosion is the main concern of management.

Nearly all of this association is cultivated. The major soils

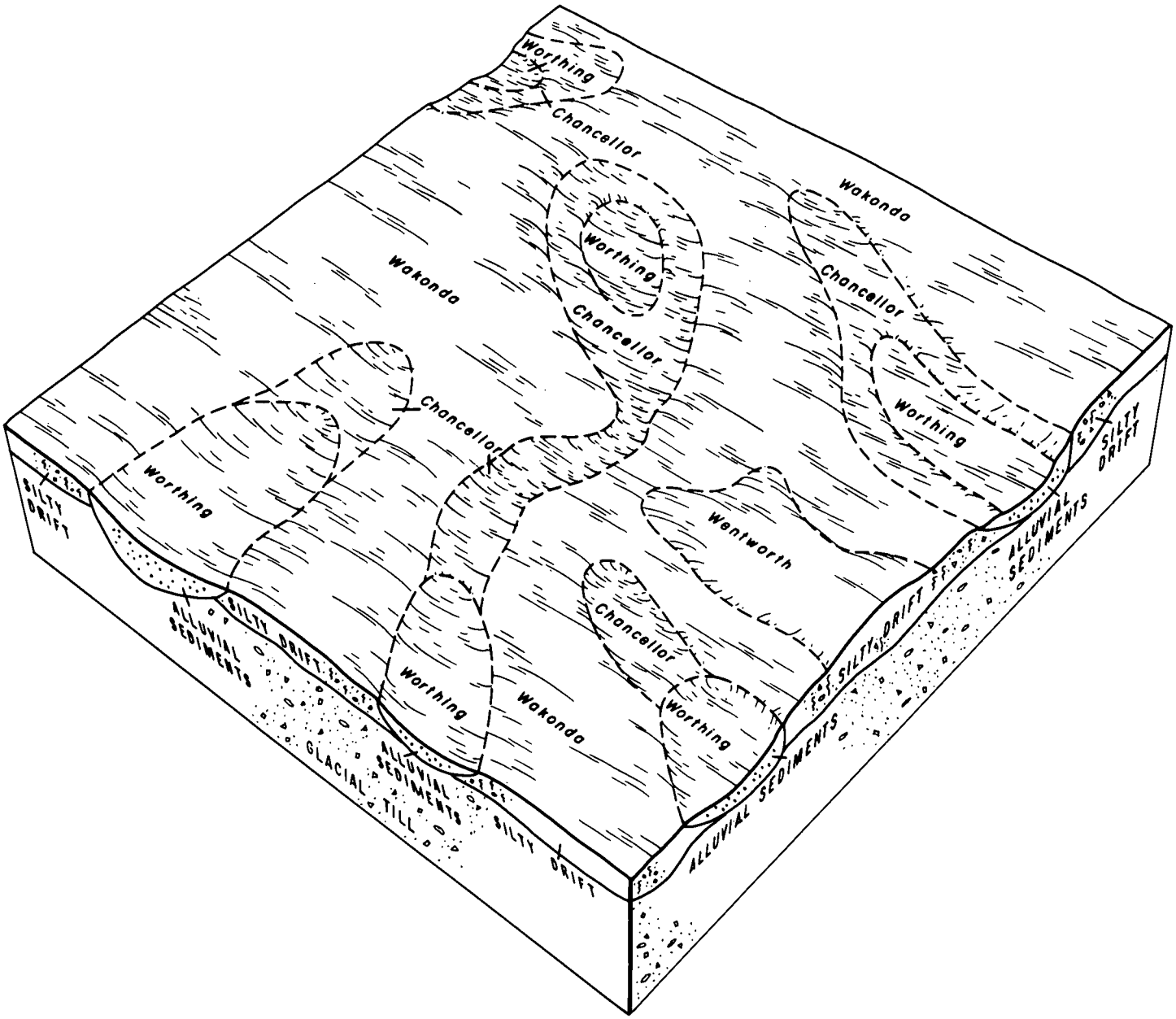


***Figure 1.*—Typical pattern of soils and underlying material in Wakonda-Worthing-Chancellor association.**

sloping to strongly sloping but are steeper on valley sides along the Big Sioux River and its larger tributaries. The drainage pattern is well defined.

This association makes up about 26 percent of the county. It is about 45 percent Crofton soils, 20 percent Nora soils, 20 percent Alcester soils (fig. 2), and 15 percent minor soils.

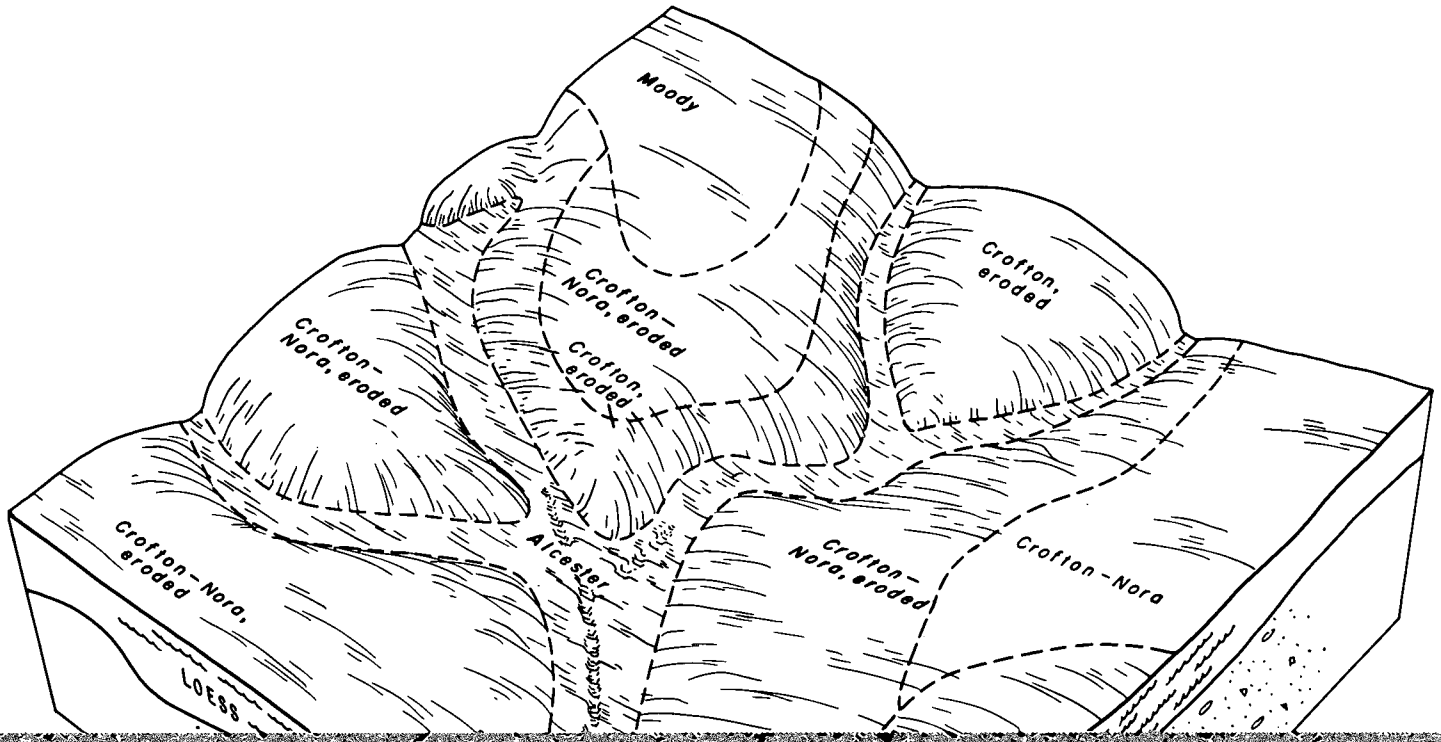
Crofton soils are well drained. The surface layer is calcareous, pale brown silt loam. The underlying material is calcareous, light yellowish brown silt loam.

Nora soils are well drained. The surface layer is dark grayish brown silty clay loam. The upper part of the subsoil is brown silt loam. The lower part of the subsoil and the

drained. They are on foot slopes and in narrow drainageways. The surface layer is dark grayish brown silt loam. The subsoil is dark grayish brown and grayish brown silt loam. The underlying material is light brownish gray silty clay loam.

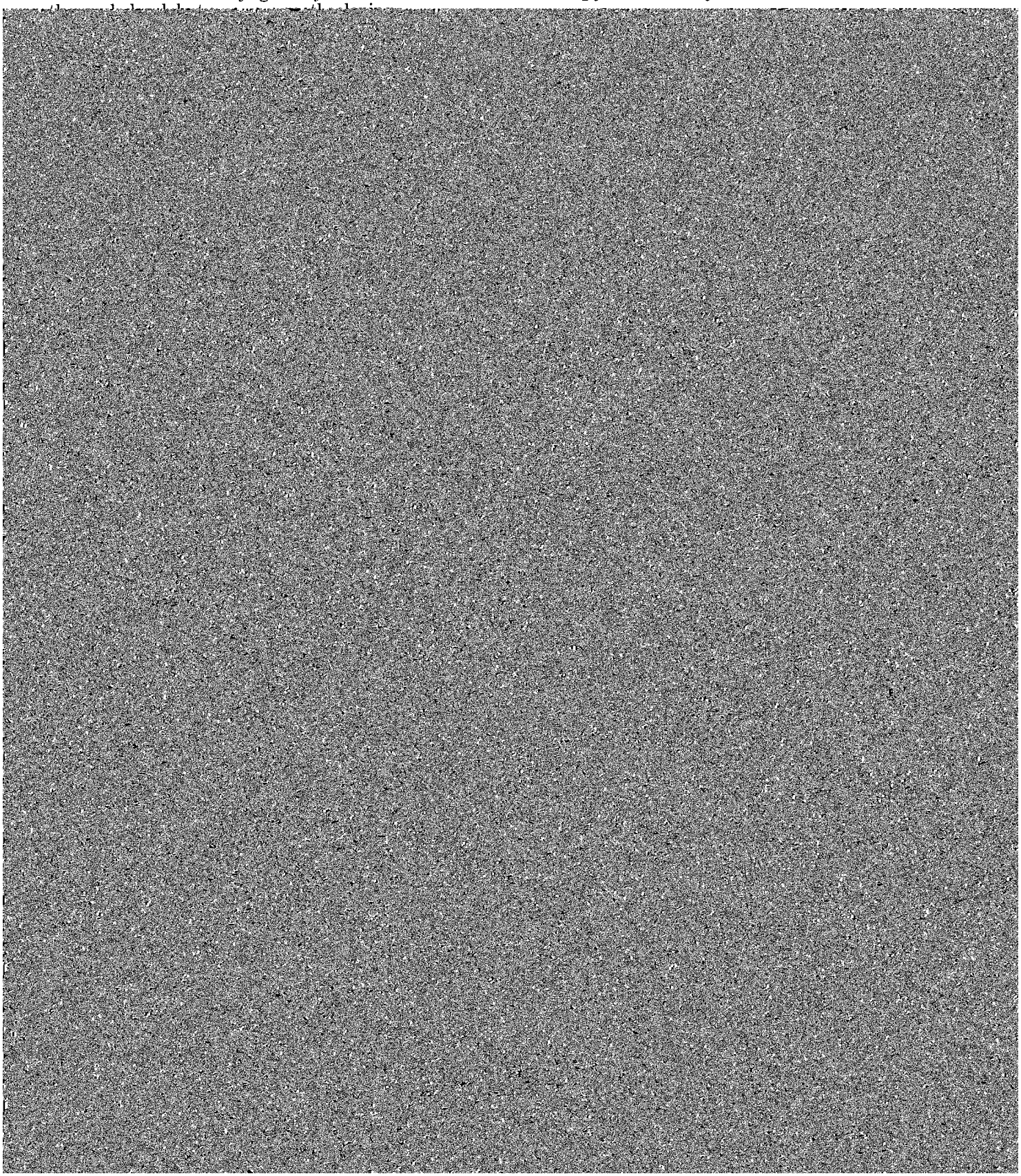
The minor soils in this association are Calco, Kennebec, and McPaul soils on narrow bottoms along creeks and drainageways, Moody soils on the lower part of concave side slopes, and Shindler soils on the lower positions on sides of entrenched drainageways where there is no mantle of loess over glacial till.

Crofton soils have low organic-matter content and low


Moody
Crofton-
Nora, eroded
Crofton,
eroded
Crofton-
Nora, eroded
Crofton,
eroded
Alcester
Crofton-
Nora, eroded
Crofton-Nora
Crofton-Nora,
eroded
LOESS

soils that are underlain by gravelly sand. The soils are

6. Sarpy-Grable-Haynie association



soils on foot slopes and fans on the edges of bottom lands; Benclare, Lamo, and McPaul soils scattered throughout the area; and Dempster soils on terraces.

The major soils have high fertility, are subject to flooding, and have a seasonal high water table. Wetness limits the use of Calco soils for crops, but Kennebec soils have only slight limitations for crops.

Most of this association is used for pasture or hay. Drainage improvement is not feasible in many areas of the poorly drained Calco soils. Some better drained soils are used for corn, soybeans, and alfalfa, but much of the association is better suited to pasture and hay.

8. Kennebec-Fluvaquents-Bonplain association

It is about 35 percent Albaton soils, 25 percent Haynie soils, 20 percent Onawa soils, and 20 percent minor soils.

Albaton soils are level and poorly drained. They are on lower parts of the landscape, many of which are former stream channels. The surface layer and underlying material are calcareous, grayish brown silty clay, but some areas have an overwash of silt loam on the surface.

Haynie soils are level to nearly level and are moderately well drained to well drained. They are on slightly higher levels between the former stream channels. The surface layer commonly is calcareous, light brownish gray silt loam, but in some places an overwash of silty clay loam is on the surface. The underlying material is calcareous, light brownish

late-planted crops such as corn and soybeans. Alfalfa and winter wheat also are grown.

11. Modale-Blyburg-Benclare association

Deep, well drained to somewhat poorly drained, nearly level and level, silty soils

This soil association is on bottom lands of the Big Sioux and Missouri Rivers. The terrain appears flat and is broken only by shallow swales and low spots.

describing the mapping unit. Color terms are for dry soil unless otherwise stated.

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

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed

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

Soil	Area	Extent
Albaton silt loam, overwash	930	0.3
Albaton silty clay	7,800	2.7
Albaton silty clay, depressional	1,450	.5
Alcester silty loam, 2 to 6 percent slopes	27,490	9.5
Benclare silty clay loam, somewhat poorly drained	4,150	1.4
Benclare soils, overwash	1,320	.5
Blencoe silty clay	2,500	.9
Blyburg silt loam	4,150	1.4
Calco silty clay loam, wet	9,710	3.4
Crofton silt loam, 12 to 17 percent slopes, eroded	11,320	3.9
Crofton silt loam, 17 to 30 percent slopes	2,400	.8
Crofton-Nora silt loams, 2 to 6 percent slopes	1,500	.5
Crofton-Nora silt loams, 6 to 12 percent slopes, eroded	37,190	12.9
Davis loam	1,500	.5
Dempster silty clay loam	1,960	.7
Egan-Shindler complex, 2 to 6 percent slopes	4,200	1.5
Egan-Shindler complex, 6 to 9 percent slopes	1,300	.5
Enet loam, 0 to 2 percent slopes	700	.2
Enet and Dempster soils, 2 to 6 percent slopes	480	.2
Fluvaquents	2,600	.9
Fluvaquents, wet	3,450	1.2
Forney silty clay	15,730	5.4
Forney soils, overwash	1,260	.4
Grable silt loam	3,150	1.1
Graceville silty clay loam	2,600	.9
Haynie silt loam	7,250	2.5
Haynie silty clay loam	2,300	.8
Moody-Nora silty clay loams, 6 to 10 percent slopes	14,320	5.0
Nora-Crofton silt loams, 20 to 50 percent slopes	610	.2
Omadi silt loam	3,450	1.2
Onawa silty clay	6,500	2.3
Percival silty clay	1,400	.5
Salix silty clay loam	3,200	1.1
Salmo silty clay loam, somewhat poorly drained	780	.3
Sarpy loamy fine sand, 3 to 9 percent slopes	2,800	1.0
Sarpy silty clay overwash, 0 to 1 percent slopes	720	.3
Sarpy soils, 0 to 3 percent slopes	2,900	1.0
Shindler clay loam, 9 to 15 percent slopes	1,330	.5
Shindler clay loam, 15 to 30 percent slopes	1,000	.3
Storla loam	720	.3
Thurman fine sandy loam, 3 to 9 percent slopes	670	.2
Wakonda-Worthing-Chancellor complex	11,820	4.1
Wentworth silty clay loam, 0 to 2 percent slopes	8,950	3.1
Wentworth silty clay loam, 2 to 6 percent slopes	4,150	1.4
Wentworth-Worthing silty clay loams	4,300	1.5
Whitewood silty clay loam	1,230	.4
Worthing silty clay loam	1,000	.3
Worthing-Chancellor silty clay loams	2,950	1.0
Water (less than 40 acres in size)	370	.1
Intermittent lake	270	.1

along the Big Sioux River the surface layer is darker and contains slightly less clay.

Runoff accumulates on this soil and remains ponded until it evaporates. The water table usually is high during the early part of the growing season.

This soil is too wet for farming in most years and is better suited to pasture, hay, or wildlife habitat. A few areas are cropped in drier years, but in most areas improved drainage is not feasible. The vegetation in undisturbed areas consists mainly of slough sedge, reedgrasses, and rushes. Capability unit Vw–2, pasture group B, windbreak group 10.

Alcester Series

The Alcester series consists of deep, moderately well drained, gently sloping, silty soils on uplands along intermittent drainageways. These soils formed in alluvium washed from adjacent upland soils. The native vegetation consisted mainly of tall grasses.

In a representative profile the surface layer is dark grayish brown silt loam about 15 inches thick. The subsoil is silt loam about 27 inches thick. It is dark grayish brown in the upper 19 inches and grayish brown in the lower 8 inches. The underlying material is light brownish gray light silty clay loam. It is calcareous below a depth of 50 inches.

Alcester soils have high fertility and low organic-matter content. Permeability is moderate, and the available water capacity is high. These soils receive additional moisture in the form of runoff from adjacent soils.

Almost all areas are used for crops. A few areas are used for grazing or hay.

Representative profile of Alcester silt loam, 2 to 6 percent slopes, in cultivation, 270 feet south and 2,020 feet west of the northeast corner of sec. 34, T. 95 N., R. 49 W.

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

A12—7 to 15 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak thick platy structure parting to weak coarse subangular blocky; slightly hard, very friable; neutral; gradual wavy boundary.

B1—15 to 24 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) crushing to very dark grayish brown (10YR 3/2) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; neutral; gradual wavy boundary.

B2—24 to 34 inches; dark grayish brown (2.5Y 4/2) silt loam, very dark grayish brown (10YR 3/2) crushing to dark brown (10YR 3/3) moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable; few darker colored worm casts; neutral; gradual wavy boundary.

B3—34 to 42 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak coarse and medium subangular blocky structure; hard, friable; few darker colored worm casts; neutral; gradual wavy boundary.

C1—42 to 50 inches; light brownish gray (2.5Y 6/2) light silty clay loam, dark grayish brown (10YR 4/2) moist; few fine distinct gray (5Y 5/1) and yellowish brown (10YR 5/6) mottles, moist; weak coarse subangular blocky structure; hard, friable, slightly sticky; neutral; gradual wavy

The A horizon ranges from very dark gray to dark grayish brown and is 14 to 22 inches thick. The upper part of the B horizon ranges from very dark gray to dark grayish brown. The lower part ranges from dark gray to light olive brown in a hue of 10YR or 2.5Y. The C horizon typically is light silty clay loam or silt loam, but in places it is loam at a depth of 40 to 60 inches.

Alcester soils are near Calco, Crofton, Davis, Kennebec, Lamo, McPaul, Moody, and Nora soils. Alcester soils are better drained than Calco and Lamo soils. They have a thicker A horizon than Crofton, McPaul, Moody, and Nora soils. Alcester soils are more silty than Davis soils. They have a thinner A horizon and are shallower to free carbonates than Kennebec soils.

Ae—Alcester silt loam, 2 to 6 percent slopes. This is a gently sloping soil on narrow strips along upland drainageways. Most areas are less than 60 acres in size. Slopes are mostly concave.

Included with this soil in mapping are small areas of Kennebec, McPaul, and Moody soils. Kennebec soils are on the lower parts of the landscape adjacent to drainage channels. McPaul soils are in places where recent overwash has accumulated along fencelines or roadsides. Moody soils are on the higher parts of the landscape, generally along the edges of the mapped area.

Runoff is medium, and the hazard of erosion is moderate. Gullies form easily in the drainageway channels. Controlling erosion is the main concern of management.

This soil is well suited to all crops commonly grown in the county. Capability unit IIe–1, pasture group K, windbreak group 1.

Benclare Series

The Benclare series consists of deep, somewhat poorly drained, level, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses.

In a representative profile the surface layer is dark gray silty clay loam about 16 inches thick. The subsoil is about 20 inches thick. It is dark gray silty clay loam in the upper part and dark gray silty clay in the lower part. The underlying material is grayish brown silty clay and silty clay loam.

Benclare soils have moderate to high organic-matter content and high fertility. Permeability is slow, and the available water capacity is high. These soils are occasionally flooded and have a seasonal water table at a depth of 3 to 6 feet.

Most areas are used for crops. A few areas are used for pasture and hay.

Representative profile of Benclare silty clay loam, somewhat poorly drained, in cultivation, 1,230 feet west and 2,450 feet south of the northeast corner of sec. 25, T. 93 N., R. 49 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

A12—7 to 16 inches; dark gray (10YR 4/1) silty clay loam, black

structure parting to moderate medium and fine subangular blocky; very hard, firm, sticky and plastic; slightly acid; gradual wavy boundary.

C1—36 to 48 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; common fine distinct strong brown (7.5YR 5/6) and few fine faint dark gray mottles, moist; massive; very hard, firm, sticky and plastic; slightly acid; gradual wavy boundary.

C2—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; common fine dis-

In a representative profile the surface layer is dark gray silty clay about 12 inches thick. The subsoil is about 16 inches thick. It is grayish brown and dark grayish brown silty clay in the upper 12 inches and grayish brown and light brownish gray light silty clay loam in the lower 4 inches. The underlying material is calcareous, light yellowish brown silt loam and silty clay loam.

Blencoe soils have high fertility and high organic-matter

than 20 inches. Included in mapping are small areas of Forney and Lakeport soils intermingled with the Blencoe soil.

Runoff is slow, and flooding is a hazard in some areas. Wetness caused by a seasonal high water table is the main limitation in using this soil for crops. It delays farming in some years. If farmed when wet, this soil compacts and easily loses its tilth.

Calco Series

The Calco series consists of deep, poorly drained, level, calcareous, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses, sedges, and stringers of native trees along stream channels.

In a representative profile the surface layer is calcareous,

Included with this soil in mapping are small areas of Alcester and Kennebec soils on the edges of areas immediately below the adjacent upland soils. Also included are a few small areas of Fluvaquents, wet, along Brule Creek.

Runoff is slow, and most areas are subject to occasional flooding. Wetness caused by flooding and the high water table severely limits the use of this soil for crops. The surface layer compacts if the soil is farmed or grazed when wet. Overcoming wetness is the main concern of management.

This soil is best suited to pasture or hay plants that tolerate wetness. In some years late crops can be grown successfully. Measures to improve drainage are not feasible in most places. Capability unit IVw–2, pasture group B, windbreak group 2.

Chancellor Series

The Chancellor series consists of deep, somewhat poorly drained, nearly level, silty soils on uplands in swales and depressions. These soils formed in alluvium washed from surrounding soils. The native vegetation consisted mainly of tall grasses.

(7.5YR 5/6) mottles, moist, and common fine distinct dark reddish brown (5YR 2/2) mottles, moist; massive; hard, firm, slightly sticky and slightly plastic; common fine and medium segregations of lime; strong effervescence; mildly alkaline.

Depth to free carbonates ranges from 30 to 44 inches. The A horizon is dark gray or very dark gray in a hue of 10YR or 2.5Y. It is 12 to 20 inches thick. The B2t horizon ranges from dark gray to light olive gray in a hue of 2.5Y or 5Y. It is 38 to 48 percent clay and ranges from 16 to 22 inches in thickness. Mottles in the lower part of the B horizon and in the C horizon range from few to many. Segregations of lime are few or common in the C horizon.

Chancellor soils are mapped with or are near Wakonda, Wentworth, and Worthing soils and are similar to Benclare soils. Moist colors of very dark gray or darker are nearer the surface in Chancellor soils than in Benclare soils. Chancellor soils are less calcareous and have more clay than Wakonda soils. They have a more clayey B horizon than Wentworth soils and are better drained than Worthing soils.

Crofton Series

The Crofton series consists of deep, well drained, gently sloping to very steep, silty soils on uplands. These soils formed in loess. The native vegetation consisted mainly of mid and tall grasses, but deciduous trees and shrubs grew

CbE2—Crofton silt loam, 12 to 17 percent slopes, eroded. This is a strongly sloping soil on the sides of large drainageways on uplands. Most of the original surface layer has been removed by erosion or has been mixed with the underlying material by tillage. This soil has a profile similar to the one described as representative of the series, but the surface layer is grayish brown in a few areas that remain in native grasses or that are not so eroded as most other areas.

Included with this soil in mapping, and making up about 20 percent of any given area, are small areas of Alcester, Moody, and Nora soils. Alcester soils are on foot slopes and along drainageways. Moody and Nora soils are on the mid and lower parts of the landscape immediately above Alcester soils. Small outcrops of glacial till and small sandy spots are in some areas and are shown on the soil map by a special symbol.

Runoff is rapid, and the hazard of erosion is very severe. Controlling erosion and improving fertility are the main concerns of management.

Most areas are cultivated or have been seeded to tame grasses and legumes. A few areas remain in native grasses and are used for pasture. Because of the very severe erosion hazard, this soil is better suited to pasture or hay than to other uses. Capability unit VIe–3, pasture group G, windbreak group 10.

CbF—Crofton silt loam, 17 to 30 percent slopes. This is a moderately steep to steep soil on the sides of valleys of the larger streams. It has a profile similar to the one described as representative of the series, but in many places the surface layer is grayish brown and noncalcareous (fig. 3).

Included with this soil in mapping are small areas of Alcester, Moody, and Nora soils. Alcester soils are on foot slopes and along drainageways. Moody and Nora soils are on the mid and lower parts of the landscape below Crofton soils. Small outcrops of glacial till and limestone are in some areas and are shown on the soil map by a special symbol.

Runoff is rapid, and the hazard of erosion is very severe. Gullies form easily in small drainageways and sags. Controlling erosion is the main concern of management.

Almost all areas remain in native grasses and are used for pasture or hay. A few areas that had been cropped are now seeded to tame grasses and legumes. This soil is too erodible for cultivation. Capability unit VIe–3, pasture group G, windbreak group 10.

CnB—Crofton-Nora silt loams, 2 to 6 percent slopes. These are gently sloping soils in long, narrow areas on upland ridgetops. They have smooth, well rounded slopes. Crofton and Nora soils occur in almost equal proportions in all areas, but the Crofton soil is on the top and upper side of convex ridges and knolls, and the Nora soil is on the side of ridges and knolls and on some of the flat ridgetops. The Nora soil has a profile similar to the one described as representative of the series, but the surface layer is silt loam.

Included with these soils in mapping are small areas of Moody soils on the lower part of the landscape.

Runoff is medium, and the hazard of erosion is moderate. The Nora soil has medium fertility, and the Crofton soil has low organic-matter content and low fertility. Controlling erosion and improving fertility are the main concerns of management.

Almost all areas are cultivated. Corn, oats, and alfalfa are the main crops. Crofton soil in capability unit IIIe–6, pasture group G, windbreak group 8; Nora soil in capability unit IIe–3, pasture group F, windbreak group 3.

Figure 3.—**Profile of Crofton silt loam, 17 to 30 percent slopes.**

CnD2—Crofton-Nora silt loams, 6 to 12 percent slopes, eroded. This complex is about 55 percent Crofton soil, 25 percent Nora soil, and 20 percent other soils. The areas are irregularly shaped and range to several hundred acres in size. The soils have long, smooth slopes. The Crofton soil is in the highest areas where slopes are more convex. The Nora soil is on the mid and lower parts of the landscape. The Crofton soil has the profile described as representative of the series. The Nora soil has a surface layer of silt loam and is shallower to lime than the Nora soil described as representative of the series. These soils are moderately to severely eroded. Much of the original surface layer has been removed by erosion, and the rest has been mixed with the underlying material by plowing (fig. 4). Gullies have formed in some areas.

Included with these soils in mapping are small areas of Alcester and Moody soils. Alcester soils are on foot slopes and along drainageways. Moody soils are on the lower parts of the landscape above the Alcester soils.

Runoff is rapid, and the hazard of erosion is severe. These soils have low organic-matter content and low fertility. Controlling erosion and improving fertility are the main concerns of management.

Most areas are used for corn, oats, alfalfa, and tame grasses. Capability unit IVe–2; Crofton soil in pasture

***Figure 4.*—Tillage has mixed the surface layer and the underlying layers in this area of Crofton-Nora silt loams, 6 to 12 percent slopes, eroded.**

group G and windbreak group 8; Nora soil in pasture group F and windbreak group 3.

Davis Series

B1—7 to 14 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky; slightly acid; gradual wavy boundary.

B21—14 to 20 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting

or silt loam 7 to 18 inches thick. Some pedons lack a B1 horizon. The B2 horizon is loam or silt loam. Some pedons lack a B3 horizon. The C horizon ranges from fine sandy loam to clay loam, and in places it is stratified with thin layers of fine sand.

Davis soils are near Benclare, Dempster, Enet, Graceville, Kennebec, and Salix soils and are similar to Alcester soils. Davis soils have more sand and are less silty than Alcester, Graceville, Kennebec, and Salix soils. They are less clayey than Benclare soils. Davis soils are not underlain by gravelly sand as are Dempster and Enet soils.

Da—Davis loam. This is a nearly level soil on high bottom lands along the Big Sioux River. Slopes are 0 to 2 percent. The areas are long and narrow and range to 120 acres in size. This soil has a profile similar to the one described as representative of the series, but in a few places it has sandy underlying material and in other places it is underlain by silty clay loam and is shallower to lime.

Included with this soil in mapping are small areas of Kennebec soils along drainageways that head in adjacent uplands.

Runoff is slow, and the hazard of erosion is slight. Flooding occurs mainly in spring before crops are planted. This soil has few or no limitations for crops. Maintaining fertility is the main concern of management.

Most areas are cultivated. Corn, soybeans, oats, and alfalfa are the main crops. This soil is well suited to irrigation, and in most places adequate water for irrigation can be obtained from shallow wells. Capability unit I–1, pasture group K, windbreak group 1.

Dempster Series

The Dempster series consists of well drained, nearly level to gently sloping, silty soils that are moderately deep to gravelly sand. These soils are on stream terraces. They formed in alluvium underlain by gravelly sand. The native vegetation consisted mainly of mid grasses.

In a representative profile the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is dark grayish brown silty clay loam in the upper part, brown silty clay loam in the middle, and yellowish brown silt loam in the lower part. The underlying material is calcareous, gravelly sand (fig. 5). It is yellowish brown to a depth of 38 inches and light yellowish brown below.

Dempster soils have moderate organic-matter content and medium fertility. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. The available water capacity is moderate.

Most areas are cultivated. These soils are well suited to irrigation. A few areas remain in native grass and are used for pasture and hay.

Representative profile of Dempster silty clay loam, in cultivation, 81 feet west and 560 feet north of the southeast corner of sec. 24, T. 93 N., R. 49 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam, black (10YR 2/1) moist; weak medium subangular blocky structure parting to weak fine granular; hard, friable, slightly sticky; slightly acid; abrupt smooth boundary.

B21—9 to 17 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable, slightly sticky; slightly acid; clear wavy boundary.

B22—17 to 28 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky; medium acid; clear wavy boundary.

Figure 5.—**Gravelly sand is at a depth of about 30 inches in this profile of Dempster silty clay loam.**

B3—28 to 34 inches; yellowish brown (10YR 5/4) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; medium acid; clear wavy boundary.

IIC1—34 to 38 inches; yellowish brown (10YR 5/4) gravelly sand, dark yellowish brown (10YR 4/4) moist; single grained; loose; medium acid; gradual wavy boundary.

IIC2—38 to 60 inches; light yellowish brown (10YR 6/4) gravelly sand, yellowish brown (10YR 5/4) moist; single grained; loose; weak effervescence; neutral.

Depth to gravelly sand and to lime ranges from 20 to 40 inches. The A horizon is very dark gray to dark grayish brown silty clay loam or silt loam 6 to 12 inches thick. The B2 horizon ranges from dark grayish brown to light olive brown silty clay loam or silt loam in a hue of 10YR or 2.5Y. Some pedons lack a B3 horizon, but where present it is silt loam, loam, or silty clay loam. In some pedons the entire IIC horizon is calcareous.

Dempster soils are near Enet and Graceville soils. They have a more silty B horizon than Enet soils and are shallower to gravelly sand than Graceville soils.

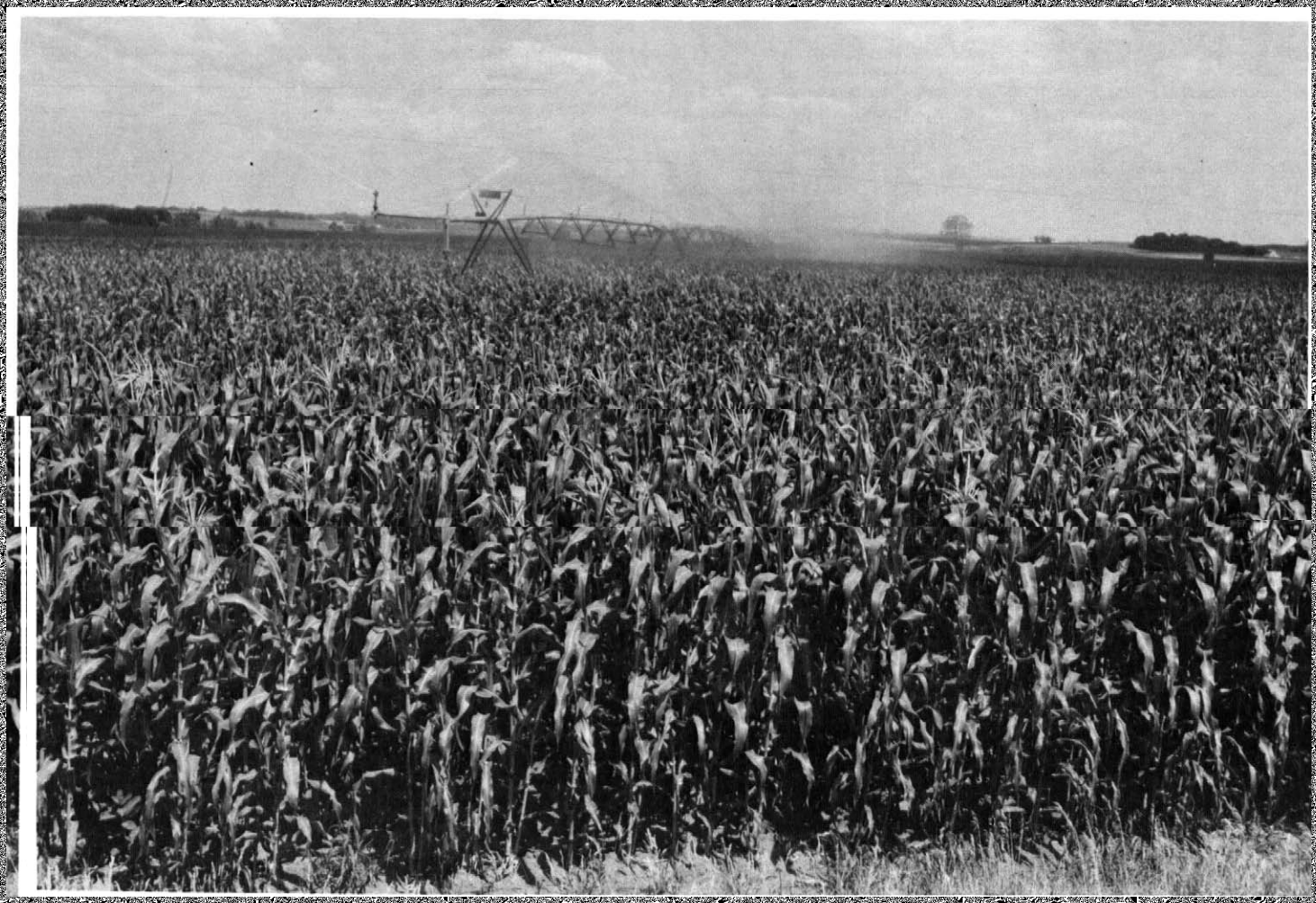
De—Dempster silty clay loam. This is a nearly level soil on stream terraces in irregularly shaped areas that range to 200 acres in size. Slopes are 0 to 2 percent. In most areas this soil has the profile described as representative of the series, but in some areas along Brule Creek the surface layer is loam.

Included with this soil in mapping are small areas of Enet

and Graceville soils. Enet soils are on slightly raised humps or low ridges, and Graceville soils are in swales and low areas.

Runoff is slow, and there is little or no hazard of erosion. This Dempster soil is somewhat droughty because of the content. Permeability is moderate in the subsoil and moderately slow in the underlying material. The available water capacity is high.

Most areas are used for crops. A few areas are used for



hard, friable, slightly sticky; common medium concretions and segregations of lime; strong effervescence;

ageways on the lower parts of the landscape. Wentworth soils are intermingled with Egan soils. Small gravelly spots

Enet soils in Union County have thicker transitional horizons of sandy loam or gravelly sandy loam than is defined as the range of the series. This difference does not alter the usefulness or behavior of the soils.

Enet soils have more sand in the B horizon than the nearby Dempster and Graceville soils.

EmA—Enet loam, 0 to 2 percent slopes. This nearly level soil is on stream terraces. The areas are irregularly shaped and are mostly less than 100 acres in size. In most areas this soil has the profile described as representative of the series, but in places the underlying gravelly loamy sand or gravelly sand is at a depth of 36 to 60 inches.

Included with this soil in mapping is an area of a somewhat poorly drained soil that has a seasonal water table at a depth of 3 to 5 feet.

Runoff is slow. This soil takes in water readily, but it is somewhat droughty because of the underlying gravelly loamy sand. It also is subject to soil blowing in dry years. Conserving moisture is the main concern of management.

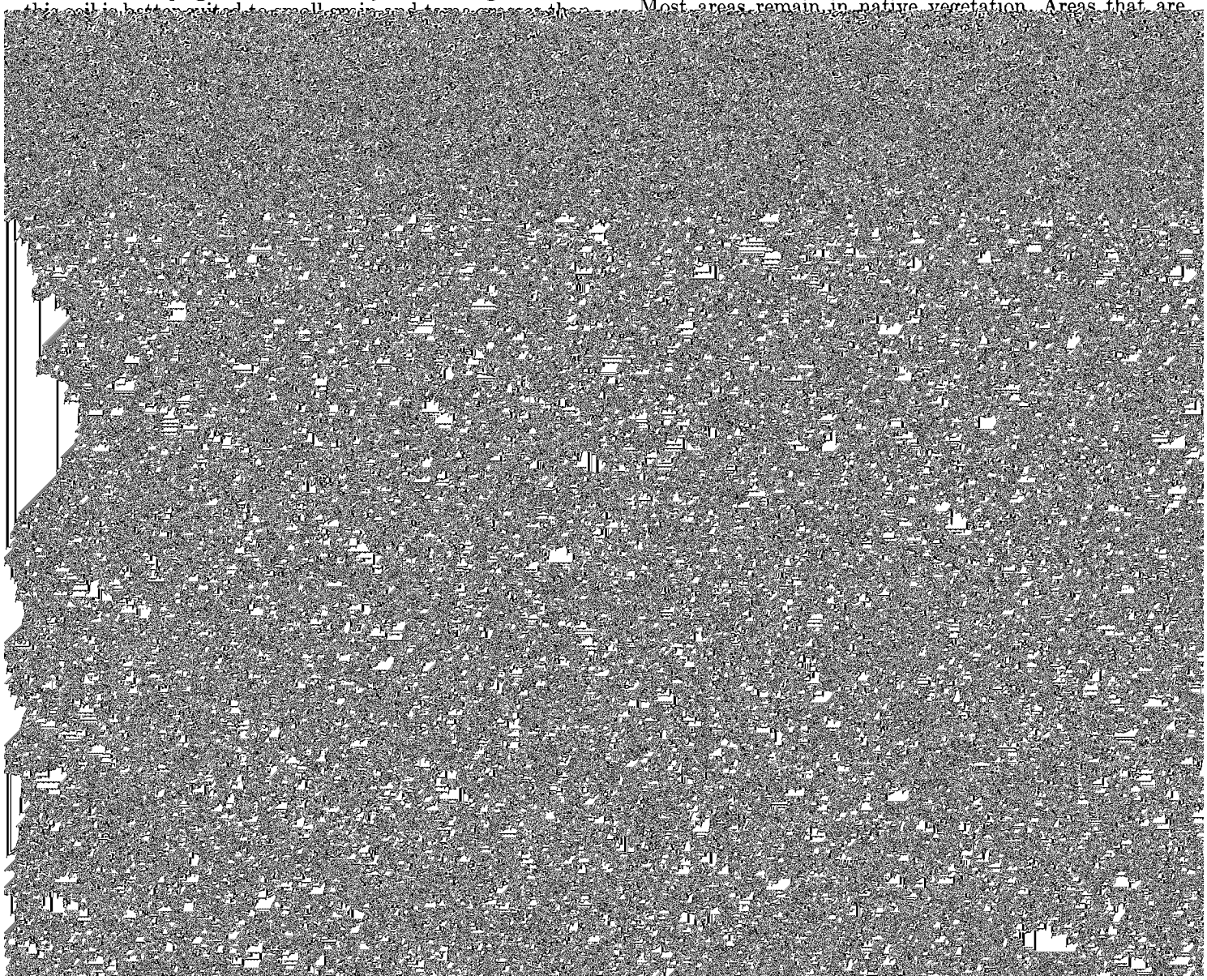
Most areas are cultivated. If irrigated, this soil is well suited to all crops grown in the county. In nonirrigated areas this soil is better suited to small grains, grasses, the [illegible] from flooding and from a seasonal high water table is the main concern of management. Some sandy areas are droughty and are subject to soil blowing if the vegetation is removed.

Most areas remain in native vegetation and are used for pasture, hay, and wildlife habitat. A few areas have been cleared of trees and are used for crops, but the choice of crops is limited by wetness during the early part of the growing season. Capability unit IVw–2, pasture group A, windbreak group 2.

Fb—Fluvaquents, wet. These are level soils on bottom lands in partly filled old channels and meander scars. Some areas consist mainly of low-lying bars along the main channel of the Missouri River. Slopes are 0 to 1 percent.The surface layer is mostly loamy sand to loam, but in a few areas it is clay. The underlying alluvium ranges from sand to clay and commonly is stratified.

Runoff is very slow to ponded. All areas are subject to flooding, and some are under water much of the time (fig. 7). The water table is at or near the surface. Wetness limits the use of these soils to pasture, hay, and wildlife habitat.

Most areas remain in native vegetation. Areas that are



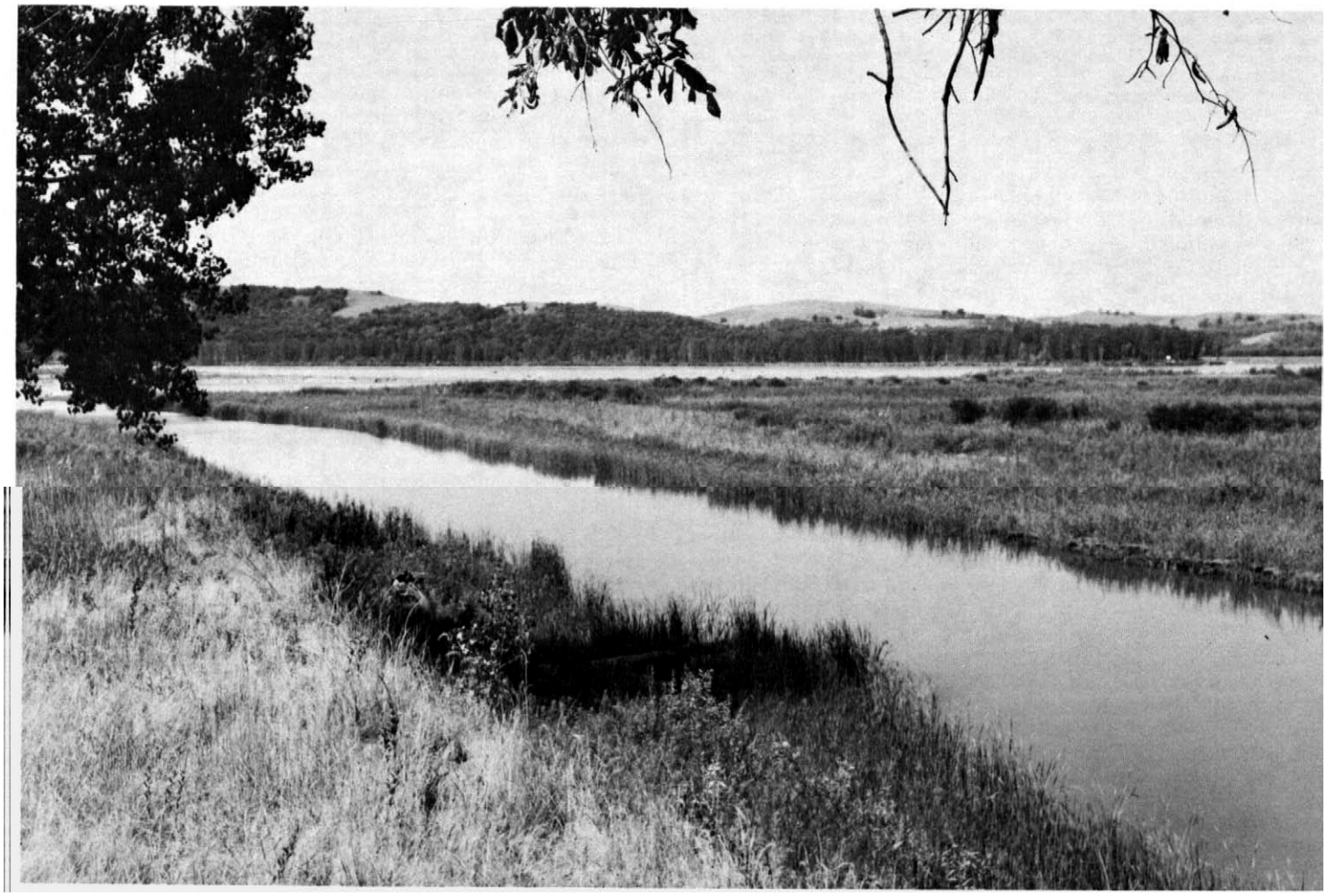


Figure 7.—**Floodwater has accumulated in the old channel within this area of Fluvaquents, wet. Aquatic plants grow where the water table is at the surface.**

IIA1b—21 to 29 inches; very dark gray (2.5Y 3/1) silty clay, black (N 2/0) moist; few fine faint olive brown mottles, moist; moderate fine subangular blocky structure; very hard, firm, sticky and plastic; neutral; clear smooth boundary.

IIA3b—29 to 34 inches; dark gray (5Y 4/1) silty clay, black (5Y 2/1) and very dark gray (5Y 3/1) moist; few fine distinct dark yellowish brown (10YR 4/4) mottles, moist, and common fine faint olive gray mottles, moist; moderate medium and fine subangular blocky structure; extremely hard, very firm, sticky and plastic; neutral; gradual smooth boundary.

IIB2gb—34 to 44 inches; gray (5Y 5/1) silty clay, dark gray (5Y 4/1) and very dark gray (5Y 3/1) moist; many fine distinct strong brown (7.5YR 5/6) and olive brown (2.5Y 4/4) mottles, moist, and common fine distinct black (5Y 2/1) mottles, moist; moderate medium and fine subangular blocky structure; extremely hard, very firm, sticky and plastic; shiny coats on faces of peds; neutral; gradual smooth boundary.

IIB3gb—44 to 60 inches; gray (5Y 6/1) silty clay, dark gray (5Y 4/1) moist; many fine and medium distinct olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) mottles, moist, and few coarse faint gray mottles, moist; weak medium subangular blocky structure; extremely hard, very firm, sticky and plastic; shiny coats on faces of peds; few fine concretions of lime; neutral.

The solum is 15 to 24 inches thick and is underlain by a buried soil. Lime commonly is leached to a depth of 36 inches or more, but in places it is at a depth of 20 to 36 inches. The A horizon commonly is silty clay, but in places it is silt loam or silty clay loam. It is 5 to 11 inches thick. Some pedons lack an A3 horizon. Texture below the A horizon is silty clay or clay. The B2g horizon ranges from dark gray to grayish brown in a hue of 5Y or 2.5Y, and it has few to many mottles. It is 6 to 10 inches thick. The IIAb horizon is 10 to 16 inches thick. The IIBg horizon is gray or grayish brown in a hue of 5Y or 2.5Y, and it has few to many mottles.

Forney soils are near Albaton, Benclare, Blencoe, Lakeport, and Luton soils. Unlike Albaton soils, Forney soils are noncalcareous to a depth of 20 inches or more. They are more poorly drained than Benclare, Blencoe, and Lakeport soils. Forney soils have thinner A and B horizons than Luton soils.

Fc—Forney silty clay. This is a level, clayey soil on high stream bottoms. Slopes are 0 to 1 percent. The areas commonly are large and range to several hundred acres in size. In most areas this soil has the profile described as representative of the series, but in places the depth to lime is as shallow as 20 inches. In a few places a thin layer of silt loam is below the subsoil.

Runoff is slow. Wetness from flooding or from a seasonal high water table commonly delays spring planting and tillage. The clayey surface layer dries slowly, and it compacts and loses its tilth if farmed when wet. Overcoming wetness is the main concern of management.

Most areas are used for crops. This soil is better suited to corn, soybeans, and winter wheat than to spring-sown small

grain. Capability unit IIIw–2, pasture group A, windbreak group 2.

Fe—Forney soils, overwash. These are level soils on high stream bottoms in irregularly shaped areas that range from 20 to 200 acres in size. Slopes are 0 to 1 percent. These soils have 5 to 15 inches of recent overwash on the surface. The overwash consists of calcareous, grayish brown silt loam, very fine sandy loam, or silty clay loam. Some low spots have no overwash and have a surface layer of silty clay.

Included with these soils in mapping are small areas of Modale soils on very narrow, low humps.

These Forney soils have a seasonal high water table. Areas adjacent to the Big Sioux River are subject to flooding. Runoff is slow, but the overwash layer dries quickly and is easy to work. Fertility is low, however, because of the overwash layer. Overcoming wetness and improving fertility are the main concerns of management.

Most areas are used for crops. Corn, oats, soybeans, and alfalfa are the main crops. Capability unit IIw–1, pasture group A, windbreak group 2.

Grable Series

The Grable series consists of deep, somewhat excessively drained, nearly level, silty soils that are underlain by fine sand at a moderate depth. These soils are on bottom lands. They formed in alluvium. The native vegetation consisted mainly of tall and mid grasses and a few deciduous trees.

In a representative profile the surface layer is calcareous, grayish brown silt loam about 7 inches thick. The underlying material is calcareous, light gray silt loam to a depth of 15 inches and is calcareous, light brownish gray very fine sandy loam to a depth of 27 inches. Below this is calcareous, light olive brown fine sand.

Grable soils have moderately low organic-matter content and medium fertility. Permeability is moderate in the upper inches thick, but it is very fine sandy loam in places. A thin overwash of silty clay loam or silty clay is on the surface in places. The IIC horizon is fine sand, loamy fine sand, sand, or loamy sand stratified, in places, with thin lenses of finer textured material.

Grable soils are near Albaton, Haynie, Onawa, Percival, and Sarpy soils. Grable soils are better drained and less clayey than Albaton, Onawa, and Percival soils. They have a more sandy C horizon than Haynie soils. They contain more silt and very fine sand to a greater depth than Sarpy soils.

Ga—Grable silt loam. This is a nearly level soil on bottom lands. Slopes are 0 to 2 percent. The areas are long and narrow and are mostly less than 30 acres in size. In most areas this soil has the profile described as representative of the series, but in places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Haynie, Onawa, and Percival soils. Haynie soils are the most common and make up as much as 30 percent of some areas. Onawa and Percival soils are in swales or low areas.

Runoff is slow. This soil is somewhat droughty because of the sandy underlying material, and it is subject to some soil blowing. Conserving moisture and controlling soil blowing are the main concerns of management.

Most areas are cropped. A few areas are irrigated. If irrigated, this soil is well suited to corn, soybeans, and alfalfa. In nonirrigated areas it is better suited to small grain than to late-maturing row crops. Capability unit IIs–3, pasture group D, windbreak group 6.

Graceville Series

The Graceville series consists of deep, moderately well drained, nearly level, silty soils on stream terraces. These soils formed in alluvium overlying outwash sand and gravel. The native vegetation consisted mainly of tall grasses.

In a representative profile the surface layer is silty clay loam about 16 inches thick. It is dark grayish brown in the upper part and dark gray in the lower part. The subsoil is silty clay loam about 36 inches thick. It is dark grayish brown

sticky; common fine pores; few pebbles and visible sand grains; slightly acid; gradual wavy boundary.

B22—36 to 52 inches; light yellowish brown (2.5Y 6/3) silty clay loam, olive brown (2.5Y 4/3) moist; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable, slightly sticky; neutral; abrupt smooth boundary.

IIC—52 to 60 inches; brown (10YR 5/3) gravelly sand, dark brown (10YR 4/3) moist; single grained; loose; strong effervescence; mildly alkaline.

Depth to gravelly sand ranges from 40 to 60 inches. The A horizon ranges from very dark gray to dark grayish brown and in places is silt loam. It is 12 to 22 inches thick. The B2 horizon ranges from dark grayish brown to yellowish brown. Some pedons have a thin B3 horizon. The IIC horizon ranges from fine sand to gravel, and in places it is noncalcareous.

Graceville soils are near Alcester, Benclare, Davis, Dempster, Enet, and Kennebec soils. Unlike Alcester, Benclare, Davis, and Kennebec soils, Graceville soils have a C horizon of gravelly sand. Graceville soils are deeper to gravelly sand than Dempster and Enet soils.

Gb—Graceville silty clay loam. This is a nearly level soil on stream terraces in broad areas that range to 240 acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Dempster soils on slightly raised humps.

Runoff is slow, and there is little or no risk of erosion. Some areas receive runoff from adjacent soils, and this additional moisture generally is beneficial. This soil has few or no limitations for crops.

Almost all areas are cultivated. Corn, soybeans, and alfalfa are the main crops. In places the underlying gravelly sand has been excavated for construction uses. Capability unit I-3, pasture group K, windbreak group 1.

Haynie Series

strong effervescence; mildly alkaline; clear smooth boundary.

C3—21 to 60 inches; light brownish gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) moist; common fine distinct strong brown (7.5YR 5/6) mottles, moist, and few fine faint gray mottles, moist; massive, laminations evident; soft, very friable; thin lenses of fine sand at about 30 inches; strong effervescence; mildly alkaline.

All horizons are silt loam or very fine sandy loam, but some places have an overwash of silty clay loam or silty clay. The A horizon is light brownish gray or grayish brown in a hue of 2.5Y or 10YR. It is 6 to 10 inches thick. In places it is noncalcareous. In places the C horizon is stratified with thin lenses of clayey or sandy material.

Haynie soils in this survey commonly have an A horizon that is lighter colored than is defined as the range of the series. This difference does not alter the usefulness or behavior of the soils.

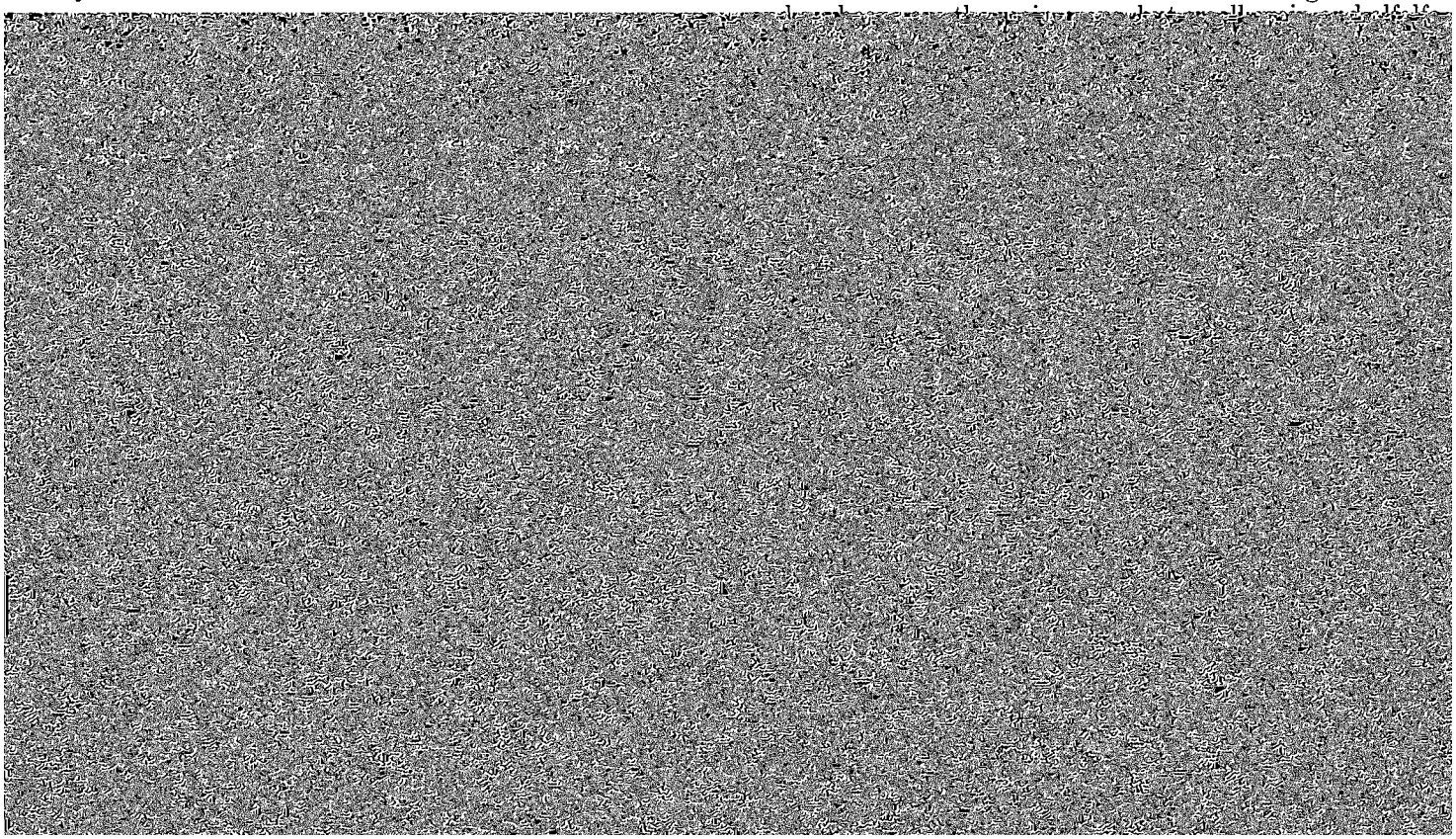
Haynie soils are near Albaton, Blyburg, Grable, and Onawa soils and are similar to McPaul soils. Haynie soils have less clay than Albaton and Onawa soils and a thinner A horizon than Blyburg soils. Haynie soils have a less sandy C horizon than Grable soils and contain more sand in the C horizon than McPaul soils.

Ha—Haynie silt loam. This is a nearly level soil on bottom lands in irregularly shaped areas that are mostly less than 100 acres in size. Slopes are 0 to 2 percent. This soil has the profile described as representative of the series, but in some narrow swales and low areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Onawa and Grable soils. Onawa soils are in small swales and low areas, and Grable soils are on very slight rises. Also included in some areas are small sandy spots that are shown on the soil map by a special symbol.

Runoff is slow. This Haynie soil is well drained and has few limitations for crops. Maintaining fertility and organic-matter content is the main concern of management.

Most areas are cultivated. Some areas are irrigated. Corn



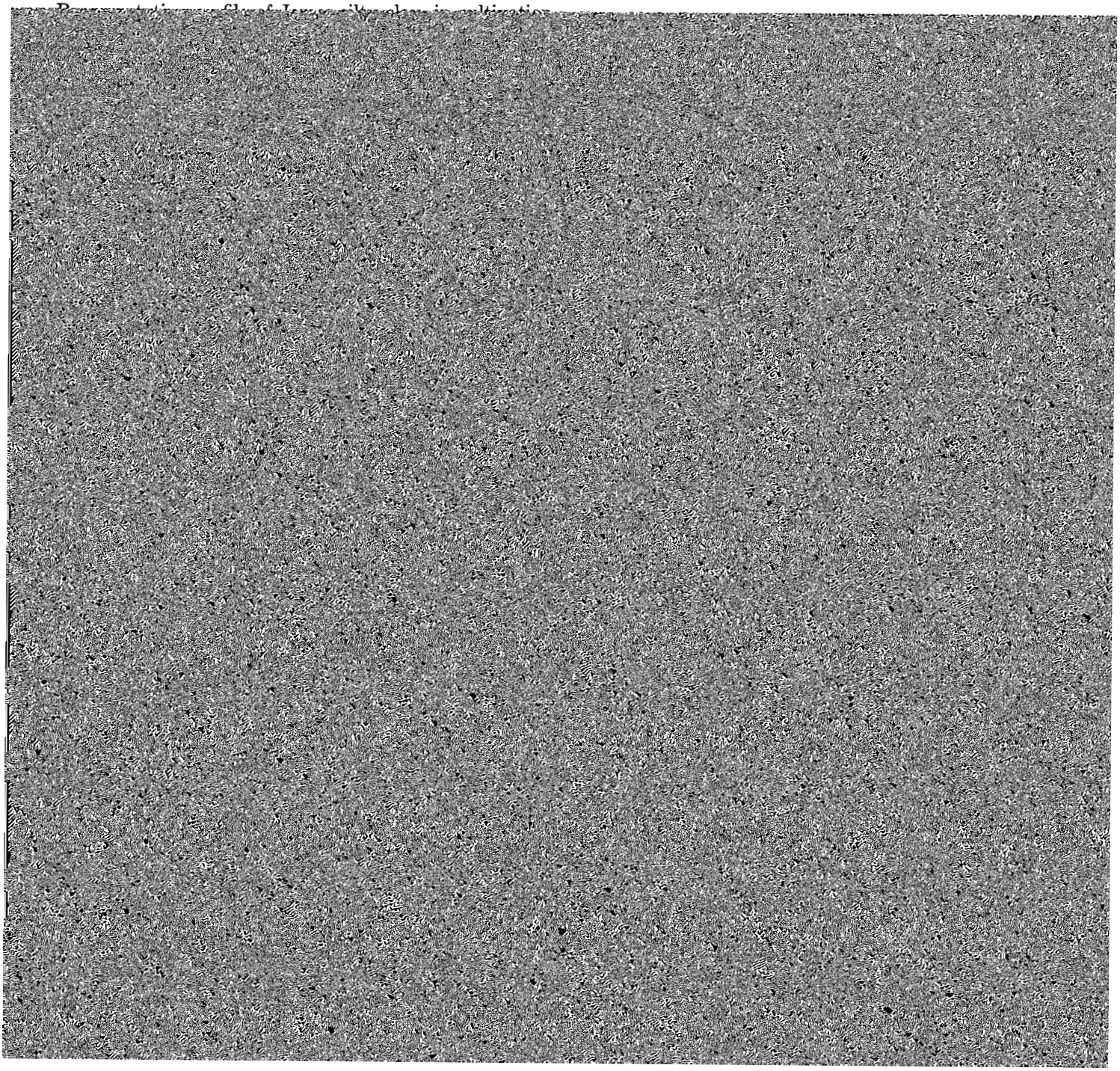
dark gray silty clay about 30 inches thick. The underlying material is calcareous, light olive gray and gray silty clay loam and silty clay. Spots and streaks of gypsum and other salts are throughout the profile.

James soils have high organic-matter content and medium fertility. Permeability is slow, and the available water capacity is low or moderate. These soils are subject to flooding and have a seasonal high water table within 2 feet of the surface.

Many areas are used for crops, but some areas remain in native vegetation and are used for hay and pasture. A few areas are wooded.

Runoff is very slow or is ponded in some areas. Wetness commonly delays planting and tillage, and in some years the soil is too wet to farm. This soil dries slowly, and it compacts and loses its tilth if farmed when wet. Overcoming wetness caused by flooding and a high water table, managing the high content of salts, and maintaining tilth are the main concerns of management if this soil is farmed.

Many areas are used for crops, but some are used for hay and pasture. This soil is better suited to late-planted crops such as corn, soybeans, and sorghum than to small grain. Capability unit IVw–2, pasture group J, windbreak group 10.



Kennebec soils have high fertility and high organic-matter content. Permeability is moderate, and the available water capacity is high. These soils occasionally are flooded and have a seasonal water table at a depth of 3 to 5 feet.

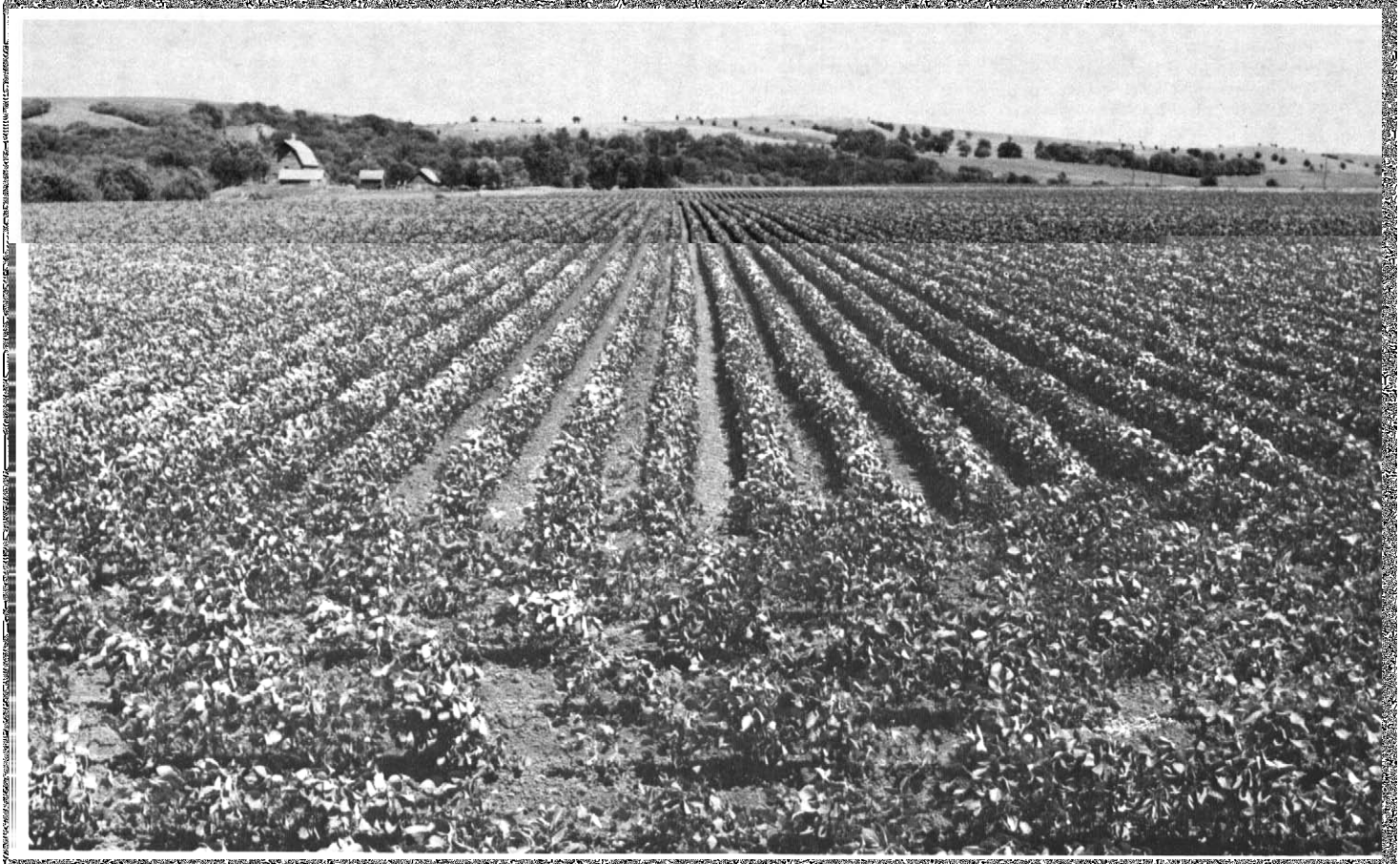
Most areas are cultivated but a few areas remain in native grass and are used for grazing or hay.

Representative profile of Kennebec silty clay loam, in cultivation, 126 feet west and 300 feet north of the center of sec. 2, T. 92 N., R. 49 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silty clay loam, very dark [illegible] structure; slightly hard, friable; neutral; gradual smooth boundary.

C2—50 to 60 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; many fine distinct dark reddish brown (5YR 3/2) and strong brown (7.5YR 5/6) mottles, moist, and many fine faint dark gray mottles, moist; massive; slightly hard, very friable; few thin lenses of fine sand; neutral.

Depth to free carbonates ranges from 45 to 60 inches or more. The A horizon commonly ranges from very dark gray to dark grayish brown, but it is grayish brown in places that have recent



McPaul soils are in places where recent overwash has accumulated, mainly along fencelines and roadsides.

Runoff is slow. This soil is flooded from stream overflow in some years and generally receives some runoff from adjacent uplands. In most years the additional moisture is beneficial, however, and the limitations for crops are slight.

Almost all areas are used for crops. Corn, soybeans, and alfalfa are the main crops. Capability unit I–1, pasture group K, windbreak group 1.

Lakeport Series

The Lakeport series consists of deep, somewhat poorly drained, nearly level, silty soils on high bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses.

In a representative profile the surface layer is dark grayish brown and grayish brown silty clay loam about 15 inches thick. The subsoil is grayish brown and is about 27 inches thick. The upper part is silty clay loam, and the lower part is silty clay. The underlying material is grayish brown and light brownish gray, stratified silty clay loam and silty clay that contains thin lenses of silt loam.

Lakeport soils have high fertility and high organic-matter content. Permeability is moderately slow, and the available water capacity is moderate or high. These soils have a seasonal high water table at a depth of 2 to 4 feet.

Almost all areas are used for crops, and some are irrigated. A few areas are used for pasture and hay.

Representative profile of Lakeport silty clay loam, in cultivation, 135 feet west and 246 feet south of the northeast corner of sec. 19, T. 91 N., R. 50 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; slightly hard, friable, sticky and plastic; neutral; abrupt smooth boundary.

A12—7 to 15 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) and dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to moderate fine subangular blocky; hard, friable, slightly sticky and slightly plastic; neutral; gradual smooth boundary.

B21—15 to 25 inches; grayish brown (2.5Y 5/2) silty clay loam, hard, firm, sticky and plastic; strong effervescence; mildly alkaline.

Clay content of the solum ranges from 35 to 42 percent. The A horizon ranges from dark gray to grayish brown and is 12 to 18 inches thick. The B horizon is dark grayish brown or grayish brown in a hue of 2.5Y or 10YR. It is 18 to 32 inches thick. The C horizon commonly is silty clay or silty clay loam, but in places it is silt loam or very fine sandy loam below a depth of 40 inches.

Lakeport soils in Union County differ from the defined range of the series because they have fine stratification in the B and C horizons, but this difference does not alter their usefulness or behavior.

Lakeport soils are near Blencoe, Blyburg, Forney, Omadi, and Salix soils. Lakeport soils have a less clayey A horizon than Blencoe soils but are more clayey below a depth of 20 to 30 inches. Lakeport soils are more clayey than Blyburg and Omadi soils. They are better drained than Forney soils and have a more clayey B horizon than Salix soils.

La—Lakeport silty clay loam. This is a nearly level soil on high bottom lands in irregularly shaped areas that range to 200 or more acres in size. Slopes are 0 to 2 percent.

Included with this soil in mapping are small areas of Blencoe and Omadi soils. Blencoe soils are in slightly concave low areas, and Omadi soils are on very slight rises.

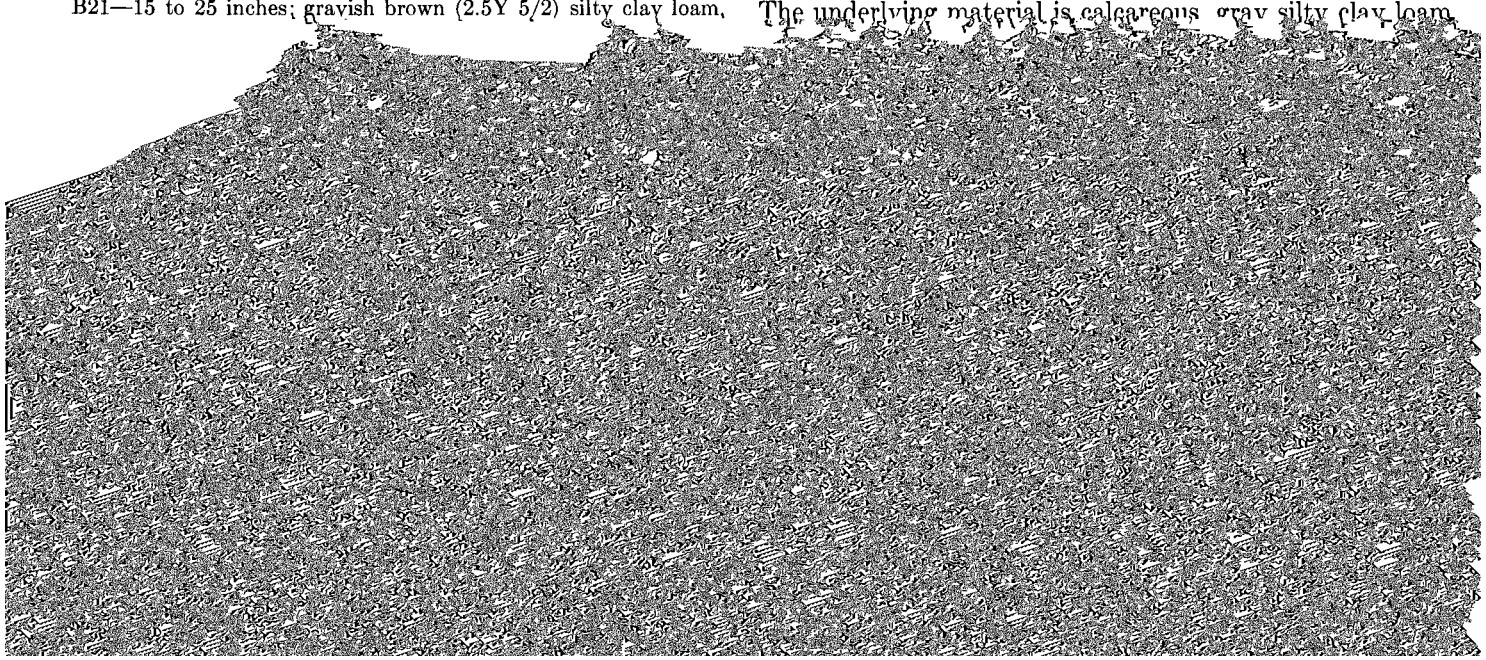
Runoff is slow. Wetness from a seasonal high water table delays farming in some years. This soil compacts and loses its tilth if farmed when wet. Overcoming wetness and maintaining tilth are the main concerns of management.

This soil is well suited to all crops commonly grown in the county. Almost all areas are used for crops. Corn and soybeans are the main crops. Capability unit IIw–1, pasture group A, windbreak group 2.

Lamo Series

The Lamo series consists of deep, somewhat poorly drained, level, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses and some stringers of native trees and shrubs along stream channels.

In a representative profile the surface layer is calcareous, dark gray silty clay loam about 17 inches thick. Below this is calcareous, dark gray silty clay loam about 13 inches thick. The underlying material is calcareous, gray silty clay loam,



gray (5Y 3/1) moist; common medium and coarse distinct light olive brown (2.5Y 5/4) mottles, moist; moderate medium and fine subangular blocky structure;

Ap—0 to 6 inches; very dark gray (5Y 3/1) silty clay, black (N 2/0) moist; weak medium subangular blocky structure; very hard, firm, sticky and plastic; neutral; abrupt smooth

late-planted crops such as corn and soybeans. Alfalfa and some winter wheat also are grown. Capability unit IIIw–2, pasture group A, windbreak group 2.

McPaul Series

The McPaul series consists of deep, moderately well drained, nearly level, silty soils on bottom lands. These soils formed in recent alluvium washed from adjoining uplands. The native vegetation consisted mainly of tall grasses, but stringers of native trees were common along stream channels.

In a representative profile the surface layer is calcareous, grayish brown silt loam about 6 inches thick. The underlying material to a depth of 41 inches is calcareous, grayish brown and pale brown silt loam. Below this it is dark gray silty clay loam.

McPaul soils have moderately low organic-matter content and medium fertility. Permeability is moderate, and the available water capacity is high. These soils are occasionally flooded and have a seasonal water table at a depth of 3 to 5 feet.

Most areas are used for crops. Some narrow areas are dissected by channels and are used for pasture.

Representative profile of McPaul silt loam, in cultivation, 520 feet south and 1,130 feet west of the northeast corner of sec. 34, T. 94 N., R. 49 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—6 to 41 inches; grayish brown (10YR 5/2) and pale brown (10YR 6/3) silt loam, dark grayish brown (10YR 4/2) and brown (10YR 5/3) moist; massive, laminations evident; slightly hard, friable; slight effervescence; mildly alkaline; clear wavy boundary.

IIAb—41 to 60 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; few fine faint gray mottles, moist; moderate medium subangular blocky structure; hard, friable; slight effervescence; mildly

intensive rain during the growing season results in the deposition of sediment and debris in places. Still, in most years the flooding damage is slight, and this soil has few limitations for crops. Maintaining fertility is the main concern of management.

Most areas are used for crops. This soil is well suited to all crops commonly grown in the county. Capability unit I–1, pasture group F, windbreak group 1.

Modale Series

The Modale series consists of deep, moderately well drained, nearly level, silty soils that are underlain by silty clay. These soils are on bottom lands. They formed in alluvium. The native vegetation consisted mainly of tall grasses and deciduous trees.

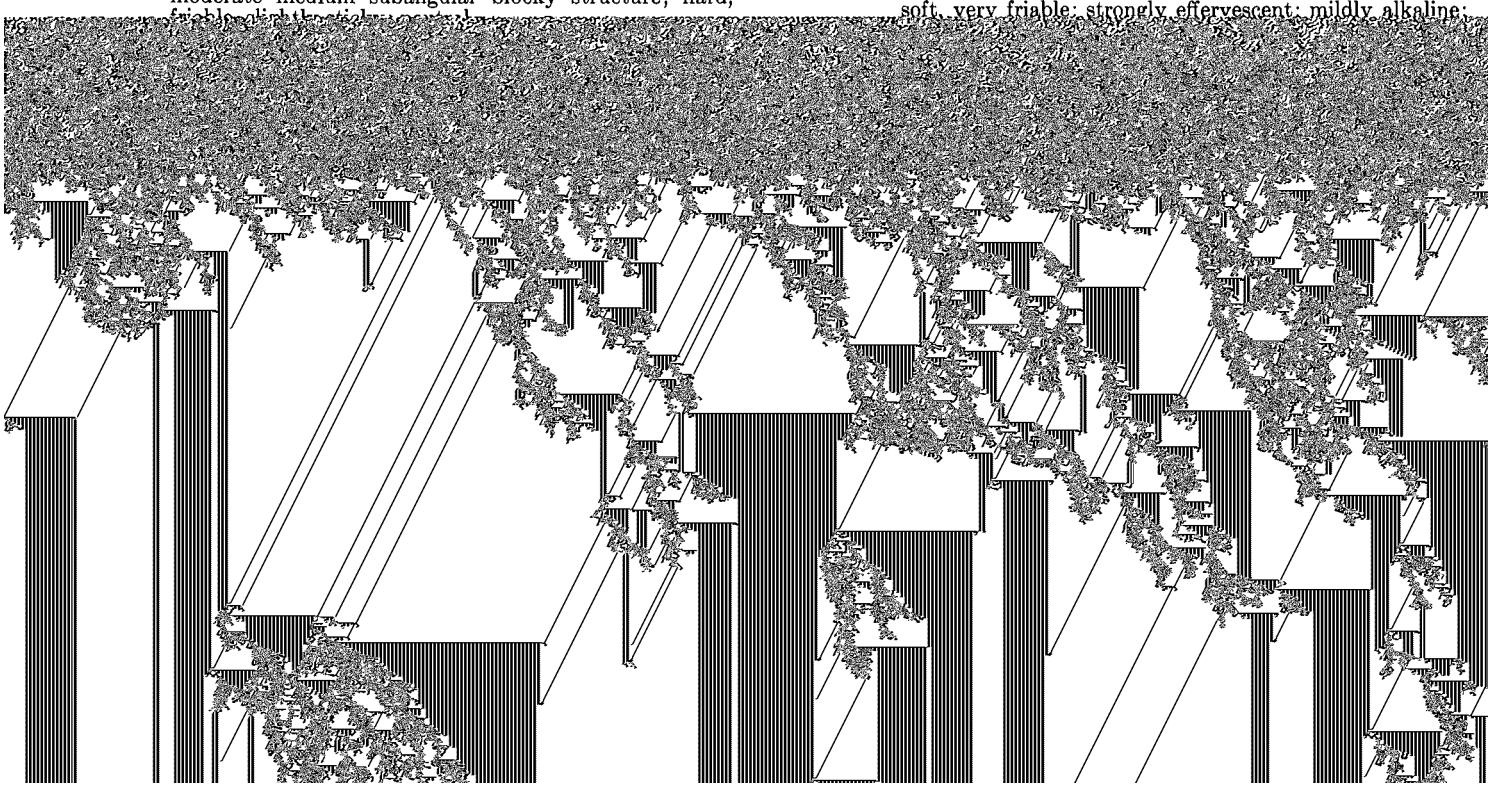
In a representative profile the surface layer is calcareous, grayish brown silt loam about 7 inches thick. The underlying material, to a depth of 24 inches, is calcareous, light brownish gray silt loam and very fine sandy loam. Below this it is calcareous, grayish brown silty clay.

Modale soils have moderately low organic-matter content and medium fertility. Permeability is moderate in the silty upper part of the profile but very slow in the clayey lower part. The available water capacity is moderate. A seasonal high water table is at a depth of 1 to 3 feet, and some areas are subject to flooding.

Most areas are used for crops and some are irrigated. A few areas remain in native vegetation and are used for pasture and hay.

Representative profile of Modale silt loam, in cultivation, 87 feet west and 825 feet south of the northeast corner of sec. 29, T. 90 N., R. 49 W.

Ap—0 to 7 inches; grayish brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, very friable; strongly effervescent; mildly alkaline;



Mb—Modale silt loam. This is a nearly level soil on wide bottom lands along the major streams. Slopes are 0 to 2 percent. In most areas this soil has the profile described as representative of the series, but in some areas along the Big Sioux River the underlying material is silty clay loam, and in a few places the depth to clayey material is slightly more than 30 inches.

Included with this soil in mapping are small areas of Albaton and Haynie soils. Albaton soils are in swales and low areas and commonly have a thin overwash of silt loam. Haynie soils are on slight rises.

Runoff is slow. This soil has a seasonal high water table, and some areas are subject to flooding. In most years, however, the additional moisture is beneficial, and the limitations for crops are slight. Maintaining fertility is the main concern of management.

This soil is well suited to all crops commonly grown in the county. Corn, soybeans, and alfalfa are the main crops. Some areas are irrigated. Capability unit I–1, pasture group K, windbreak group 1.

Moody Series

The Moody series consists of deep, well drained, nearly level to sloping, silty soils on uplands. These soils formed in loess. The native vegetation consisted mainly of mid and tall grasses.

In a representative profile the surface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 32 inches thick. It is dark grayish brown silty clay loam in the upper part, brown and pale brown silty clay loam in the middle, and pale brown silt loam in the lower part. The underlying material is calcareous, light yellowish brown silt loam.

Moody soils have high fertility and high organic-matter content. Permeability is moderate, and the available water capacity is high.

Almost all areas are used for crops. A few small areas are used for pasture and hay.

Representative profile of Moody silty clay loam, 2 to 6 percent slopes, in cultivation, 172 feet west and 102 feet south of the northeast corner of sec. 2, T. 94 N., R. 49 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky; slightly acid; abrupt smooth boundary.

B21—7 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable, slightly sticky; many worm casts; slightly acid; clear wavy boundary.

B22—12 to 21 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common worm casts; faint clay films in voids and as patches on faces of peds; slightly acid; gradual wavy boundary.

B23—21 to 33 inches; pale brown (10YR 6/3) silty clay loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky; faint clay films in voids and as patches on faces of peds; slightly acid; gradual wavy boundary.

B3—33 to 39 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; few fine distinct strong brown (7.5YR 5/6) mottles, moist, and few fine faint gray mottles, moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, friable; slightly acid; clear wavy boundary.

C1ca—39 to 50 inches; light yellowish brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) moist; common medium distinct gray (5Y 5/1) mottles, moist, and common fine distinct strong brown (7.5YR 5/6) mottles, moist; weak coarse and medium subangular blocky structure; slightly hard, very friable; common fine concretions and segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—50 to 60 inches; light yellowish brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) moist; common fine distinct gray (5Y 5/1), strong brown (7.5YR 5/6), and very dark brown (10YR 2/2) mottles, moist; massive; slightly hard, very friable; few fine segregations of lime; strong effervescence; moderately alkaline.

Depth to lime ranges from 30 to 50 inches. The A horizon is dark grayish brown or very dark grayish brown and is 6 to 10 inches thick. Some pedons have a thin B1 horizon. The B21 horizon is dark grayish brown or grayish brown and is 4 to 7 inches thick. The rest of the B horizon ranges from brown to light yellowish brown in a hue of 10YR or 2.5Y. The B3 horizon is calcareous in some pedons.

Moody soils are mapped with or are near Alcester, Crofton, and Nora soils, and they are similar to Wentworth soils. Moody soils have a thinner A horizon than Alcester soils and are deeper to lime than Crofton and Nora soils. Moody soils have a more uniformly silty C horizon than Wentworth soils.

McA—Moody silty clay loam, 0 to 2 percent slopes. This nearly level soil is on uplands in irregularly shaped areas that range from 5 to 40 acres in size. Slopes are plane to concave. The surface layer is slightly thicker and the depth to lime is greater than that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Alcester soils in shallow swales.

Runoff is slow, and the hazards of erosion and soil blowing are slight. This Moody soil has few if any limitations for crops. Maintaining fertility is the main concern of management.

Almost all areas are used for crops. Corn, oats, soybeans, and alfalfa are the main crops. Capability unit I–2, pasture group F, windbreak group 3.

McB—Moody silty clay loam, 2 to 6 percent slopes. This gently sloping soil is on uplands in irregularly shaped areas that range to 400 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Alcester and Nora soils. Alcester soils are on the lower part of the landscape along drainageways, and Nora soils are on the tops and upper sides of ridges and knolls.

Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main concern of management.

Almost all areas are cultivated, and this soil is well suited to all crops grown in the county. Corn, oats, soybeans, and alfalfa are the main crops. Capability unit IIe–3, pasture group F, windbreak group 3.

MdC—Moody-Nora silty clay loams, 6 to 10 percent slopes. This complex is about 50 percent Moody soil, 35 percent Nora soil, and 15 percent other soils. The areas are irregularly shaped and range to 800 acres in size. Slopes are convex, long, and smooth (fig. 10). The Moody soil is on the mid and lower parts of the landscape, and the Nora soil is on the tops and upper sides of ridges and knolls. This Moody soil is slightly shallower to lime than the Moody soil described as representative of the series. The Nora soil has the profile described as representative of the Nora series, but in eroded

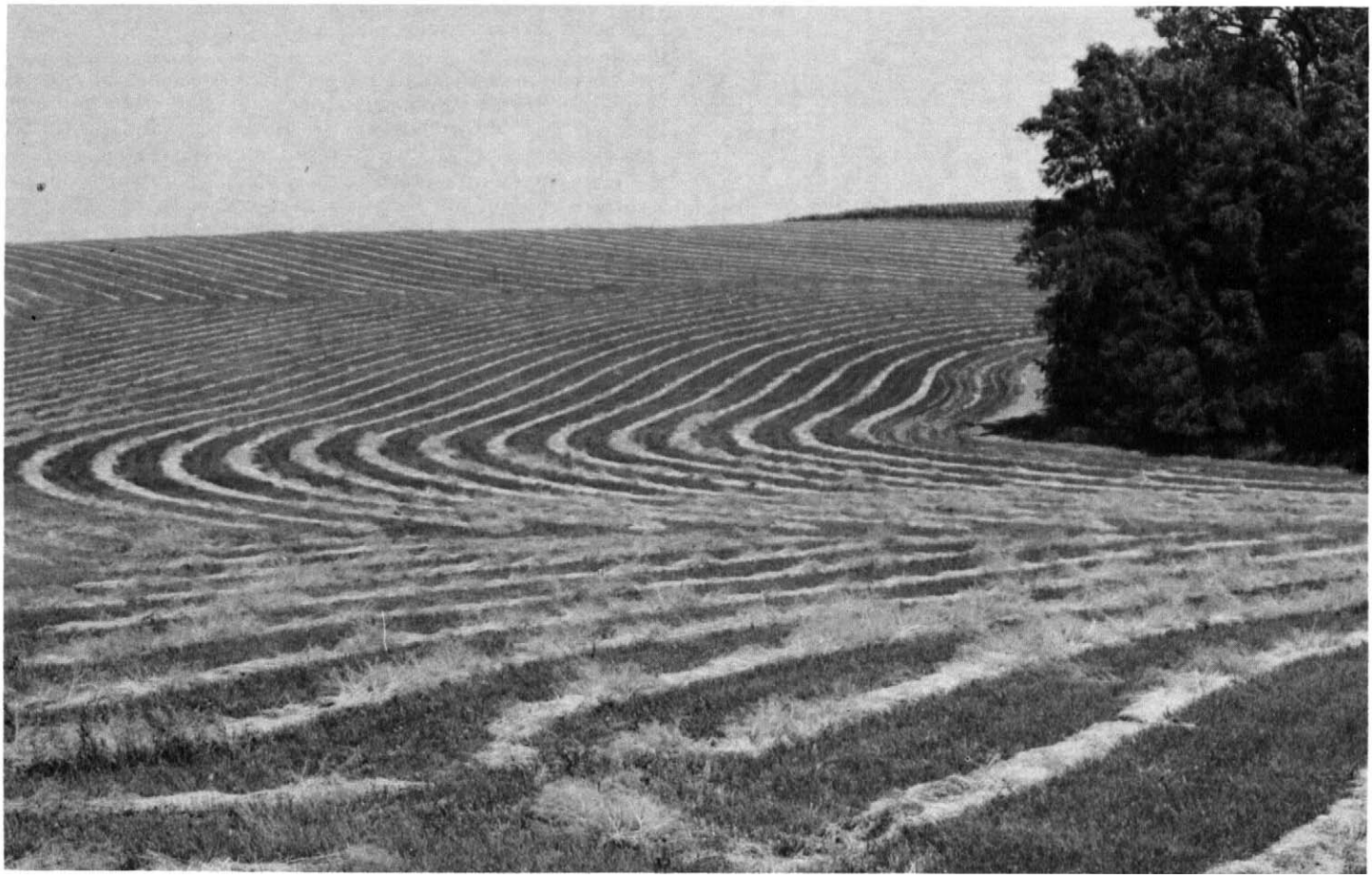


Figure 10.—**An area of Moody-Nora silty clay loams, 6 to 10 percent slopes.**

areas the surface layer is grayish brown because it has been mixed with the subsoil in plowing.

Included with these soils in mapping are small areas of Alcester and Crofton soils. Alcester soils are on foot slopes along drainageways, and Crofton soils are on ridgetops and knolls.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main concern of management.

Most areas are used for crops, but some areas are used for pasture and hay. These soils are well suited to all crops grown in the county. Corn, oats, and alfalfa are the main crops. Capability unit IIIe–2, pasture group F, windbreak group 3.

Nora Series

The Nora series consists of deep, well drained, gently sloping to very steep, silty soils on uplands. These soils

medium fertility. Permeability is moderate, and the available water capacity is high.

Many areas are cultivated. Some areas are in tame grasses and are used for hay and pasture. Steep areas remain in native vegetation and are used for pasture.

Representative profile of Nora silty clay loam, in an area of Moody-Nora silty clay loams, 6 to 10 percent slopes, in cultivation, 2,355 feet north and 230 feet west of the southeast corner of sec. 11, T. 94 N., R. 49 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

B21—8 to 12 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak medium and fine subangular blocky; slightly hard, friable; common fine and very fine pores; common worm casts; slightly acid; gradual wavy boundary.

B22—12 to 20 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure part-

The areas are mostly long and narrow and range to 80 acres in size.

This complex is about 50 percent Nora soil, 40 percent Crofton soil, and 10 percent other soils. The Nora soil is on the mid and lower parts of the landscape and is mostly moderately steep. The Crofton soil is on the higher parts of the landscape and is steep to very steep. The Nora soil has a surface layer of silt loam and, in most places, has a thicker surface layer than the Nora soil described as representative of the series.

Included with these soils in mapping are small areas of Alcester soils on foot slopes and along drainageways. Outcrops of glacial till and limestone are in some areas and are shown on the soil map by a special symbol.

Runoff is rapid, and the hazard of erosion is very severe. Controlling erosion is the main concern of management.

All areas remain in native vegetation and are used mainly for pasture. Deciduous trees and shrubs are in many areas, mainly on the Nora soil. Some trees are cut for posts, poles, and fuelwood and, in places, for saw logs. These soils are best suited to pasture, woodland, recreation, and wildlife habitat. Windbreak group 10; Nora soil in capability unit VIe–1 and pasture group F; Crofton soil in capability unit VIIe–1, not placed in a pasture group.

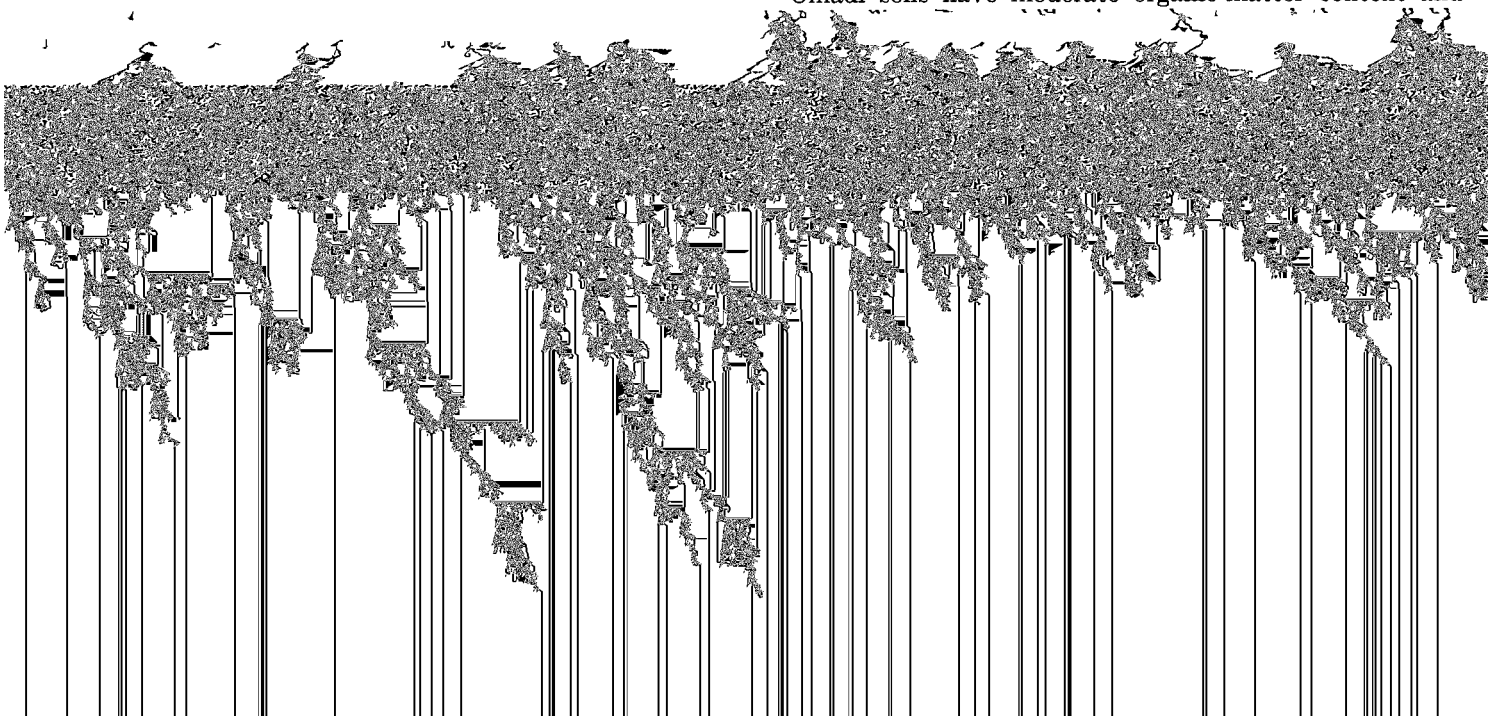
Omadi Series

The Omadi series consists of deep, well drained, nearly level, silty soils on high bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses.

In a representative profile the surface layer is grayish brown silt loam about 11 inches thick. The lower 3 inches is calcareous. Below that is calcareous, light brownish gray silt loam about 8 inches thick. The underlying material is calcareous silt loam that is mostly light gray and light brownish gray but has thin layers of dark grayish brown between depths of 22 and 28 inches.

Omadi soils have moderate organic-matter content and

***Figure 11.*—Profile of Nora silty clay loam, 6 to 10 percent slopes.**



lens of very fine sandy loam at a depth of about 20 inches; strong effervescence; mildly alkaline; clear smooth boundary.

C2—22 to 28 inches; dark grayish brown (10YR 4/2) and light brownish gray (2.5Y 6/2) silt loam, very dark brown (10YR 2/2) and grayish brown (2.5Y 5/2) moist; few

Representative profile of Onawa silty clay, in cultivation, 2,270 feet north and 750 feet west of the southeast corner of sec. 25, T. 91 N., R. 50 W.

Ap—0 to 7 inches; grayish brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate fine granular

lying material to a depth of 25 inches is calcareous, grayish brown and gray silty clay. Below this it is calcareous, light brownish gray, stratified fine sand and loamy fine sand.

Percival soils have moderately low organic-matter content and low fertility. Permeability is slow in the clayey

Salix Series

The Salix series consists of deep, moderately well drained, nearly level, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall

Included with this soil in mapping are small areas of Benclare and Kennebec soils in swales and concave low areas.

Runoff is slow. Areas along the Big Sioux River are flooded in some years, but wetness generally is not a problem. This soil has only slight limitations for crops.

Most areas are used for crops, and a few areas are irrigated. Corn and soybeans are the main crops, but this soil is well suited to all crops grown in the county. Capability unit I–1, pasture group F, windbreak group 3.

Salmo Series

The Salmo series consists of deep, somewhat poorly drained, level, silty soils that are high in salt content. These soils are on bottom lands. They formed in alluvium. The native vegetation consisted mainly of tall grasses, sedges, and a few deciduous trees.

5/6) mottles, moist, and few fine distinct dark reddish brown (5YR 2/2) mottles, moist; massive; hard, firm, sticky and plastic; many fine and medium segregations of lime; strong effervescence; moderately alkaline.

The greatest accumulation of salts other than gypsum is in the A horizon. Electrical conductivity of the saturation extract ranges from 4 to 16 millimhos per centimeter in the upper 15 inches and from 4 to 8 below this. The A horizon is dark gray or very dark gray in a hue of 10YR, 2.5Y, or 5Y, or it is neutral. It ranges from 11 to 20 inches in thickness. The C horizon ranges from dark gray to light olive gray in a hue of 5Y or 2.5Y, or it is neutral. In places the C horizon below a depth of 40 inches is thinly stratified with lenses of fine sand or silty clay.

Salmo soils are near Blencoe, Blyburg, James, Luton, Omadi, and Salix soils. Salmo soils contain more salts than Blencoe, Blyburg, Luton, Omadi, and Salix soils. They contain less clay than James soils.

Sb—Salmo silty clay loam, somewhat poorly drained. This is a level soil on bottom lands. Slopes are 0

of 10 and 40 inches averages loamy fine sand or fine sand. The C horizon is mildly alkaline or moderately alkaline.

Sarpy soils are more sandy between depths of 10 and 40 inches than the nearby Albaton, Grable, Haynie, Onawa, and Percival soils.

native vegetation and are used for pasture. Unless irrigated, this soil is better suited to small grain and tame grasses than to row crops. Capability unit IVs-1, pasture group H, windbreak group 7.

SeA—Sarpy soils, 0 to 3 percent slopes. These nearly

and strong brown (7.5YR 5/6) mottles, moist; weak coarse subangular blocky structure parting to weak medium and fine subangular blocky; hard, firm, slightly sticky and slightly plastic; common medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—33 to 60 inches; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) moist; common medium and coarse distinct yellowish brown (10YR 5/6), strong

Storla Series

The Storla series consists of calcareous, somewhat poorly drained, nearly level, loamy soils that are moderately deep over gravelly sand. These soils are on bottom lands. They formed in alluvium overlying outwash sand and gravel. The native vegetation consisted mainly of tall grasses and sedges.

about 3 to 10 percent in the A horizon and from about 16 to 30 percent in the Cca horizon. The A horizon is very dark gray or dark gray in a hue of 10YR or 2.5Y. It is 6 to 10 inches thick. Reaction in all horizons is mildly alkaline or moderately alkaline. Some pedons lack an ACca horizon. Segregations of gypsum and lime range from few to many in the Cca horizon. The IIC horizon ranges from loamy sand to gravel.

Storla soils are near Calco, Dempster, Enet, and Graceville soils. Storla soils are better drained and have a more sandy C horizon than Calco soils. They are more poorly drained and more calcareous than Dempster, Enet, and Graceville soils.

St—Storla loam. This is a nearly level soil on high stream bottoms. The areas are long and narrow and range to 160 acres in size. Slopes are 0 to 2 percent. In most areas this soil has the profile described as representative of the series.

C2ca—41 to 50 inches; pale brown (10YR 6/3) loamy fine sand, yellowish brown (10YR 5/4) moist; single grained; loose; few fine concretions and segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C3ca—50 to 60 inches; pale brown (10YR 6/3) fine sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; few fine concretions and segregations of lime; strong effervescence; mildly alkaline.

Depth to lime ranges from 30 to 60 inches or more. The A horizon is dark gray to grayish brown fine sandy loam, loamy fine sand, or loam. It is 10 to 15 inches thick. Some pedons lack an AC horizon. The C horizon to a depth of 40 inches is loamy fine sand or fine sand, but below 40 inches it ranges from sand to silt loam.

Thurman soils are more sandy in horizons immediately below a depth of 10 inches than nearby Crofton, Dempster, Enet, Moody, and Nora soils. They contain less gravel in the C horizon than

C1ca—10 to 17 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; weak coarse subangular blocky structure; slightly hard, friable; common very dark brown (10YR 2/2) worm casts, moist; many fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2ca—17 to 31 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; few fine distinct yellowish brown (10YR 5/6) mottles, moist, and few fine faint olive gray mottles, moist; weak coarse subangular blocky structure; slightly hard, friable; few fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

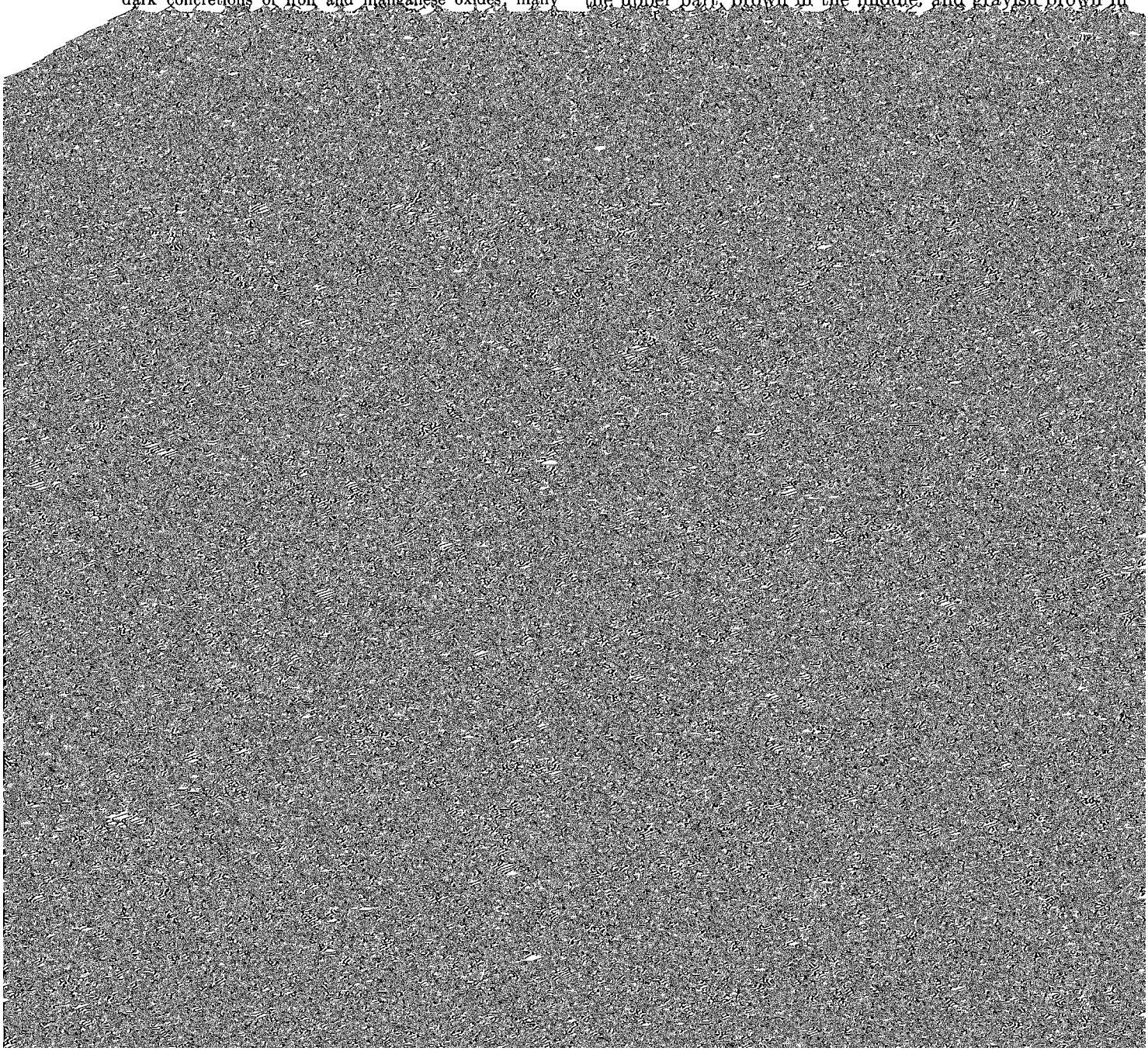
C3cacs—31 to 45 inches; light yellowish brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) moist; many fine distinct strong brown (7.5YR 5/6), light gray (5Y 6/1), and dark reddish brown (5YR 2/2) mottles, moist; weak coarse subangular blocky structure; hard, friable; common fine dark concretions of iron and manganese oxides; many

group 1; Worthing soil in capability unit IIIw–1 drained and Vw–2 undrained, pasture group A drained and B undrained, windbreak group 10; Chancellor soil in capability unit IIw–1, pasture group A, windbreak group 2.

Wentworth Series

The Wentworth series consists of deep, well drained, nearly level to gently sloping, silty soils on uplands. These soils formed in silty glacial drift. The native vegetation consisted mainly of mid and tall grasses.

In a representative profile the surface layer is dark grayish brown silty clay loam about 9 inches thick. The subsoil is silty clay loam about 27 inches thick. It is grayish brown in the upper part, brown in the middle, and grayish brown in



loam at a depth of 50 inches; common fine dark concretions of iron and manganese oxides; common fine segregations of lime; strong effervescence; mildly alkaline.

Depth to free carbonates ranges from 18 to 32 inches. The A horizon ranges from very dark gray to dark grayish brown. It is slightly acid or neutral and is 6 to 10 inches thick. The B2 horizon has colors in a hue of 10YR or 2.5Y that range from dark grayish brown to light olive brown in the upper part and from brown to light yellowish brown in the lower part. It is 12 to 22 inches thick. The B3ca horizon is 6 to 10 inches thick. The C horizon is silty clay loam or silt loam and commonly is stratified with thin layers of loam, very fine sandy loam, or sandy loam. It is mildly alkaline or moderately alkaline. In places clay loam or loam glacial till is at a depth of 40 to 60 inches.

Wentworth soils are mapped with or are near Chancellor, Egan, and Worthing soils and are similar to Moody and Nora soils. Wentworth soils are better drained and have a less clayey B horizon than Chancellor and Worthing soils. They have deeper silty horizons than Egan soils. Unlike Moody and Nora soils, Wentworth soils have a silty C horizon that is thinly stratified with loamy material.

WbA—Wentworth silty clay loam, 0 to 2 percent slopes. This is a nearly level soil on uplands in irregularly shaped areas that are mostly less than 150 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Egan and Worthing soils. Egan soils are on very slight rises. Worthing soils are in small depressions less than 2 acres in size that are shown on the soil map by a wet spot symbol.

Runoff is slow, and the hazard of erosion is slight. This soil has few or no limitations for crops. Maintaining fertility is the main concern of management.

Almost all areas are used for crops. Corn, oats, soybeans, [illegible] This soil is well suited to all

Most areas are used for crops. If the Worthing soil is adequately drained, this complex is suited to all crops grown in the county. In wet years, however, it is better suited to late-planted crops. Undrained areas of the Worthing soil are best suited to pasture or hay, but annual crops can be grown in dry years. Wentworth soil in capability unit I–2, pasture group F, windbreak group 3; Worthing soil in capability unit IIIw–1 drained and Vw–2 undrained, pasture group A drained and B undrained, windbreak group 10.

Whitewood Series

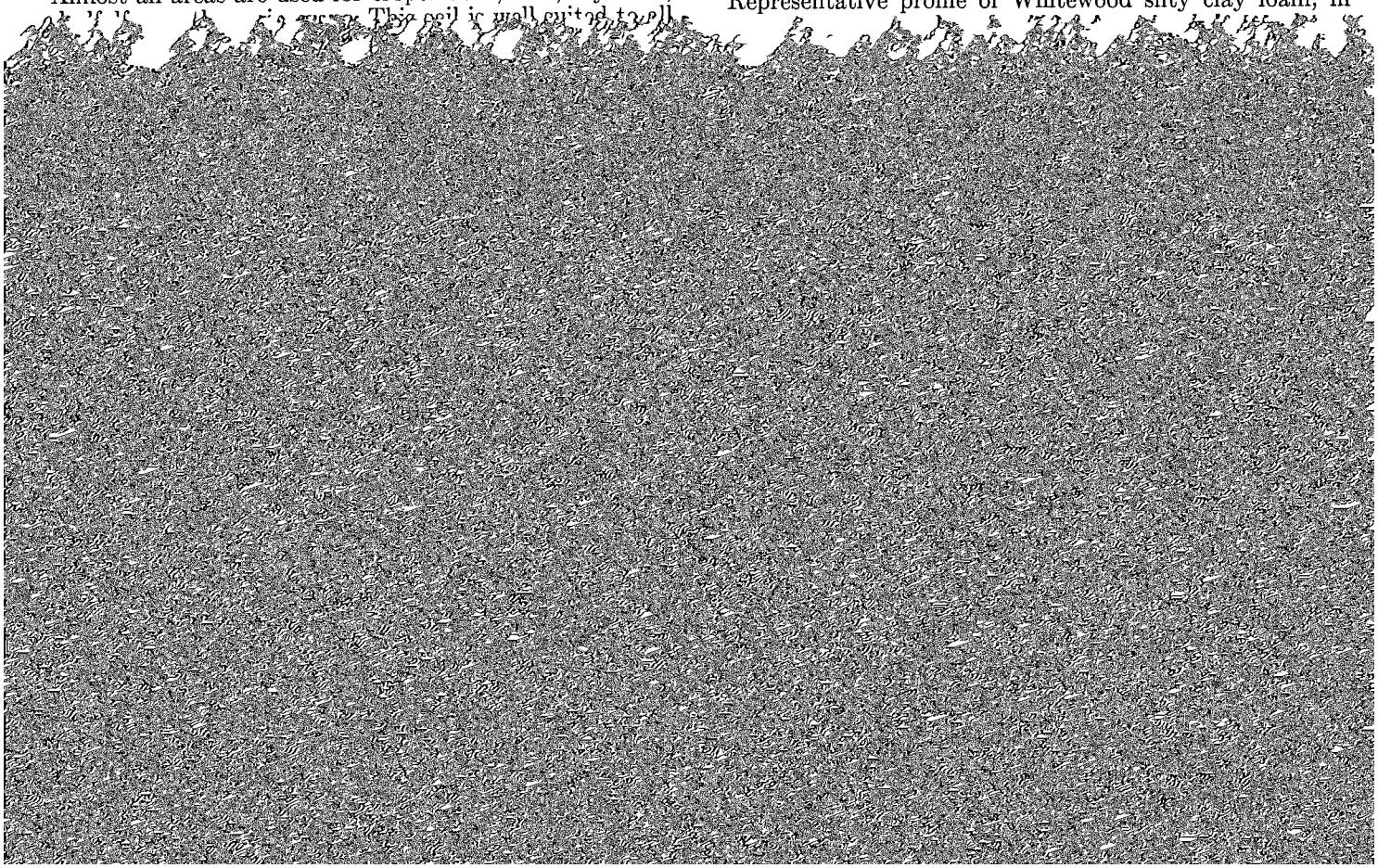
The Whitewood series consists of deep, somewhat poorly drained, nearly level, silty soils on bottom lands. These soils formed in alluvium. The native vegetation consisted mainly of tall grasses and a few deciduous trees along stream channels.

In a representative profile the surface layer is dark gray silty clay loam about 14 inches thick. The subsoil is silty clay loam about 28 inches thick. It is dark grayish brown in the upper part, gray in the middle, and grayish brown in the lower part. The underlying material is calcareous, light brownish gray silty clay loam.

Whitewood soils have high fertility and high organic-matter content. Permeability is moderately slow, and the available water capacity is high. These soils have a seasonal water table at a depth of 1 to 5 feet, and they are occasionally flooded.

Most areas are used for crops. A few areas are used for pasture.

Representative profile of Whitewood silty clay loam, in



(10YR 2/2), and light gray (5Y 6/1) mottles, moist, and many fine faint dark gray mottles, moist; massive; hard, friable, slightly sticky and slightly plastic; common fine concretions of lime; strong effervescence; mildly alkaline.

Depth to lime ranges from 40 to 52 inches. The A horizon is dark or very dark gray silty clay loam or silt loam 14 to 20 inches thick. The B2 horizon ranges from dark gray to grayish brown in a hue of 10YR, 2.5Y, or 5Y. It is 14 to 20 inches thick. The B3g horizon is 4 to 12 inches thick. In places the C horizon below a depth of 40 inches is calcareous clay loam glacial till.

slightly sticky and slightly plastic; slightly acid; clear wavy boundary.

A13—12 to 19 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; few medium faint dark gray mottles, moist, and few fine distinct strong brown (7.5YR 5/6) mottles, moist; weak coarse and medium subangular blocky structure parting to weak fine subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine pores; few visible sand grains and silt coatings on faces of peds; slightly acid; clear wavy boundary.

B21—19 to 28 inches; dark gray (5Y 4/1) silty clay, black (5Y 2/1)

Included with these soils in mapping are small areas of Wakonda soils in narrow bands around depressions or on the edges of swales.

Runoff is slow on the Chancellor soil, and water ponds on the Worthing soil. Wetness that results from ponded water and from the seasonal water table commonly delays planting in spring. These soils compact and lose their tilth if farmed when wet. Overcoming wetness and maintaining tilth are the main concerns of management.

If the Worthing soil is adequately drained, this complex is suited to all crops grown in the county. It generally is better suited to late-planted crops than to spring-sown crops. In some undrained areas the Worthing soil is better suited to pasture or hay. Worthing soil in capability unit IIIw–1 drained and Vw–2 undrained, pasture group A drained and B undrained, windbreak group 10; Chancellor soil in capability unit IIw–1, pasture group A, windbreak group 2.

Use and Management of the Soils

This section discusses the use and management of the soils for crops and pasture, for trees and shrubs in windbreaks, for

and diversions also help to control erosion. Usually a combination of practices is more effective than just one or two.

Among the practices that help to maintain tilth are minimum tillage, use of crop residue, timely tillage, use of green-manure crops, and grasses and legumes in the cropping system. These measures and the use of animal manure and chemical fertilizers help to maintain fertility and organic-matter content.

Some soils are more susceptible to soil blowing than others. On such soils, in addition to the practices named above, the use of cover crops and close-sown crops, wind stripcropping, field windbreaks, and spring plowing in place of fall plowing help to control soil blowing. Emergency tillage helps to control soil blowing until more permanent measures can be applied.

Some soils on bottom lands and in low areas in the uplands are too wet to be farmed early, but this wetness can be reduced by installing drainage structures and controlling the runoff from adjacent sloping soils. Selection of crops is also important. The natural drainage of the soil and the feasibility of installing artificial drainage must be determined onsite.

Capability grouping

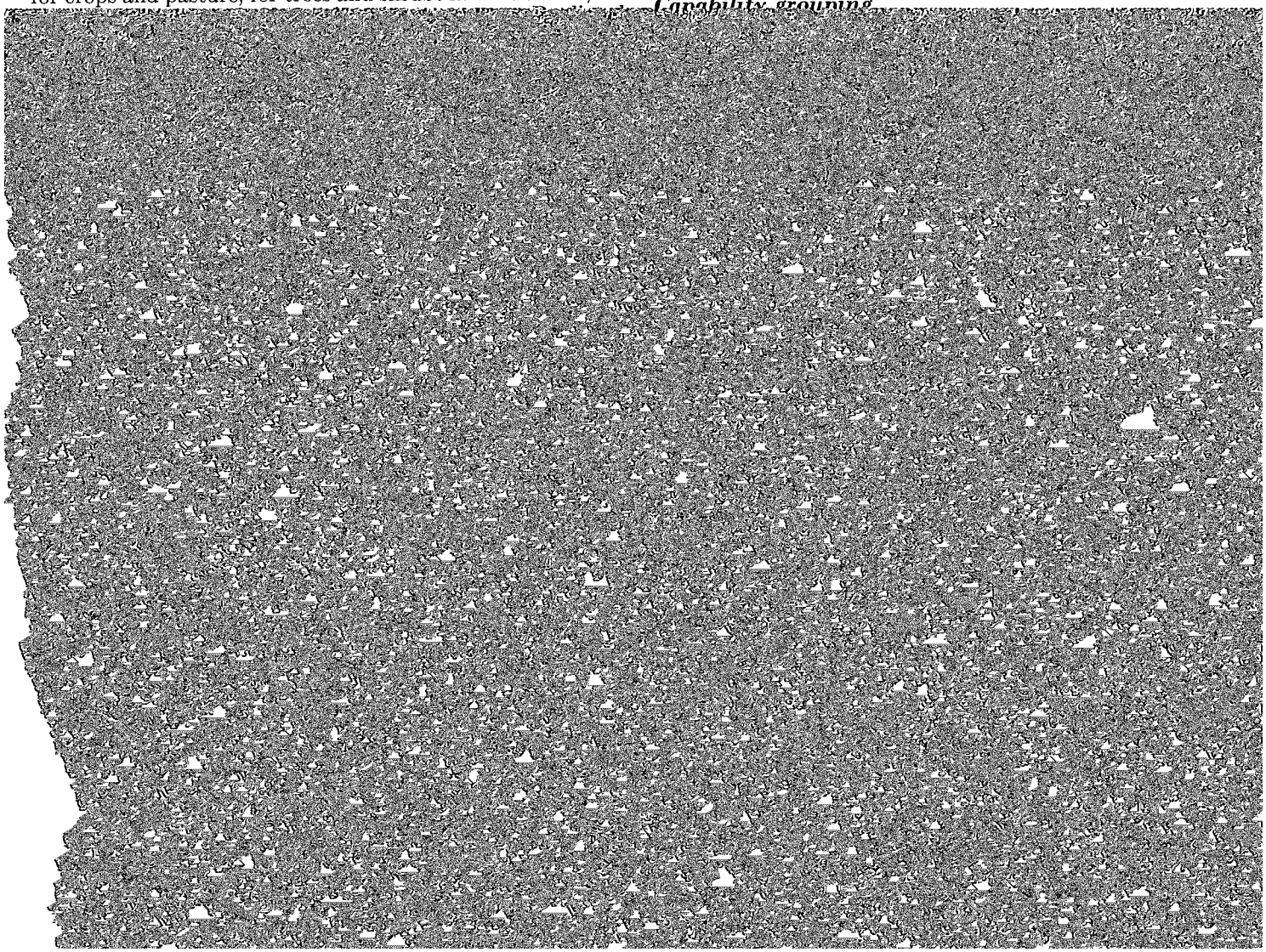


Figure 13.—**Terracing on Crofton-Nora silt loams, 6 to 12 percent slopes, eroded.**

use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuitable for cultivation and restrict their use largely to pasture or range, woodland, or wildlife

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management (*6*). Thus, the capability unit is a

Most have similar textures in the underlying layers, but one soil is silty clay at a depth of about 24 inches.

These soils are easy to work and have medium to high fertility. The available water capacity is high in most soils. Some have a seasonal high water table and some are subject to flooding, but in most years the additional moisture is beneficial and wetness is not a problem. Runoff is slow. There is no hazard of erosion and soil blowing, or the hazard is only slight. These soils can be farmed intensively without damage. Maintaining fertility is the main concern of management.

These soils are used mostly for corn, soybeans, oats, and alfalfa. They also are well suited to tame and native grasses. Most of the soils are well suited to irrigation.

Managing crop residue, using grasses and legumes in the cropping system, and applying fertilizer help to maintain fertility. Plowing in spring or leaving fields rough after fall plowing helps to control soil blowing.

CAPABILITY UNIT I-2

This unit consists of deep, well drained, nearly level soils on uplands. These soils have a surface layer and subsoil of silty clay loam.

These soils are easy to work and have high fertility. The available water capacity is high, and permeability is moderate. Runoff is slow, and the hazard of erosion is slight. These soils have only slight limitations for crops and can be farmed intensively.

These soils are used mainly for corn, soybeans, oats, and alfalfa. They also are well suited to tame grasses.

Managing crop residue, using grasses and legumes in the cropping system, and applying fertilizer help to maintain fertility and tilth.

CAPABILITY UNIT I-3

Graceville silty clay loam is the only soil in this unit. It is a moderately well drained, nearly level soil on stream terraces. It has a subsoil of silty clay loam and is underlain by gravelly sand at a depth of about 52 inches.

This soil has high fertility. The available water capacity is

Proper management of crop residue and contour farming help to control erosion. Grassed waterways help to prevent gullying.

CAPABILITY UNIT IIe-3

This unit consists of deep, well drained, gently sloping soils on uplands. The surface layer is silty clay loam, and the subsoil is silty clay loam or silt loam.

These soils are easy to work and have medium or high fertility. The available water capacity is high. All of these soils have moderate permeability in the subsoil, but in places permeability is moderately slow in the underlying material. Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main concern of management. Conserving moisture, controlling soil blowing, and maintaining fertility are also concerns.

Most areas are cultivated and are used for corn, soybeans, small grains, and alfalfa. These soils also are suited to tame and native grass pasture.

Contour farming and terracing help to control erosion and conserve moisture. If slopes are too irregular for these mechanical practices, erosion and soil blowing can be controlled by properly managing crop residue and using more close-sown crops.

CAPABILITY UNIT IIe-4

The Wakonda part of the Wakonda-Worthing-Chancellor complex is the only soil in this unit. It is a deep, moderately well drained, nearly level soil on uplands. It is silt loam throughout and has a high content of lime.

This soil has medium fertility. The available water capacity is high, and permeability is moderate. Runoff is slow. The high content of lime causes this soil to blow easily and also affects crop growth. In some years wetness from a seasonal high water table delays planting and tillage. Controlling soil blowing and improving fertility are the main concerns of management but improving drainage and maintaining tilth are also concerns.

Most areas are cultivated and are used for corn, soybeans, small grain, sorghum, and alfalfa. This soil also is suited to

Most areas are used for corn, soybeans, small grain, and alfalfa. In wet years these soils are better suited to late-planted crops than to small grain. They also are suited to tame and native grass pasture.

Surface or underground drains help to control wetness. Managing crop residue, minimum tillage, and timely tillage help to maintain tilth, improve water intake rate, and control soil blowing. Fall plowing generally is more satisfactory than spring plowing.

CAPABILITY UNIT IIw-2

Whitewood silty clay loam is the only soil in this unit. It is a somewhat poorly drained, nearly level, silty soil on narrow bottom lands. It has a surface layer and subsoil of silty clay loam.

This soil has high fertility. The available water capacity is high, and permeability is moderately slow. Runoff is slow. Wetness that results from flooding and from a seasonal high water table commonly delays planting and tillage, but if these soils are properly drained, they can be used for crops in most years. Controlling wetness, maintaining tilth, and improving water intake rate are the main concerns of management.

In drained areas, this soil is suited to corn, soybeans, small grain, sorghum, alfalfa, and tame grasses. It is better suited to late-planted crops such as corn, soybeans and sorghum than to early-sown crops.

If outlets are available, the water table can be lowered by underground drains. Constructing dikes, floodwater diversions, or floodways to remove excess water help to reduce damage from flooding. Proper management of crop residue, minimum tillage, and timely tillage help to maintain tilth.

CAPABILITY UNIT IIw-3

This unit consists of deep, moderately well drained to poorly drained, level soils on bottom lands. The surface layer and the upper part of the underlying material are silty clay loam or silty clay. At a moderate depth the underlying material ranges from silty clay loam to fine sand.

These soils have medium to high fertility. The available water capacity is moderate or high in most areas but low in the soil that has sandy underlying material. Permeability is moderate to slow in the upper part of these soils but moderate to rapid in the underlying layers. Wetness that results from flooding and from a seasonal high water table commonly delays planting and tillage, but drainage is adequate for intensive cropping in most years. These soils compact and lose their tilth if farmed when wet. Controlling wetness, improving water intake rate, and maintaining tilth and fertility are the main concerns of management.

Most areas are used for corn, soybeans, small grain, and alfalfa. These soils are better suited to late-planted crops such gravelly sand, gravelly loamy sand, or fine sand. These soils are on terraces and bottom lands. They have a surface layer of loam, silt loam, and silty clay loam.

These soils are easy to work and have medium fertility. Because the available water capacity is moderate or low, the soils are somewhat droughty. Permeability is moderate in the upper layers but rapid in the underlying gravelly material. Runoff is slow. Conserving moisture is the main concern of management. Controlling soil blowing and maintaining fertility are also concerns.

Most areas are cultivated and are used for corn, oats, soybeans, and alfalfa. Some areas are irrigated. Soils in nonirrigated areas are better suited to early-maturing crops, such as small grain and tame grasses, than to late-maturing crops, such as corn and soybeans. The soils also are suited to tame and native grass pasture.

Proper management of crop residue and wind stripcropping help to conserve moisture and control soil blowing. Leaving the surface rough after fall plowing helps to catch moisture and control soil blowing. Applying fertilizer helps to maintain fertility.

CAPABILITY UNIT IIIe-2

This unit consists of deep, well drained, sloping soils on uplands. These soils have a surface layer of silty clay loam and a subsoil of silty clay loam or silt loam.

These soils are easy to work and have high or medium fertility. The available water capacity is high. Permeability is mostly moderate, but one soil in this unit has moderately slow permeability in the underlying material. Runoff is medium, and the hazard of erosion is severe—especially if row crops are grown. Controlling erosion is the main concern of management. Maintaining fertility and tilth and conserving moisture are also concerns.

Most areas are used for corn, oats, soybeans, and alfalfa. Some areas are in tame grass and are used for pasture and hay.

Proper management of crop residue, terracing, and grassed waterways help to control erosion and conserve moisture. If slopes are too irregular for mechanical controls, using fewer row crops and more small grain, tame grasses, and legumes in the cropping system helps to control erosion and conserve moisture. Applying fertilizer helps to maintain fertility.

CAPABILITY UNIT IIIe-6

This unit consists of deep, well drained, gently sloping and gently undulating soils on uplands. The surface layer is silt loam or clay loam. These soils are calcareous at a depth of 8 inches.

These soils are easy to work but have low or medium fertility. The available water capacity is high. Permeability is mostly moderate in the subsoil or underlying material, but

of crop residue, minimum tillage, and plowing in spring rather than in fall also help to control erosion and soil blowing. Applying animal manure and chemical fertilizer helps to improve fertility.

CAPABILITY UNIT IIIw-1

This unit consists of deep, poorly drained, level soils in depressions on uplands. The surface layer is silty clay loam, and the subsoil is silty clay.

These soils have high fertility and high available water capacity. Water ponds on these soils, and they commonly remain wet during spring. However, drainage either has been provided or is feasible, and crops can be grown in most years. These soils compact and lose their tilth if farmed when wet.

Most areas are used for crops. These soils are better suited to corn, soybeans, and sorghum than to spring-sown small grain because they are wet in spring. This soil also is suited to tame and native grass pasture.

Maintaining existing drainage systems or constructing open and underground drains helps to remove excess water and lower the water table. It also helps leach salts from the upper part of the soil. Dikes or floodwater diversions help to reduce damage from flooding. Proper management of crop residue, timely tillage, and the use of grasses and legumes in the cropping system help to maintain tilth and fertility. Applying animal manure and fertilizer helps to maintain fertility.

CAPABILITY UNIT IVe-2

This unit consists of deep, well drained, sloping to strongly sloping soils on uplands. These soils are silt loam or clay loam throughout, and most are calcareous at a depth of 8 inches or less. Some of the soils are moderately eroded to severely eroded.

These soils are easy to work but have low or medium fertility. The hazards of erosion and soil blowing are severe. The available water capacity is high, and permeability is moderate to moderately slow. Runoff is medium. Controlling erosion and soil blowing and improving fertility are the main concerns of management. Improving the organic-matter content and conserving moisture in the soil are also concerns.

Most areas are used for corn, oats, alfalfa, and tame grasses. These soils are better suited to close-sown crops than to row crops because of the severe erosion hazard. They are also suited to tame and native grass pasture.

Proper management of crop residue, minimum tillage, [illegible] bluestem, western wheatgrass, green needlegrass, needleandthread, and sideoats grama. If these pastures are in excellent condition, the annual air-dry yield per acre ranges from about 2,300 pounds in a dry year to about 4,300 in a year of favorable moisture.

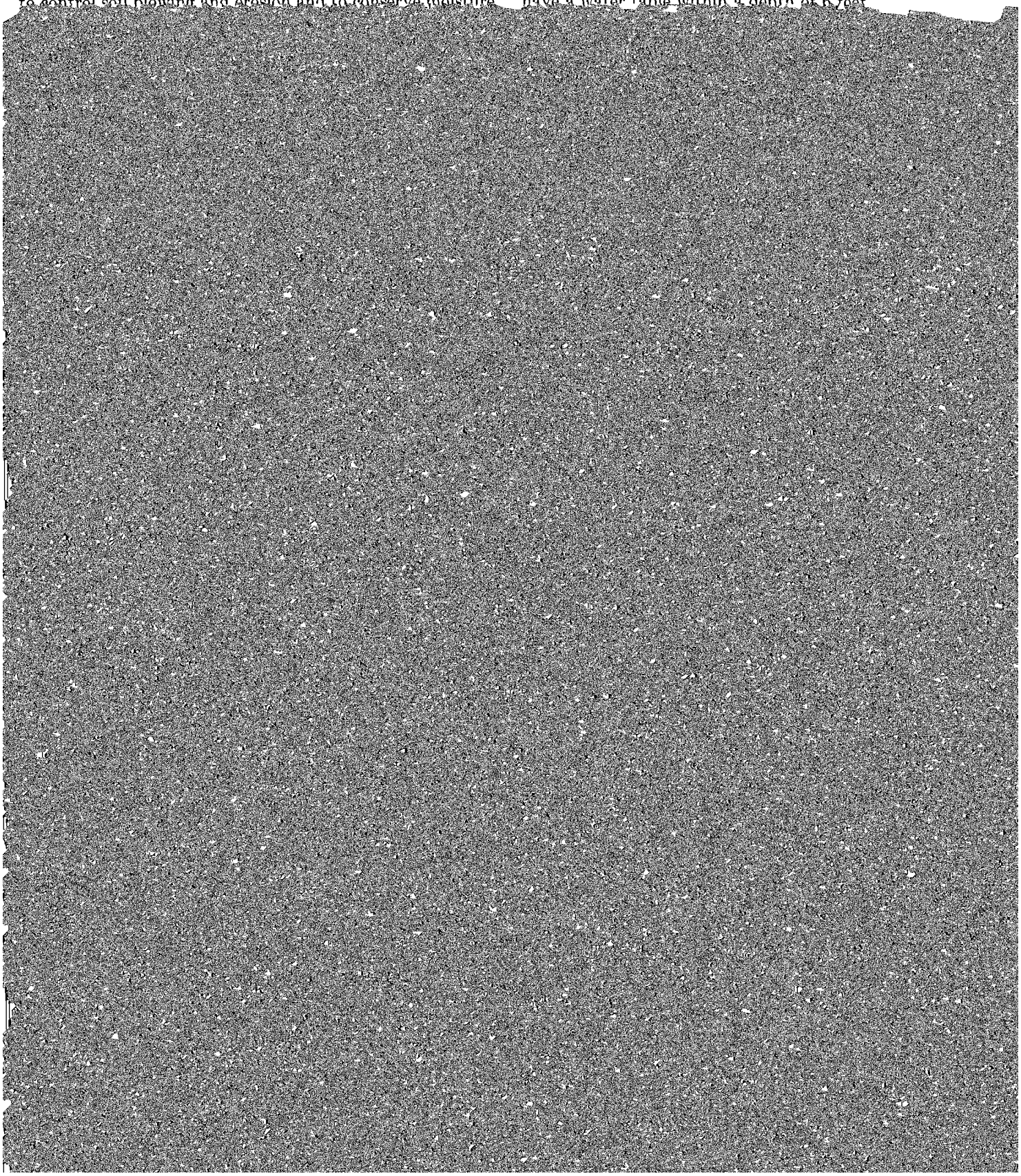
CAPABILITY UNIT IVe-3

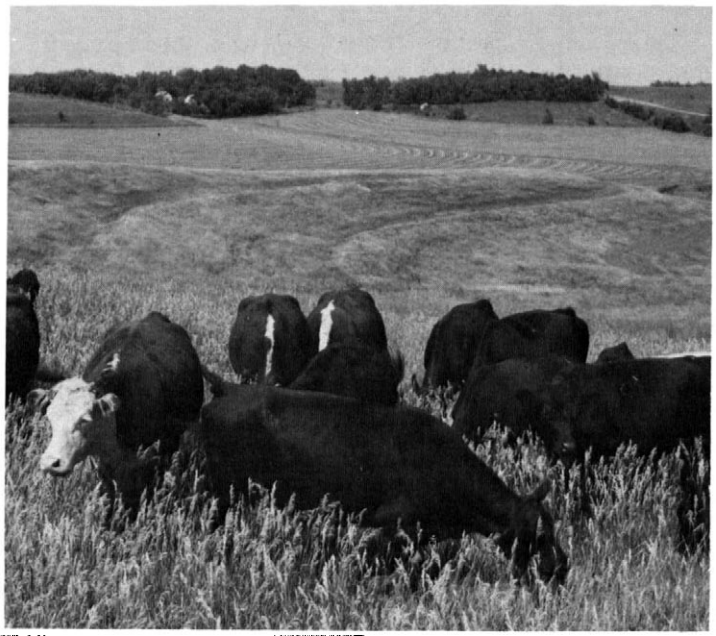
Thurman fine sandy loam, 3 to 9 percent slopes, is the only soil in this unit. It is a deep, somewhat excessively drained, gently undulating to undulating soil on uplands and terrace fronts. The surface layer is fine sandy loam, and the underlying material is mainly loamy fine sand.

This soil takes in water readily, but the available water capacity is low or moderate and the soil is somewhat droughty. Fertility is medium, and organic-matter content is moderately low. Permeability is rapid. Runoff is slow, but cultivated areas are subject to soil blowing and erosion. Controlling soil blowing and conserving moisture are the

sown crops in the cropping system, and field windbreaks help to control soil blowing and erosion and to conserve moisture.

acre is about 3,500 pounds. The yield is higher in places that have a water table within a depth of 6 feet.





CAPABILITY UNIT VIs-1

Sarpy loamy fine sand, 3 to 9 percent slopes, is the only soil in this unit. It is a deep, excessively drained, sandy soil on bottom lands. The underlying material is stratified loamy fine sand and fine sand.

This soil has low fertility and low organic-matter content. The hazard of soil blowing is very severe. The available water capacity is low, and the soil is droughty. Permeability is rapid. Runoff is slow. This soil is not suited to cultivated crops because of the soil blowing hazard and droughtiness.

Most areas remain in native pasture and are used for pasture. Some areas are wooded. Maintaining a good grass cover helps to control soil blowing and conserve moisture. Important grasses are big bluestem, little bluestem, needle-andthread, prairie sandreed, sand bluestem, and switchgrass. If these pastures are in excellent condition, the annual air-dry yield per acre ranges from 1,800 pounds in a dry year to 3,500 pounds in a year of favorable moisture.

CAPABILITY UNIT VIIe-1

The Crofton part of Nora-Crofton silt loams, 20 to 50 percent slopes, is the only soil in this unit. It is deep, well drained, and moderately steep to very steep. It is calcareous

PASTURE GROUP B

This group consists of deep, somewhat poorly drained and poorly drained, silty and clayey soils on bottom lands and in depressions on uplands. These soils have a water table within the root zone. They also receive additional moisture from stream flooding or as runoff from adjacent soils. These soils are not artificially drained, and in many areas improving drainage is not feasible.

to such grasses and legumes as alfalfa, big bluestem, indiangrass, intermediate wheatgrass, smooth bromegrass, and switchgrass.

PASTURE GROUP J

This group consists of deep, poorly drained and somewhat poorly drained, silty and clayey soils that have a high content of salts at or near the surface. These soils are on bottom

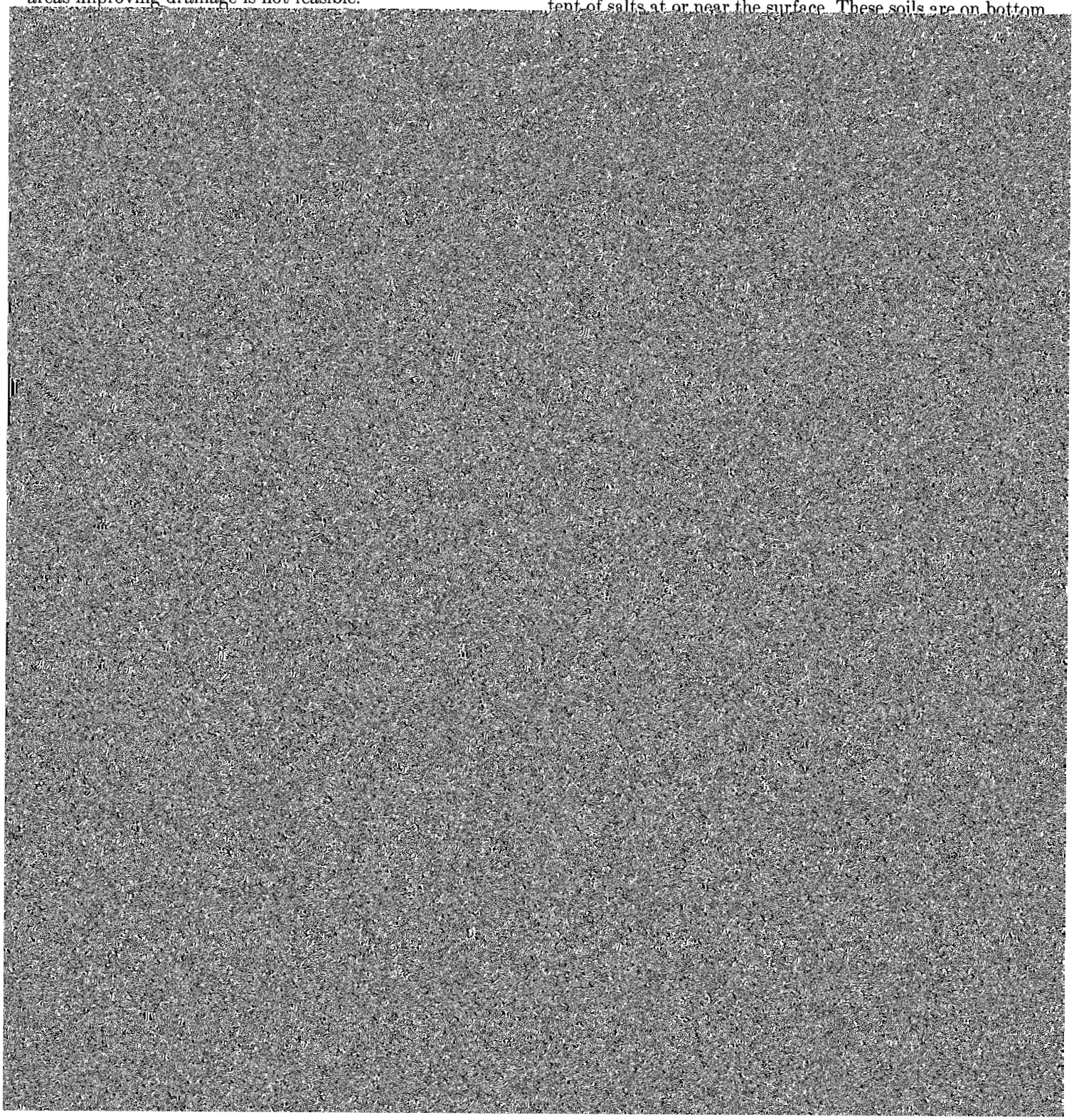


TABLE 2.—*Predicted average annual yields per acre of principal dryfarmed crops and tame pasture*

[Yields in columns A can be expected under prevailing management; yields in columns B can be expected under improved management. Only soils suitable for crops or tame pasture are listed. The absence of a yield figure indicates that the crop is not commonly grown on the soil or that the soil is not suited to the crop. Yields for soil complexes are weighted averages based on the proportionate extent and relative productivity of the soils in the complex]

Soil	Corn		Oats		Soybeans		Alfalfa		Pasture	
	A	B	A	B	A	B	A	B	A	B
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 2.—*Predicted average annual yields per acre of principal dryfarmed crops and tame pasture*—Continued

Soil	Corn		Oats		Soybeans		Alfalfa		Pasture	
	A	B	A	B	A	B	A	B	A	B
	Bu	*Bu*	*Bu*	*Bu*	*Bu*	*Bu*	*Tons*	*Tons*	*AUM* [1]	*AUM*
Wentworth-Worthing silty clay loams	60	80	52	78	20	31	2.5	3.3	4.2	6.0
Whitewood silty clay loam	53	77	52	74	18	29	2.3	3.4	3.8	5.7
Worthing silty clay loam	45	63	49	67	15	24	2.1	3.0	3.4	5.0
Worthing-Chancellor silty clay loams	49	68	50	70	16	26	2.2	3.2	3.6	5.4

[1] AUM, *animal-unit-months*, is a term used to express the carrying capacity of pasture. It is the number of animal units, or 1,000 pounds of live [illegible] This figure multiplied by the number of acres, then divided by the number

Figure 16.—Windbreak used to protect farmstead [illegible]

TABLE 3.—*Estimated height of trees and shrubs at 20 years of age*

[Dashes indicate that the tree or shrub is not suited to soils in the specified group. Windbreak group 10 is not listed because the soils in that group are not suitable for windbreaks]

Trees and shrubs	Windbreak suitability group of soil						
	Group 1	Group 2	Group 3	Group 5	Group 6	Group 7	Group 8
Carolina poplar	35–40	30–35	----	----	----	----	----
Eastern cottonwood	35–40	32–36	----	----	----	----	----
Plains cottonwood	35–40	32–36	----	----	----	----	----
Northwest poplar	40–45	40–45	----	----	----	----	----
Robusta poplar	35–40	30–35	----	----	----	----	----
Chinkota elm	32–36	----	30–32	30–34	16–20	----	18–22
Dropmore elm	32–36	----	30–32	30–34	16–20	----	18–22
Golden willow	32–35	30–34	----	----	----	----	----
Siberian elm	32–36	----	30–32	30–34	16–20	----	18–22
Siouxland cottonwood	35–40	32–36	----	----	----	----	----
Austrian pine	24–30	20–22	22–26	----	----	----	----
Honeylocust	24–30	30–34	26–30	28–32	15–17	----	17–20
Ponderosa pine	24–30	20–22	22–26	20–24	13–15	14–16	14–16
Silver maple	30–35	30–35	25–30	----	----	----	----
White willow	32–35	30–34	----	----	----	----	----
Black Hills spruce	24–30	20–24	24–28	----	----	----	----
Blue spruce	24–30	20–24	24–28	----	----	----	----
Green ash	23–27	20–24	20–24	22–26	22–26	----	14–16
Scotch pine	24–30	20–22	22–26	----	----	----	----
White spruce	24–30	20–24	24–28	----	----	----	----
Bur oak	20–23	18–20	18–20	18–20	----	----	----
Hackberry	23–27	22–26	20–24	21–25	10–12	----	14–16
Laurel willow	20–25	20–25	----	----	----	----	----
Russian mulberry	20–23	18–20	18–20	----	----	----	----
Siberian larch	24–30	20–24	24–28	----	----	----	----
Boxelder	20–22	18–20	20–22	----	----	----	----
Harbin pear	16–18	14–16	15–17	15–17	11–12	----	7–9
Manchurian crabapple	18–20	16–18	15–17	17–19	12–14	----	----
Russian-olive	16–20	14–16	15–18	14–18	9–12	----	14–16
Siberian crabapple	18–20	16–18	15–17	17–19	12–14	----	----
Common chokecherry	12–14	9–11	9–12	9–11	----	----	----
Eastern redcedar	15–18	14–16	13–15	13–15	9–12	9–11	9–11
Manchurian apricot	12–14	12–14	12–15	11–13	----	----	----
Rocky Mountain juniper	15–18	14–16	13–15	13–15	9–12	9–11	9–11
Siberian apricot	12–14	12–14	12–15	11–13	----	----	----
Amur maple	10–12	10–11	9–10	----	----	----	----
Missouri River willow	10–15	10–15	----	----	----	----	----
Siberian peashrub	9–11	7–9	9–10	8–10	6–7	----	7–8
Silver buffaloberry	8–10	6–8	7–9	6–8	5–6	----	4–5
Tatarian honeysuckle	8–10	6–8	7–9	6–7	5–7	----	6–8
American plum	8–9	5–6	8–9	6–7	6–7	----	5–6
Late lilac	8–9	6–7	6–7	----	----	----	----
Lilac	7–8	5–6	6–7	6–7	4–5	----	5–6
Peking cotoneaster	6–7	5–6	5–6	6–7	4–5	----	5–6
Redosier dogwood	6–7	6–7	5–7	----	----	----	----
Golden currant	5–7	5–6	5–6	3–6	----	----	----
Nanking cherry[1]	5–7	6–8	5–6	6–8	----	----	----
Saskatoon serviceberry	5–6	5–6	----	----	----	----	----
Skunkbush sumac	5–7	5–6	5–6	5–7	----	----	----
Western sandcherry[2]	3–4	4–5	3–4	4–5	----	----	----

[1] Generally has a serious decline in vigor in 10 years or less.
[2] Generally has a serious decline in vigor after 5 years.

TABLE 4.—*Suitability for wildlife habitat*

Soil associations	Extent of major soils	Suitability for—		
		Farmland wildlife	Woodland wildlife	Wetland wildlife
	Percent			
1. Wentworth-Shindler-Worthing:				
Wentworth	50	Good	Very poor	Very poor.
Shindler	25	Fair	Very poor	Very poor.
Worthing	15	Fair	Very poor	Good.
2. Wakonda-Worthing-Chancellor:				
Wakonda	35	Fair	Very poor	Poor.
Worthing	25	Fair	Very poor	Good.
Chancellor	25	Good	Very poor	Fair.
3. Moody-Nora-Alcester:				
Moody	50	Good	Very poor	Very poor.
Nora	15	Good	Very poor	Very poor.
Alcester	15	Good	Poor	Very poor.
4. Crofton-Nora-Alcester:				
Crofton	45	Fair	Very poor	Very poor.
Nora	20	Good	Very poor	Very poor.
Alcester	20	Good	Poor	Very poor.
5. Graceville-Dempster:				
Graceville	45	Good	Poor	Very poor.
Dempster	35	Good	Very poor	Very poor.
6. Sarpy-Grable-Haynie:				
Sarpy	50	Poor	Poor	Very poor.
Grable	25	Fair	Fair	Very poor.
Haynie	15	Good	Good	Poor.
7. Calco-Kennebec:				
Calco	70	Poor	Fair	Good.
Kennebec	10	Good	Good	Poor.
8. Kennebec-Fluvaquents-Benclare:				
Kennebec	50	Good	Good	Poor.
Fluvaquents	15	Poor	Good	Fair.
Benclare	10	Good	Fair	Fair.
9. Albaton-Haynie-Onawa:				
Albaton	35	Fair	Fair	Good.
Haynie	25	Good	Good	Poor.
Onawa	20	Good	Good	Fair.
10. Forney-Luton:				
Forney	45	Fair	Poor	Fair.
Luton	25	Fair	Poor	Good.
11. Modale-Blyburg-Benclare:				
Modale	20	Good	Good	Poor.
Blyburg	15	Good	Fair	Very poor.
Benclare	15	Good	Fair	Fair.

erate soil limitations that affect habitat management or construction. A moderate intensity of management and fairly frequent attention may be required to insure satisfactory results.

Poor: Habitat can frequently be established, constructed, improved, or maintained on these soils, but there are rather

Engineering

This section is useful to planning commissions, town and city managers, land developers, engineers, contractors, farmers, and others who need information about soils used as structural material or as foundation on which structures

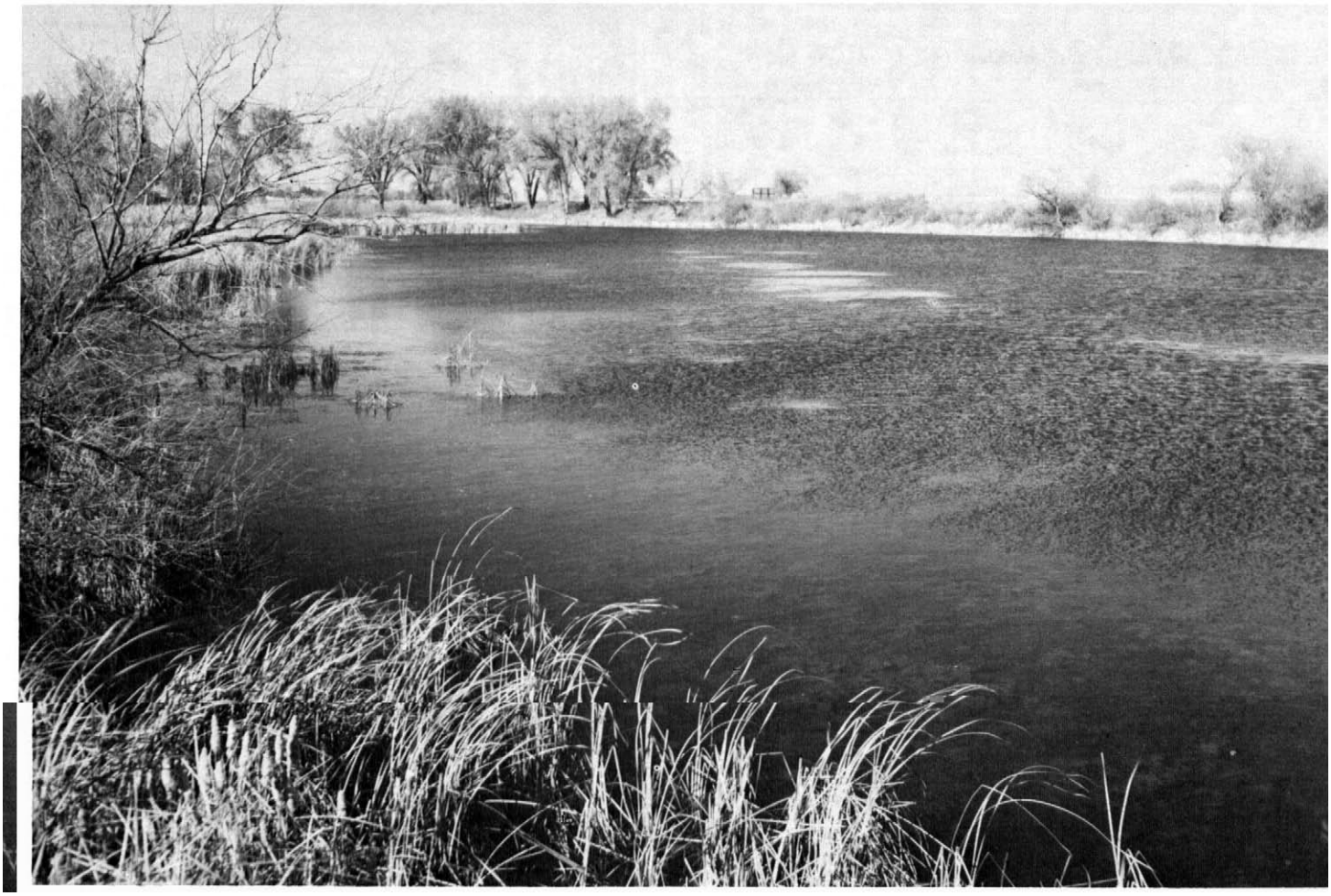


Figure 17.—**This intermittent lake in the Albaton-Haynie-Onawa association provides habitat for wetland wildlife.**

roads, airports, pipelines, foundations for small buildings, engineering, and table 6 gives interpretations for various

TABLE 5.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such column. The symbol > means more

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		Percentage less than 3 inches passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
	Feet	*Inches*					
Albaton: Ab, Ac, Ad	1–3	0–7	Silty clay	CH	A–7	----------	100
		7–60	Silty clay	CH	A–7	----------	100
Alcester: Ae	>5	0–34	Silt loam	ML or CL	A–6 or A–4	----------	100
		34–60	Silty clay loam	CL	A–6 or A–7	----------	100
Benclare: Bd, Be	[1] 3–6	0–16	Silty clay loam	CL, CH, or MH	A–7	----------	100
		16–48	Silty clay	MH, CH, or ML	A–7	----------	100
		48–60	Silty clay loam	CL or CH	A–7	----------	100
Blencoe: Bf	[1] 1–3	0–24	Silty clay	CH or MH	A–7	----------	100
		24–60	Silt loam	ML or CL	A–4 or A–6	----------	100
Blyburg: Bg	>5	0–11	Silt loam	ML or CL	A–4 or A–6	----------	----------
		11–60	Silt loam	ML or CL–ML	A–4	----------	----------
Calco: Ca	[1] 0–3	0–47	Silty clay loam	CL, MH, CH, or ML	A–7	----------	100
		47–60	Silty clay loam	CL, MH, or CH	A–7	----------	100
Chancellor. Mapped only with Wakonda and Worthing soils.	[1] 2–5	0–17	Silty clay loam	CL or CH	A–6 or A–7	----------	100
		17–33	Silty clay	CL or CH	A–7	----------	100
		33–60	Silty clay loam	CL or CH	A–6 or A–7	----------	100
*Crofton: CbE2, CbF, CnB, CnD2. For Nora part of CnB and CnD2, see Nora series.	>6	0–60	Silt loam	ML or CL	A–4, A–6, or A–7	----------	100
Davis: Da	[1] >5	0–52	Loam	CL or ML	A–4 or A–6	100	90–100
		52–60	Loam	CL or ML	A–4 or A–6	100	95–100
Dempster: De	>5	0–17	Silty clay loam	CL	A–6 or A–7	----------	100
		17–34	Silty clay loam	CL	A–6 or A–7	----------	100
		34–60	Gravelly sand	SM, SW–SM, or SM–SC	A–1 or A–2	50–80	30–70
*Egan: EaB, EaC. For Shindler part of EaB and EaC, see Shindler series.	>6	0–13	Silty clay loam	CL or ML	A–6 or A–7	----------	100
		13–30	Silty clay loam	CL or CH	A–6 or A–7	100	95–100
		30–60	Clay loam	CL or CH	A–6 or A–7	95–100	80–100
*Enet: EmA, EnB. For Dempster part of EnB, see Dempster series.	>5	0–20	Loam	ML or CL	A–4 or A–6	90–100	85–100
		20–33	Gravelly sandy loam	SM or SC	A–2 or A–4	60–100	60–95
		33–60	Gravelly loamy sand	GM, SM, SP–SM, or SC–SM	A–1 or A–2	40–80	30–70
Fluvaquents: Fa, Fb. Too variable to be rated.							
Forney: Fc, Fe	[1] 1–3	0–11	Silty clay	CH or MH	A–7	----------	100
		11–60	Silty clay	CH or MH	A–7	----------	100
[illegible]	[illegible]	0–7	Silt loam	CL or ML	A–4 or A–6		100

significant in engineering

mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series as indicated in the first than; the symbol < means less than]

Percentage less than 3 inches passing sieve—Continued		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				In per hr	*In per in of soil*	*pH*	*Mmhos per cm*			
95–100	95–100	55–75	35–55	0.06–0.2	0.10–0.14	7.4–7.8	<2	High	High	Low.
95–100	95–100	60–85	40–60	0.02–0.2	0.08–0.12	7.4–8.4	<2	High	High	Low.
90–100	70–90	20–40	5–25	0.6–2.0	0.19–0.22	6.6–7.3	<2	Moderate	Moderate	Low.
90–100	70–100	30–50	10–30	0.6–2.0	0.17–0.20	6.6–7.8	<2	Moderate	Moderate	Low.
95–100	85–95	40–65	20–40	0.2–0.6	0.19–0.22	5.6–7.3	<2	High	Moderate	Moderate.
95–100	85–100	45–70	15–45	0.06–0.2	0.13–0.18	6.1–7.3	<2	High	Moderate	Moderate.
90–100	80–100	40–60	20–35	0.06–0.2	0.14–0.17	6.1–7.8	<2	High	High	Moderate.
95–100	95–100	50–65	20–35	<0.06	0.13–0.18	6.1–7.3	<2	High	High	Low.
95–100	85–100	30–40	5–20	0.6–2.0	0.17–0.20	6.6–8.4	<2	Moderate	High	Low.
100	90–100	20–40	5–20	0.6–2.0	0.19–0.22	6.6–7.8	<2	Low	Low	Low.
100	70–100	20–35	5–10	0.6–2.0	0.17–0.20	7.4–8.4	<2	Low	Low	Low.
95–100	85–100	40–60	15–35	0.2–0.6	0.19–0.22	7.4–8.4	<2	High	High	Low.
90–100	80–100	40–60	20–35	0.2–0.6	0.17–0.20	7.9–8.4	<2	High	High	Low.
95–100	85–100	35–55	15–35	0.06–0.2	0.19–0.22	6.1–7.3	<2	High	High	Low.
95–100	95–100	40–60	20–40	0.06–0.2	0.13–0.18	6.6–7.3	<2	High	High	Low.
95–100	85–100	35–55	15–35	0.06–0.6	0.14–0.17	6.6–7.8	<2	High	High	Moderate.
95–100	95–100	30–45	5–20	0.6–2.0	0.17–0.20	7.4–8.4	<2	Low	Moderate	Low.
80–100	50–95	25–40	5–20	0.6–2.0	0.18–0.20	6.1–7.3	<2	Moderate	Moderate	Low.
85–100	55–90	25–40	5–20	0.6–2.0	0.16–0.18	6.6–7.8	<2	Moderate	Moderate	Low.
90–100	70–90	30–45	10–25	0.6–2.0	0.19–0.22	5.6–6.6	<2	Moderate	Moderate	Low.
95–100	85–95	30–45	10–25	0.6–2.0	0.17–0.20	5.6–7.3	<2	Moderate	Moderate	Low.
20–50	5–30	<25	[2] NP–5	6.0–20.0	0.03–0.06	5.6–7.8	<2	Low	Moderate	Low.
95–100	85–100	35–50	10–25	0.6–2.0	0.19–0.22	6.1–7.3	<2	Moderate	Moderate	Low.
90–100	80–100	35–55	15–35	0.6–2.0	0.17–0.20	6.6–7.8	<2	Moderate	High	Low.
70–100	60–85	30–55	10–35	0.2–0.6	0.17–0.20	7.4–8.4	<2	Moderate	High	Moderate.
70–95	50–80	25–40	5–20	0.6–2.0	0.18–0.20	6.1–7.3	<2	Low	Low	Low.
50–95	30–50	20–30	5–10	2.0–6.0	0.09–0.13	6.6–7.3	<2	Low	Moderate	Low.
20–50	5–35	<20	NP–5	6.0–20.0	0.03–0.06	7.4–8.4	<2	Low	Moderate	Low.
95–100	95–100	60–85	25–50	0.06–0.2	0.13–0.18	6.1–7.3	<2	High	High	Low.
95–100	95–100	60–85	25–55	<0.06	0.08–0.12	6.1–7.3	<2	High	High	Low.
90–100	75–95	20–40	8–20	0.6–2.0	0.19–0.22	7.4–8.4	<2	Moderate	Moderate	Low.
90–100	75–95	20–40	8–20	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate	Moderate	Low.
80–90	40–60	15–30	3–15	2.0–6.0	0.15–0.17	7.4–8.4	<2	Low	Moderate	Low.
40–60	5–30	<20	NP–5	6.0–20.0	0.06–0.08	7.4–8.4	<2	Low	Moderate	Low.
80–95	70–90	35–50	10–30	0.6–2.0	0.19–0.22	5.6–6.5	<2	Moderate	Moderate	Low.
80–90	75–85	35–50	10–30	0.6–2.0	0.17–0.20	6.1–7.3	<2	Moderate	Moderate	Low.
20–50	5–30	<25	NP–5	6.0–20.0	0.03–0.06	6.6–7.8	<2	Low	Moderate	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		Percentage less than 3 inches passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
	Feet	*Inches*					
Haynie: Ha, Hb	4–8	0–21	Silt loam	ML or CL	A-6 or A-7		100

significant in engineering—Continued

Percentage less than 3 inches passing sieve—Continued		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				In per hr	*In per in of soil*	*pH*	*Mmhos per cm*			
85–100	70–100	30–50	10–25	0.6–2.0	0.17–0.20	7.4–8.4	<2	Low	Moderate	Low.
85–100	60–100	15–30	5–20	0.6–2.0	0.15–0.17	7.4–8.4	<2	Low	Moderate	Low.
90–100	85–95	45–80	20–50	0.06–0.2	0.10–0.15	7.4–9.0	4–20	High	High	High.
90–100	85–95	45–80	20–50	0.06–0.2	0.08–0.13	7.8–9.0	4–8	High	High	High.
95–100	90–100	35–50	15–25	0.6–2.0	0.19–0.22	6.1–7.3	<2	Moderate	Moderate	Low.
70–95	55–80	25–35	5–20	0.6–20.0	0.18–0.20	6.1–7.3	<2	Low or moderate.	Moderate	Low.
95–100	95–100	40–60	15–30	0.2–2.0	0.19–0.22	6.1–7.3	<2	High	High	Low.
95–100	85–100	50–70	20–40	0.2–0.6	0.12–0.16	6.1–7.8	<2	High	High	Low.
95–100	85–100	40–55	15–40	0.2–0.6	0.14–0.17	7.4–8.4	<2	High	High	Low.
95–100	85–95	40–60	20–35	0.2–0.6	0.19–0.22	7.4–8.4	<2	High	High	Low.
95–100	95–100	50–80	20–50	<0.06	0.10–0.14	6.6–7.3	<2	High	High	Low.
95–100	95–100	50–80	20–50	<0.06	0.08–0.12	6.6–8.4	<2	High	High	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal water table	Depth from surface	Dominant USDA texture	Classification		Percentage less than 3 inches passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
	Feet	*Inches*					
Storla: St	2–3	0–14	Loam	ML or CL	A–4 or A–6	100	95–100
		14–31	Loam	ML, CL, or SC	A–4 or A–6	95–100	85–100
		31–60	Gravelly sand	SM, SM–SC, SP–SM, or SW–SM	A–1 or A–2	60–90	45–70
Thurman: TaB	>5	0–10	Fine sandy loam	SC, CL, or SC–SM	A–4	----------	100
		10–50	Loamy fine sand	SM or SP–SM	A–2 or A–3	----------	100
		50–60	Fine sandy loam	SC or SC–SM	A–2 or A–4	----------	100
*Wakonda: Wa. For Chancellor part, see Chancellor series; for Worthing part, see Worthing series.	2–5	0–10	Silt loam	ML or CL	A–4 or A–6	----------	100
		10–45	Silt loam	ML or CL	A–4 or A–6	----------	100
		45–60	Silt loam	CL	A–4, A–6, or A–7	----------	100
*Wentworth: WbA, WbB, Wc. For Worthing part of Wc, see Worthing series.	>5	0–9	Silty clay loam	CL	A–6 or A–7	100	95–100
		9–50	Silty clay loam	CL or CH	A–6 or A–7	100	95–100
		50–60	Stratified loam and silt loam.	CL or ML	A–4, A–6, or A–7	100	95–100
Whitewood: Wh	[1] 1–5	0–30	Silty clay loam	CL, CH, or MH	A–6 or A–7	----------	100
		30–60	Silty clay loam	CL, CH, or MH	A–6 or A–7	----------	100
*Worthing: Wo, Ws. For Chancellor part of Ws, see Chancellor series.	[1] 1–5	0–19	Silty clay loam	CL	A–7	----------	100
		19–45	Silty clay	CH	A–7	----------	100
		45–60	Silty clay loam	CL or CH	A–7	100	95–100

[1] Subject to flooding.

of State Highway and Transportation Officials (AASHTO) (*1*).

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. These are eight classes of coarse-grained soils, identified as GW, and 8; the estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Soil properties significant in engineering

Several estimated soil properties significant in engineering

significant in engineering—Continued

Percentage less than 3 inches passing sieve—Continued		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				In per hr	*In per in of soil*	*pH*	*Mmhos per cm*			
75–95	50–80	30–40	5–20	0.6–2.0	0.18–0.20	7.4–8.4	<2	Moderate	High	Moderate.
60–95	35–80	25–40	5–20	0.6–2.0	0.13–0.15	7.4–8.4	<2	Moderate	High	Moderate.
20–60	5–30	<25	NP–5	6.0–20.0	0.03–0.06	7.4–8.4	<2	Low	High	Moderate.
70–85	40–55	10–25	5–10	2.0–6.0	0.14–0.17	6.1–7.3	<2	Low	Low	Low.
85–100	5–25	<20	NP–5	6.0–20.0	0.08–0.10	6.6–7.8	<2	Low	Low	Low.
70–90	30–50	10–25	5–10	2.0–6.0	0.12–0.15	6.6–7.8	<2	Low	Low	Low.
90–100	85–100	25–40	5–25	0.6–2.0	0.19–0.22	7.4–8.4	2–4	Moderate	High	Low.
90–100	85–100	25–40	5–25	0.6–2.0	0.14–0.17	7.4–8.4	4–8	Moderate	High	Moderate.
85–95	60–90	30–45	10–25	0.6–2.0	0.17–0.20	7.4–8.4	4–8	Moderate	High	Moderate.
95–100	70–90	35–50	15–30	0.6–2.0	0.19–0.22	6.1–7.3	<2	Moderate	Moderate	Low.
85–100	75–100	35–55	15–30	0.6–2.0	0.17–0.20	6.1–7.8	<2	Moderate	Moderate	Low.
85–100	60–100	30–50	5–30	0.6–2.0	0.17–0.20	7.4–8.4	<2	Moderate	High	Low.
95–100	80–95	35–55	15–30	0.2–2.0	0.19–0.22	6.1–7.8	<2	Moderate	Moderate	Low.
95–100	80–95	35–55	15–30	0.2–0.6	0.17–0.20	6.6–7.8	<2	Moderate	High	Low.
95–100	85–95	40–50	20–30	0.2–0.6	0.19–0.22	6.1–6.6	<2	High	Moderate	Low.
95–100	85–100	50–70	25–40	0.06–0.2	0.13–0.18	6.1–7.3	<2	High	High	Low.

TABLE 6.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Roads and streets
Albaton: Ab, Ac, Ad.	Severe: slow to very slow permeability; seasonal high water table. [1]	Severe: subject to flooding. Slight if protected from flooding.	Severe: poorly drained; silty clay texture.	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; silty clay texture.	Severe: poorly drained; high shrink-swell potential.
Alcester: Ae	Moderate: moderate permeability.	Moderate: moderate permeability; gently sloping.	Slight	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam substratum.	Severe: high susceptibility to frost action.
Benclare: Bd, Be	Severe: slow permeability; seasonal high water table. [1]	Severe: subject to flooding. Slight if protected from flooding.	Severe: silty clay subsoil; subject to flooding.	Severe: high shrink-swell potential; subject to flooding.	Severe: silty clay subsoil; seasonal high water table.	Severe: high shrink-swell potential; low shear strength.
Blencoe: Bf	Severe: very slow permeability; seasonal high water table. [1]	Severe: seasonal high water table; subject to flooding.	Severe: somewhat poorly drained; silty clay texture.	Severe: seasonal high water table; high shrink-swell potential.	Severe: seasonal high water table; high shrink-swell potential.	Severe: high shrink-swell potential; subject to flooding.
Blyburg: Bg	Moderate: moderate permeability. [1]	Moderate: moderate permeability.	Moderate: wall unstable in places.	Moderate: low shear strength.	Slight	Moderate: low to medium shear strength; moderate susceptibility to frost action.
Celo: Cg	Severe: moder-	Severe: seasonal	Severe: poorly	Severe: subject	Severe: poorly	Severe: subject

interpretations of the soils

mapping units may have different properties and limitations, and for this reason it is necessary to refer to other series as indicated in the first column]

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: poorly drained; high shrink-swell potential.	Unsuited	Poor: poorly drained; silty clay texture.	Level; seasonal high water table; very slow to slow permeability.	High compressibility; medium to low shear strength; fair to poor compaction characteristics.	Slow to very slow permeability; outlets commonly not available.	Poorly drained; very slow intake rate; level.	Level; silty clay texture.
Poor: high susceptibility to frost action.	Unsuited	Good	Moderate permeability; gently sloping.	Fair to poor stability and compaction characteristics; medium to low shear strength.	Moderately well drained.	Gently sloping; high available water capacity.	Gently sloping; moderate permeability.
Poor: high shrink-swell potential; low shear strength.	Unsuited	Fair: silty clay loam texture.	Level; seasonal high water table; slow permeability.	High shrink-swell potential; low shear strength; high compressibility.	Slow permeability.	Subject to flooding; slow intake rate.	Not needed.
Poor: high shrink-swell potential; low shear strength.	Unsuited	Poor: silty clay texture.	Level; seasonal high water table; very slow permeability in upper 2 feet.	Low shear strength; high shrink-swell potential; high compressibility.	Moderate permeability below a depth of 2 feet; outlets not available in places.	Somewhat poorly drained; very slow intake rate; moderate permeability below a depth of 2 feet.	Not needed.
Fair: low to medium shear strength.	Unsuited	Good	Nearly level; moderate permeability.	Low to medium shear strength and compressibility; high susceptibility to piping; fair to poor compaction characteristics.	Well drained	High available water capacity; moderate intake rate.	Not needed.
Poor: high shrink-swell potential; low shear strength.	Unsuited	Poor: poorly drained.	Level; seasonal high water table; moderately slow permeability; thin layers of sand in substratum in places.	High compressibility; low shear strength; poor compaction characteristics.	Moderately slow permeability; subject to flooding; outlets commonly not available.	Poorly drained; subject to flooding.	Not needed.
Poor: high shrink-swell potential; low shear strength.	Unsuited	Fair: silty clay loam texture.	Seasonal high water table; slow permeability.	Fair to poor stability and compaction characteristics; high shrink-swell potential; low shear strength.	Slow permeability; poor outlets.	Subject to flooding; slow intake rate; high available water capacity.	Not needed.
Fair if slopes are less than 25	Unsuited	Fair: thin surface	Moderate permeability;	Fair to poor bearing capac-	Well drained	High available water capacity;	Erodes easily; gently slop-

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Roads and streets
Davis: Da	Severe: subject to flooding.	Moderate: moderate permeability.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Dempster: De	Slight [1]	Severe: rapid permeability in substratum. [1]	Moderate: gravelly sand at a depth of 34 inches.	Slight	Severe: rapid permeability below a depth of 34 inches. [1]	Moderate: moderate shrink-swell potential in upper 34 inches.
*Egan: EaB, EaC. For Shindler part, see Shindler series.	Severe: moderately slow permeability in substratum.	Moderate if slopes are less than 7 percent, severe if more than 7.	Moderate: clay loam texture below a depth of 30 inches.	Moderate: moderate shrink-swell potential.	Moderate: silty clay loam and clay loam textures.	Severe: high susceptibility to frost action.
*Enet: EmA, EnB. For Dempster part of EnB, see Dempster series.	Slight [1]	Severe: rapid permeability in substratum. [1]	Severe: vertical banks slough.	Slight	Severe: rapid permeability in substratum. [1]	Moderate: medium to low shear strength; moderate susceptibility to frost action.
Fluvaquents: Fa, Fb. No interpretations. Severe limitations for most uses.						
Forney: Fc, Fe	Severe: very slow permeability; seasonal high water table.	Severe: subject to flooding. Slight if protected from flooding.	Severe: poorly drained; silty clay texture; subject to flooding in places.	Severe: seasonal high water table; high shrink-swell potential; subject to flooding.	Severe: poorly drained; silty clay texture.	Severe: poorly drained; high shrink-swell potential.
Grable: Ga	Moderate: seasonal high water table. [1]	Severe: rapid permeability in substratum; seasonal high water table. [1]	Severe: fine sand below a depth of 27 inches; seasonal high water table.	Moderate: seasonal high water table.	Severe: seasonal high water table; rapid permeability in substratum. [1]	Severe: high susceptibility to frost action.
Graceville: Gb	Moderate: moderate permeability. [1]	Moderate: moderate permeability; severe if basin floor is below a depth of 4 feet. [1]	Moderate: moderately well drained; gravelly sand below a depth of 52 inches.	Moderate: moderate shrink-swell potential.	Severe: rapid permeability below a depth of 52 inches. [1]	Severe: high susceptibility to frost action.

See footnote at end of table.

interpretations of the soil—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Fair: low shear strength; moderate shrink-swell potential.	Unsuited	Good	Moderate permeability.	Low shear strength; fair to poor stability and compaction characteristics.	Moderately well drained.	Subject to flooding; high available water capacity; moderately slow intake rate.	Nearly level; generally not applicable.
Fair in upper part: moderate shrink-swell potential. Good below a depth of 34 inches.	Good to fair: excess fines in places.	Fair: silty clay loam texture.	Rapid permeability below a depth of 34 inches.	Fair to good stability and compaction characteristics; medium to low shear strength.	Well drained	Moderate available water capacity; moderate intake rate.	Moderately deep to gravelly sand; nearly level.
Poor: low shear strength; high	Unsuited	Fair: silty clay loam	Moderately slow permeability	Fair to good stability and com-	Well drained	Slow intake rate; high available	Short irregular slopes in

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Roads and streets
Haynie: Ha, Hb	Severe: subject to flooding. Slight if protected from flooding.	Severe: subject to flooding. Moderate if protected from flooding; moderate permeability.	Severe: subject to flooding. Slight if protected from flooding; sloughing in places.	Severe: subject to flooding; seasonal high water table in places. Slight if protected from flooding.	Severe: subject to flooding. Silght if protected from flooding; seasonal high water table in places.	Severe: subject to flooding. Moderate if protected from flooding; moderate susceptibility to frost action.
James: Ja	Severe: subject to flooding; slow permeability; high water table.	Severe: subject to flooding; high water table.	Severe: subject to flooding; high water table; silty clay texture.	Severe: subject to flooding; high shrink-swell potential.	Severe: subject to flooding; seasonal high water table.	Severe: high susceptibility to frost action; high shrink-swell potential.
Kennebec: Ka	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding. Moderate if protected from flooding; moderate permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; high susceptibility to frost action.
Lakeport: La	Severe: moderately slow permeability; seasonal high water table.	Moderate: seasonal water table at a depth of 2 to 4 feet.	Severe: seasonal high water table; silty clay subsoil.	Severe: seasonal high water table; high shrink-swell potential.	Severe: seasonal high water table; silty clay subsoil.	Severe: high shrink-swell potential; high susceptibility to frost action.
Lamo: Lb	Severe: moderately slow permeability; seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: seasonal high water table; subject to flooding; high shrink-swell potential.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; high susceptibility to frost action; seasonal high water table.
Luton: Ld	Severe: very slow permeability; seasonal high water table; subject to flooding.	Severe: subject to flooding. Slight if protected from flooding.	Severe: poorly drained; silty clay texture.	Severe: high shrink-swell potential; subject to flooding; seasonal high water table.	Severe: poorly drained; subject to flooding; silty clay texture.	Severe: poorly drained; subject to flooding; high shrink-swell potential.
McPaul: Ma	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding. Moderate if protected from flooding; moderate permeability.	Severe: subject to flooding. Moderate if protected from flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; high susceptibility to frost action.
Modale: Mb	Severe: very show permeability in substratum; seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: seasonal high water table; subject to flooding; silty clay substratum.	Severe: seasonal high water table; subject to flooding; high shrink-swell potential.	Severe: subject to flooding; seasonal high water table.	Severe: high shrink-swell potential; high susceptibility to frost action; subject to flooding.

See footnote at end of table.

interpretations of the soil—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and	Topsoil	Pond reservoir	Embankments	Drainage	Irrigation	Terraces and

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					

interpretations of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: high susceptibility to frost action; low shear strength.	Unsuited	Fair: silty clay loam texture.	Moderate permeability; nearly level to sloping.	Fair stability and compaction characteristics; medium to low shear strength.	Well drained	Moderately slow intake rate; high available water capacity; nearly level to sloping.	Nearly level to sloping; long, uniform slopes.
Poor: high susceptibility to frost action; low shear strength.	Unsuited	Fair: silty clay loam surface layer.	Moderate permeability; slopes of 2 to 50 percent.	Poor stability and compaction characteristics; low shear strength.	Well drained	Gently sloping to steep; moderately slow intake rate; high available water capacity.	Gently sloping to steep; long, uniform slopes; erodes easily.
Fair: medium to low shear strength; moderate shrink-swell potential.	Unsuited	Good	Moderate permeability; nearly level.	Medium to low shear strength; high susceptibility to piping; fair to poor compaction characteristics.	Well drained	High available water capacity; moderate intake rate.	Not needed.
Poor: low shear strength; high shrink-swell potential.	Unsuited	Poor: silty clay texture.	Moderate permeability in substratum; seasonal high water table; level.	High compressibility; low shear strength; fair compaction characteristics.	Moderate permeability in substratum; subject to flooding.	Very slow intake rate; moderate permeability in substratum; seasonal high water table.	Not needed.
Poor in upper part; high shrink-swell potential. Fair in lower part; somewhat poorly drained to poorly drained.	Unsuited	Poor: silty clay texture.	Rapid permeability in substratum; seasonal high water table; level.	High compressibility in upper part; low shear strength; high shrink-swell potential; sandy material below a depth of 25 inches.	Rapid permeability in substratum; subject to flooding.	Very slow intake rate; rapid permeability in substratum; level; seasonal high water table.	Not needed.
Poor: moderate to high shrink-swell potential; low to medium shear strength.	Unsuited	Fair: silty clay loam texture.	Moderate permeability; seasonal high water table; nearly level.	Low to medium shear strength; medium compressibility; fair compaction characteristics.	Moderate permeability.	High available water capacity; moderate intake rate; nearly level.	Not needed.
Poor: low shear strength; high susceptibility to frost action.	Unsuited	Poor: high salt content; silty clay loam texture.	Moderately slow permeability; seasonal high water table; level.	Low shear strength; moderate shrink-swell potential; fair to good compaction characteristics.	Subject to flooding; moderately slow permeability.	Subject to flooding; high water table; high salt content.	Not needed.
Good	Poor: excess fines; no gravel.	Poor: loamy fine sand texture.	Rapid permeability.	Medium to high susceptibility to piping; medium compacted permeability; unstable fill.	Excessively drained.	Rapid intake rate; very low to low available water capacity; very severe hazard of soil blowing.	Not needed.

TABLE 6.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings with basements	Sanitary landfill	Roads and streets
Shindler: ShD, ShE.	Severe: moderately slow permeability in substratum; slopes of more than 15 percent in places.	Moderate if slopes are less than 7 percent, severe if more than 7.	Moderate if slopes are less than 15 percent; clay loam texture. Severe if slopes are more than	Moderate if slopes are less than 15 percent; moderate shrink-swell potential. Severe if slopes are more than	Moderate if slopes are less than 25 percent; clay loam texture. Severe if slopes are more than	Severe: low shear strength.

interpretations of the soils—Continued

Suitability as source of—			Soil features affecting—				
Road fill	Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions
Poor: low shear strength.	Unsuited	Fair to poor; clay loam textures; poor if slopes are more than 15 percent.	Gently sloping to steep; moderately slow permeability in substratum.	Medium to high compressibility; fair to good stability and compaction characteristics.	Well drained	Gently sloping to steep; moderately slow intake rate; high available water capacity.	Short irregular slopes; gently sloping to steep; moderately slow permeability in substratum.
Fair: good material but site is somewhat poorly drained.	Fair: excess fines.	Fair: high lime content.	Rapid permeability in substratum.	Fair to poor stability and compaction characteristics; medium to high compressibility; gravelly sand substratum.	Rapid permeability in substratum.	Low to moderate available water capacity; moderate intake rate; high lime content.	Not needed.
Good	Fair: excess fines; no gravel.	Good to a depth of 10 inches, poor below.	Rapid permeability.	High susceptibility to piping; poor to fair stability.	Somewhat excessively drained.	Rapid intake rate; low to moderate available water capacity; severe hazard of soil blowing.	Not needed.
Poor: high susceptibility to frost action; low shear strength.	Unsuited	Fair: high lime content below a depth of 10 inches.	Moderate permeability; seasonal high water table; nearly level.	Fair to good stability and compaction characteristics; medium susceptibility to piping.	Moderate permeability; poor outlets.	Moderate intake rate; high lime content; moderate salinity; seasonal high water table.	Not needed.
Poor: high susceptibility to frost action; medium to low shear strength.	Unsuited	Fair: silty clay loam texture.	Moderate permeability; nearly level to gently sloping.	Fair to poor stability and compaction characteristics; medium to low shear strength; moderate shrink-swell potential.	Well drained	Moderately slow intake rate; high available water capacity; nearly level to gently sloping.	Nearly level to gently sloping; moderate permeability.
Poor: low shear strength; high susceptibility to frost action.	Unsuited	Fair: silty clay loam texture.	Moderately slow permeability; seasonal high water table.	Low shear strength; medium compressibility; fair to poor compaction characteristics.	Moderately slow permeability; poor availability of outlets.	Slow intake rate; seasonal high water table; subject to flooding.	Not needed.
Poor: medium to low shear strength; high shrink-swell potential.	Unsuited	Poor: poorly drained.	Slow permeability; seasonal high water table.	Fair to poor stability and compaction characteristics; high compressibility; high shrink-swell potential.	Slow permeability; poor availability of outlets.	Poorly drained; very slow intake rate.	Not needed.

TABLE 7.—*Engineering*

[Tests were made by the South Dakota Department of Highways according to standard

Soil name and location	Parent material	Depth	Horizon	Moisture density [1]	
				Maximum dry density	Optimum moisture
		Inches		*Lbs/cu ft*	*Percent*
Benclare silty clay loam:					
1,230 feet west and 2,450 feet south of NE corner of sec. 25, T. 93 N., R. 49 W.	Silty and clayey alluvium	7–16	A12	90	27
		26–36	B22	96	24
		48–60	C2	101	21
Blyburg silt loam:					
1,500 feet north and 129 feet west of SE corner of sec. 23, T. 90 N., R. 49 W.	Silty alluvial sediments	19–60	C2	100	22
Calco silty clay loam:					
115 feet north and 2,380 feet east of SW corner of sec. 12, T. 94 N., R. 50 W.	Alluvium	8–18	A12	80	33
		39–47	C1g	91	26
Forney silty clay:					
2,452 feet west and 3 feet south of NE corner of sec. 15, T. 89 N., R. 48 W.	Clayey alluvium	9–21	B2g	90	27
		21–27	IIA1b	86	30
		47–60	IIB3gb	85	30
Grable silt loam:					
205 feet west and 106 feet south of NE corner of sec. 6, T. 90 N., R. 49 W.	Silty and sandy alluvium	7–15	C1	99	22
		15–27	C2	104	20
		27–60	IIC3	98	22
Lakeport silty clay loam:					
135 feet west and 246 feet south of NE corner of sec. 19, T. 91 N., R. 50 W.	Silty alluvium	7–15	A12	95	24
		25–36	B22	89	28
		42–60	C	92	26
McPaul silt loam:					
520 feet south and 1,130 feet west of NE corner of sec. 34, T. 94 N., R. 49 W.	Silty alluvium	6–41	C	101	21
		41–60	IIAb	83	32
Modale silt loam:					
87 feet west and 825 feet south of NE corner of sec. 29, T. 90 N., R. 49 W.	Silty and clayey alluvium	11–24	C2	100	22
		24–60	IIC3g	89	28
Omadi silt loam:					
123 feet west and 2,460 feet north of SE corner of sec. 7, T. 90 N., R. 49 W.	Silty alluvium	11–19	AC	95	24
		28–48	C3	95	24
Percival silty clay:					
2,273 feet north and 90 feet west of SE corner of sec. 25, T. 91 N., R. 50 W.	Clayey alluvium over sandy alluvium.	7–25	C1g	89	28
		25–60	IIC2	99	22
Salix silty clay loam:					
2,480 feet west and 1,220 feet north of SE corner of sec. 29, T. 90 N., R. 48 W.	Silty alluvium	6–14	A12	95	24
		14–22	B2	90	27
		33–60	C1	102	20
Sarpy loamy fine sand:					
290 feet east and 760 feet north of SW corner of sec. 31, T. 90 N., R. 48 W.	Sandy alluvium	8–60	C2	99	22
Shindler clay loam:					
2,550 feet west and 210 feet north of SE corner of sec. 19, T. 95 N., R. 48 W.	Glacial till	8–13	B2	101	21
		18–33	C1ca	106	19

[1] Based on the Moisture-density Relations of Soils Using 5.5-lb. Rammer and 12-in. Drop, AASHTO Designation: T 99, Method 3.

[2] Mechanical analysis according to the AASHTO Designation: T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

test data

procedures of the American Association of State Highway and Transportation Officials (AASHTO)]

TABLE 8.—*Engineering test data for soil samples*

[Tests made by the South Dakota Department of Highways.

taken along proposed highway routes

Dashes indicate that soils were not tested for that property]

Mechanical analysis [1]—Continued: Percentage smaller than 0.005 mm		Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [7]
Range	Average	Range	Average	Range	Average	AASHTO [4] (Old index)	AASHTO [5] (New index)	Unified [6]	
56–69	62	59–73	66	40–46	43	A-7-6(20)	A-7-6(48)	CH	2
47–68	57	50–70	60	28–45	36	A-7-6(20)	A-7-6(39)	CH	2
8–33	20	37–49	43	10–21	15	A-7-6(11)	A-7-6(16)	ML	4
10–40	24	36–49	42	11–23	16	A-7-6(11)	A-7-6(18)	ML	5
11–46	28	32–51	42	10–27	18	A-7-6(12)	A-7-6(19)	CL	5
14–47	30	41–56	48	13–28	20	A-7-6(14)	A-7-6(22)	ML	4
16–64	40	36–70	53	13–46	29	A-7-6(18)	A-7-6(30)	CH	3
28–40	34	38–69	54	20–42	31	A-7-6(19)	A-7-6(28)	CH	3
----------	20	----------	29	----------	16	A-6(4)	A-6(3)	SC	9
25–48	36	47–57	51	17–31	24	A-7-6(16)	A-7-6(25)	CH	3
22–58	40	47–61	54	26–33	29	A-7-6(19)	A-7-6(32)	CH	3
29–71	49	38–59	49	19–39	29	A-7-6(17)	A-7-6(29)	CL	3
32–50	41	40–46	43	20–27	23	A-7-6(14)	A-7-6(20)	CL	4
16–38	26	30–46	38	7–24	15	A-6(10)	A-6(16)	CL	6
10–40	25	38–53	45	15–23	19	A-7-6(11)	A-7-6(13)	CL–ML	4
13–37	25	32–45	39	13–22	17	A-6(10)	A-6(11)	CL	5
23–57	39	31–53	42	13–32	22	A-7-6(13)	A-7-6(15)	CL	5
7–47	27	22–55	39	4–32	17	A-6(10)	A-6(11)	CL	5
0–30	11	8–36	22	0–19	6	A-2-4(0)	A-2-4(0)	SM–SC	(8)
21–47	34	41–51	46	14–25	19	A-7-6(13)	A-7-6(20)	ML	4
19–54	36	38–52	45	15–30	22	A-7-6(14)	A-7-6(22)	CL	4
13–58	35	30–56	43	10–35	22	A-7-6(14)	A-7-6(19)	CL	4
12–52	32	24–51	38	8–30	19	A-6(10)	A-6(11)	CL	6
0–38	19	28–54	41	5–22	13	A-7-6(7)	A-7-6(7)	ML	5
10–38	24	28–50	39	7–27	16	A-6(8)	A-6(8)	CL	5
0–25	10	17–37	27	0–19	9	A-2-4(0)	A-2-4(0)	SC	(8)
0–21	9	16–43	30	0–23	11	A-2-6(0)	A-2-6(0)	SC	(8)
35–80	57	54–83	68	29–61	44	A-7-6(20)	A-7-6(51)	CH	1
4–33	18	38–47	43	11–22	16	A-7-6(11)	A-7-6(14)	ML	4
8–37	22	25–47	36	7–24	15	A-6(10)	A-6(10)	CL	6
0–26	10	2–39	21	0–20	7	A-2-4(0)	A-2-4(0)	SM–SC	(8)
----------	30	----------	42	----------	20	A-7-6(12)	A-7-6(22)	CL	5
12–45	28	26–46	36	3–24	13	A-6(10)	A-6(13)	CL	6
15–44	29	34–55	45	8–31	19	A-7-6(13)	A-7-6(17)	CL	4
14–44	29	31–55	43	10–33	21	A-7-6(13)	A-7-6(18)	CL	4
14–51	32	31–59	43	10–36	22	A-7-6(13)	A-7-6(18)	CL	4
0–20	9	0–38	13	0–18	5	A-2-4(0)	A-2-4(0)	SM–SC	(8)
5–59	31	33–71	52	12–44	28	A-7-6(18)	A-7-6(23)	CH	3
14–72	42	38–71	55	15–49	32	A-7-6(19)	A-7-6(32)	CH	3
3–52	27	19–65	42	4–41	22	A-7-6(14)	A-7-6(18)	CL	5
0–15	5	0–30	11	0–11	3	A-2-4(0)	A-2-4(0)	SM	(8)
24–52	38	27–52	39	5–29	16	A-6(11)	A-6(17)	CL	5
0–76	36	18–52	35	0–27	13	A-6(9)	A-6(12)	CL	6
41–70	55	51–70	61	29–43	35	A-7-6(20)	A-7-6(40)	CH	2

TABLE 8.—*Engineering test data for soil samples*

Soil series	Horizon	Number of samples tested	Mechanical analysis [1]					
			Percentage less than 3 inches passing sieve—					
			No. 10 (2.0 mm)		No. 40 (0.42 mm)		No. 200 (0.074 mm)	
			Range	Average	Range	Average	Range	Average

taken along proposed highway routes—Continued

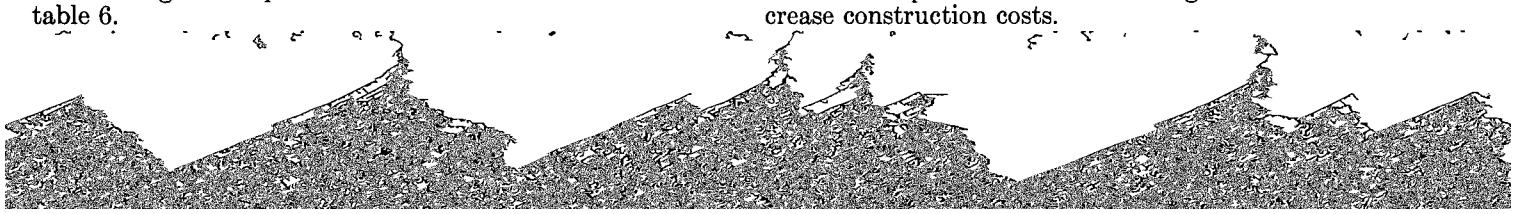
Mechanical analysis [1]—Continued		Liquid limit [2]		Plasticity index [3]		Classification			Estimated CBR [7]
Percentage smaller than 0.005 mm									
Range	Average	Range	Average	Range	Average	AASHTO [4] (Old index)	AASHTO [5] (New index)	Unified [6]	
11–45	27	40–51	45	12–22	16	A-7-6(12)	A-7-6(19)	ML	4
16–45	30	32–49	41	10–26	18	A-7-6(11)	A-7-6(19)	CL	5
20–40	29	32–45	38	10–25	17	A-6(11)	A-6(17)	CL	6
14–39	26	20–49	34	5–28	16	A-6(9)	A-6(9)	CL	7
8–28	18	35–47	41	10–17	13	A-7-6(9)	A-7-6(15)	CL–ML	5
11–38	24	28–46	37	6–23	14	A-6(10)	A-6(14)	CL	6
16–39	27	30–46	38	9–28	18	A-6(11)	A-6(16)	CL	6
----------	21	----------	27	----------	8	A-4(7)	A-4(4)	CL	10
44–62	53	48–58	53	23–33	28	A-7-6(18)	A-7-6(32)	CH	3
34–78	56	47–67	57	24–44	33	A-7-6(19)	A-7-6(37)	CH	3
18–52	34	29–51	40	7–31	19	A-6(12)	A-6(19)	CL	5
13–41	27	43–50	47	23–26	24	A-7-6(13)	A-7-6(14)	CL	4
13–29	21	32–48	40	9–27	18	A-6(6)	A-6(6)	CL	5
----------	31	----------	31	----------	17	A-6(9)	A-6(8)	CL	8
0–15	6	19–30	25	0–18	7	A-2-4(0)	A-2-4(0)	SC	(8)
6–16	10	18–27	23	0–10	4	A-2-4(0)	A-2-4(0)	SM–SC	(8)
4–18	11	17–27	22	0–11	5	A-2-4(0)	A-2-4(0)	SM–SC	(8)
----------	35	----------	40	----------	22	A-6(13)	A-6(21)	CL	5
----------	43	----------	42	----------	25	A-7-6(14)	A-7-6(24)	CL	5
7–43	25	36–52	44	10–25	17	A-7-6(12)	A-7-6(17)	ML	4
11–45	28	34–50	42	12–27	19	A-7-6(12)	A-7-6(17)	CL	5
15–46	30	30–50	40	10–29	19	A-6(12)	A-6(16)	CL	5
2–43	22	20–46	33	6–27	16	A-6(7)	A-6(6)	CL	7
7–55	31	43–59	51	12–30	21	A-7-5(15)	A-7-5(21)	MH	3
15–50	32	39–60	50	14–32	23	A-7-6(15)	A-7-6(23)	CH	3
0–56	28	20–57	39	2–36	19	A-6(10)	A-6(11)	CL	5
----------	51	----------	48	----------	28	A-7-6(17)	A-7-6(22)	CL	4
28–44	36	42–55	49	19–26	22	A-7-6(15)	A-7-6(22)	CL	3
27–48	37	34–72	53	11–46	28	A-7-6(18)	A-7-6(28)	CH	3
24–59	41	31–63	47	14–40	26	A-7-6(16)	A-7-6(22)	CL	4

[4] Based on AASHTO Designation M 145–49.
[5] Based on AASHTO Designation M 145–66I.
[6] Based on the Unified Soil Classification System, Technical Memorandum No. 3–357, Volume 1, Waterways Experiment Station, Corps of Engineers, March 1953.
[7] Estimated values based on relationships between California Bearing Ratio and liquid limit.
[8] California Bearing Ratio (CBR) and liquid limit relationship is not applicable to granular classifications A–1, A–2, and A–3 and to subgroups of these classifications.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have meanings approximately parallel to the terms *slight*, *moderate*, and *severe*.

Following are explanations of some of the columns in table 6.

absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.



ganic-matter content, and slope. If the floor needs to be leveled, depth to bedrock becomes important. The soil prop-

kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a

one major horizon. The number of samples taken for each horizon also is shown. The actual range and average value for each of the several properties are given; but because of the method of sampling, the range in properties shown in table 8 may differ from the range shown in table 5.

Some of the columns in tables 7 and 8 are explained in the following paragraphs.

material that are common during construction increase runoff to several times the amount expected when the same soil is used for crops and pasture. The concentration of such runoff in streets and gutters results in flooding and deposition of sediment in low areas below the construction site.

Soil properties need to be considered in planning recreation uses, such as athletic areas, campsites, golf courses,

tinct horizons resulting from soil forming processes. Examples of these young alluvial soils are in the Albaton, Calco, Haynie, McPaul, Opawa, and Sarpy series. Alcester, Blencoe

of soil structure. The roots take up minerals in solution from the lower parts of the soil and eventually return them to the surface in the form of organic matter. Animals, such as earth-

material is deposited periodically by floodwaters. The constantly moist condition of some alluvial soils also inhibits soil forming processes. Steeper soils are likely to be less developed than gently sloping soils. Steep soils, such as Crofton soils, remain young because soil material is removed by erosion almost as soon as it forms and, consequently, no well-defined horizons develop. These soils, therefore, have been affected little by time.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*8*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 9 the soil series of Union County are placed in four categories of the current system. Classes of the

TABLE 9.—*Classification of soil series*

Series	Family	Subgroup	Order
Albaton	Fine, montmorillonitic (calcareous), mesic	Vertic Fluvaquents	Entisols.
Alcester	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Benclare	Fine, montmorillonitic, mesic	Pachic Haplustolls	Mollisols.
Blencoe	Clayey over loamy, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Blyburg	Coarse-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Calco	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Chancellor	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Crofton	Fine-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Davis	Fine-loamy, mixed, mesic	Pachic Haplustolls	Mollisols.
Dempster	Fine-silty over sandy or sandy-skeletal, mixed, mesic	Udic Haplustolls	Mollisols.
Egan	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Enet [1]	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Pachic Haplustolls	Mollisols.
Fluvaquents	Loamy, mixed (calcareous), mesic	Typic Fluvaquents	Entisols.
Forney	Fine, montmorillonitic, nonacid, mesic	Vertic Fluvaquents	Entisols.
Grable	Coarse-silty over sandy or sandy-skeletal, mixed (calcareous), mesic.	Mollic Udifluvents	Entisols.
Graceville	Fine-silty, mixed, mesic	Pachic Haplustolls	Mollisols.
Haynie [2]	Coarse-silty, mixed (calcareous), mesic	Mollic Udifluvents	Entisols.
James	Fine, montmorillonitic (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Lakeport [3]	Fine, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Lamo	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Luton	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
McPaul	Coarse-silty, mixed (calcareous), mesic	Mollic Udifluvents	Entisols.
Modale	Coarse-silty over clayey, mixed (calcareous), mesic	Aquic Udifluvents	Entisols.
Moody	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Nora	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Omadi	Fine-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic	Mollic Fluvaquents	Entisols.
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic (calcareous), mesic.	Aquic Udifluvents	Entisols.
Salix	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Salmo	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Shindler	Fine-loamy, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Storla	Fine-loamy over sandy or sandy-skeletal, mesic	Aeric Calciaquolls	Mollisols.
Thurman	Sandy, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Wakonda	Fine-silty, mesic	Aeric Calciaquolls	Mollisols.
Wentworth	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Whitewood	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Worthing	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.

[1] Enet soils are taxadjuncts because they have thicker transitional horizons of sandy loam and they are more deeply leached than is described as the range of the series.

[2] Haynie soils are taxadjuncts because the surface layer is lighter than very dark grayish brown (10YR 3/2 or 2.5Y 3/2), moist.

[3] Lakeport soils are taxadjuncts because of fine stratification in the control section.

current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol*. An example is *Mollisol*.

SUBORDER.—Each order is divided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper solum; cracking of soils caused by a decrease in soil moisture; and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (*Aqu*, meaning water or wet, and *oll*, from Mollisol).

GREAT GROUP.—A soil suborder is divided into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl*, meaning simple horizons, and *aquoll*, as defined under suborder).

SUBGROUP.—A great group is divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties

bottom lands of the Big Sioux and Missouri Rivers. Native grasses were mainly big bluestem, blue grama, green needlegrass, indiangrass, switchgrass, and western wheatgrass. Native trees were mostly boxelder, eastern cottonwood, and willow. Only a few acres of natural vegetation remain. These are mainly on the more poorly drained bottoms and on some breaks adjacent to the bottoms of the Big Sioux River.

Relief

The valleys of the Big Sioux and Missouri Rivers merge several miles north of Elk Point and make up an area of about 225 square miles. The elevation ranges from less than 1,100 feet to about 1,200 feet. The bottoms of the Big Sioux River are subject to flooding, but large dams on the Missouri River protect most of these bottoms. Slopes are level and nearly level.

The relief in much of the northern part of the county is rolling, and the drainage pattern is well defined. Slopes are mostly long and smooth and range from 2 to 30 percent. Steeper areas are on the sides of the Big Sioux River Valley and its tributaries. The elevation in this area ranges from 1,250 to 1,450 feet.

The uplands on the western side of the county are mostly nearly level to gently undulating. Slopes are short and are broken by numerous small depressions and narrow swales. The elevation ranges from about 1,320 to 1,500 feet in the northwestern corner of the county. Natural drainage is poorly defined in this area.

Water

Ground water reservoirs in Union County make up a large and reliable source of water for domestic, industrial, stock, and municipal use. All areas of the county are underlain by one or more aquifers that yield small to very large supplies of water. The quality of water varies, but most of

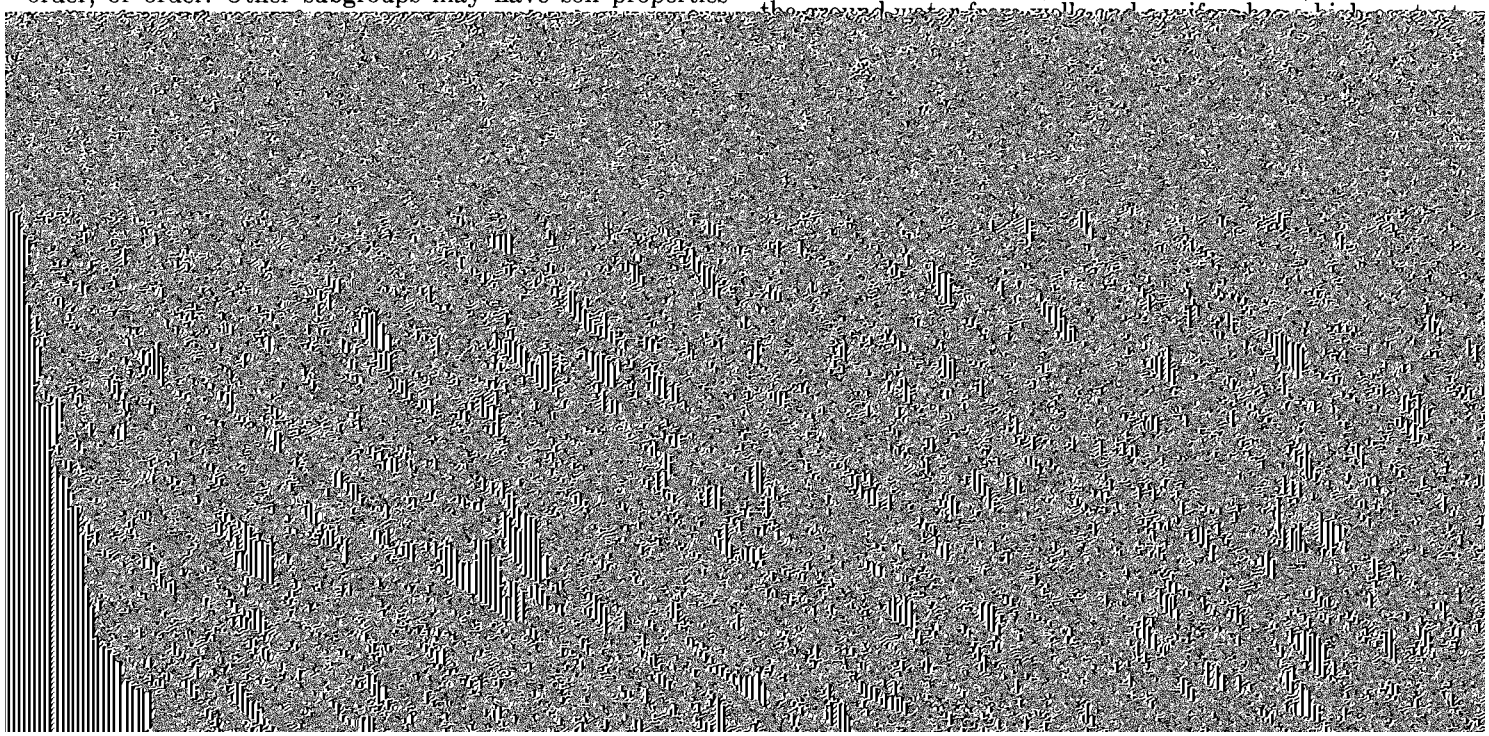


Figure 18.—**McCook Lake in the Albaton-Haynie-Onawa association.**

Surface water in the county includes perennial streams; small, manmade reservoirs; and McCook Lake (fig. 18). Some water for irrigation is taken from the Missouri and Big Sioux Rivers. These surface waters also are used for fishing, boating, and water skiing.

Climate [6]

Union County has a continental climate that is characterized by cold winters and hot summers. Precipitation is by month in table 11. The least amount of precipitation in a year—12.76 inches—was recorded in 1956, and the greatest amount—38.60 inches—was recorded in 1951. Precipitation in the growing season has ranged from 10.27 inches in 1956 to 30.29 inches in 1951. Most of the rainfall during the growing season comes from thunderstorms of widely differing intensity. About once a year 1.25 inches of rain falls in 1 hour, and about once in 5 years 2 inches of rain falls in 1 hour. At least once a year 2 inches of rain falls in 24 hours, and about once in 5 years 3.5 inches of rain falls in 24 hours.

The average annual snowfall at Vermillion is 22.7 inches. Snow protects fields and pastures, but a heavy cover of snow generally delays fieldwork in spring. The least amount of snow during the 1941–70 period was 10.9 inches in 1967–68. The greatest snowfall was in the winter of 1968–69 when 51.3 inches was recorded. The greatest snowfall in one day was 12 inches on December 22, 1968. Strong winds in winter cause snow cover to be deeper in sheltered places and less deep on open fields that have little or no vegetation or crop residue.

About 60 percent of the possible sunshine can be expected in an average year. In July or August 75 percent can be expected.

Windspeed averages 12.5 miles per hour in the summer, and the prevailing direction is south. During winter the wind averages 11 miles per hour, and the prevailing direction is northwest. A windspeed of more than 50 miles per hour can occur during any month of the year, but it is more likely to occur in the summer during thunderstorms. Thunderstorms occur on about 40 to 45 days a year. Hail occasionally accompanies the thunderstorms and can be expected 3 days a year. Hail is most likely to fall in June.

TABLE 10.—*Probability of selected temperatures after specified dates in spring and before specified dates in fall*

[From data recorded at Vermillion, South Dakota, 1941–70]

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 date in spring:						
90 percent	March 3	March 13	March 21	April 2	April 14	April 24
70 percent	March 11	March 20	March 29	April 9	April 21	May 1
50 percent	March 25	April 3	April 13	April 23	May 4	May 13
30 percent	April 7	April 15	April 27	May 6	May 17	May 25
10 percent	April 14	April 22	May 5	May 14	May 24	May 31
Before specified date in fall:						
10 percent	October 18	October 15	October 6	September 25	September 14	September 2
30 percent	October 27	October 21	October 13	October 2	September 21	September 10
50 percent	November 12	November 3	October 26	October 18	October 5	September 26
70 percent	November 28	November 14	November 7	November 1	October 18	October 11
90 percent	December 7	November 21	November 14	November 9	October 25	October 19

ways 11, 46, 48, and 50 are the main routes for motor transportation. Graveled or hard-surfaced roads are on nearly every section line. Two railroads serve the county. Daily flights of several commercial airlines are available at nearby Sioux City.

The 1963 U.S. Census of Manufacturing reported 8 manufacturing establishments in the county. Public stockyards and packing firms in Sioux City and Sioux Falls provide markets for livestock producers. Auction sales barns are in smaller towns of Union and adjacent counties. Grain ele-

Trends in Soil Use

The U.S. Census of Agriculture in 1890 reported 1,373 farms in the county with an average size of 167 acres. Since then the number of farms has gradually decreased while the average size has increased. In 1969 there were 949 farms, and the average size was 285 acres.

Field crops accounted for about 27 percent of Union County's cash farm income. In terms of value of production in 1967, corn accounted for 65 percent of all field crops pro-

to 41,500 acres in 1971. In 1971 the average yield per acre of soybeans was 24.5 bushels. The acreage planted to oats had steadily decreased during those 20 years. In 1971 oats were planted on 26,500 acres, and the average yield per acre was 58 bushels. Alfalfa grown for hay had also declined. In 1971 alfalfa was harvested for hay on 8,600 acres, and the average yield per acre was 3.2 tons. Minor amounts of barley, sorghum, and wheat also were grown.

In 1959 irrigated crops were harvested on 1,723 acres. This increased to 3,210 acres in 1970. Corn and alfalfa were the main irrigated crops.

The sale of livestock and livestock products accounted for about 66 percent of cash farm income in the county. Cattle and swine accounted for most of this income. In 1969 there were 45,003 cattle, 55,776 hogs, 4,697 sheep, and 50,965 chickens on farms. The number of cattle included 2,315 cows kept for milk production. The number of cattle raised for beef production has steadily increased during the past 40 years; the number of hogs has fluctuated according to market conditions; and the number of sheep and chickens has steadily declined.

Additional information on the trends in crop and livestock production can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service.

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Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of

surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Glacial drift (geology). Pulverized and other rock material trans-

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

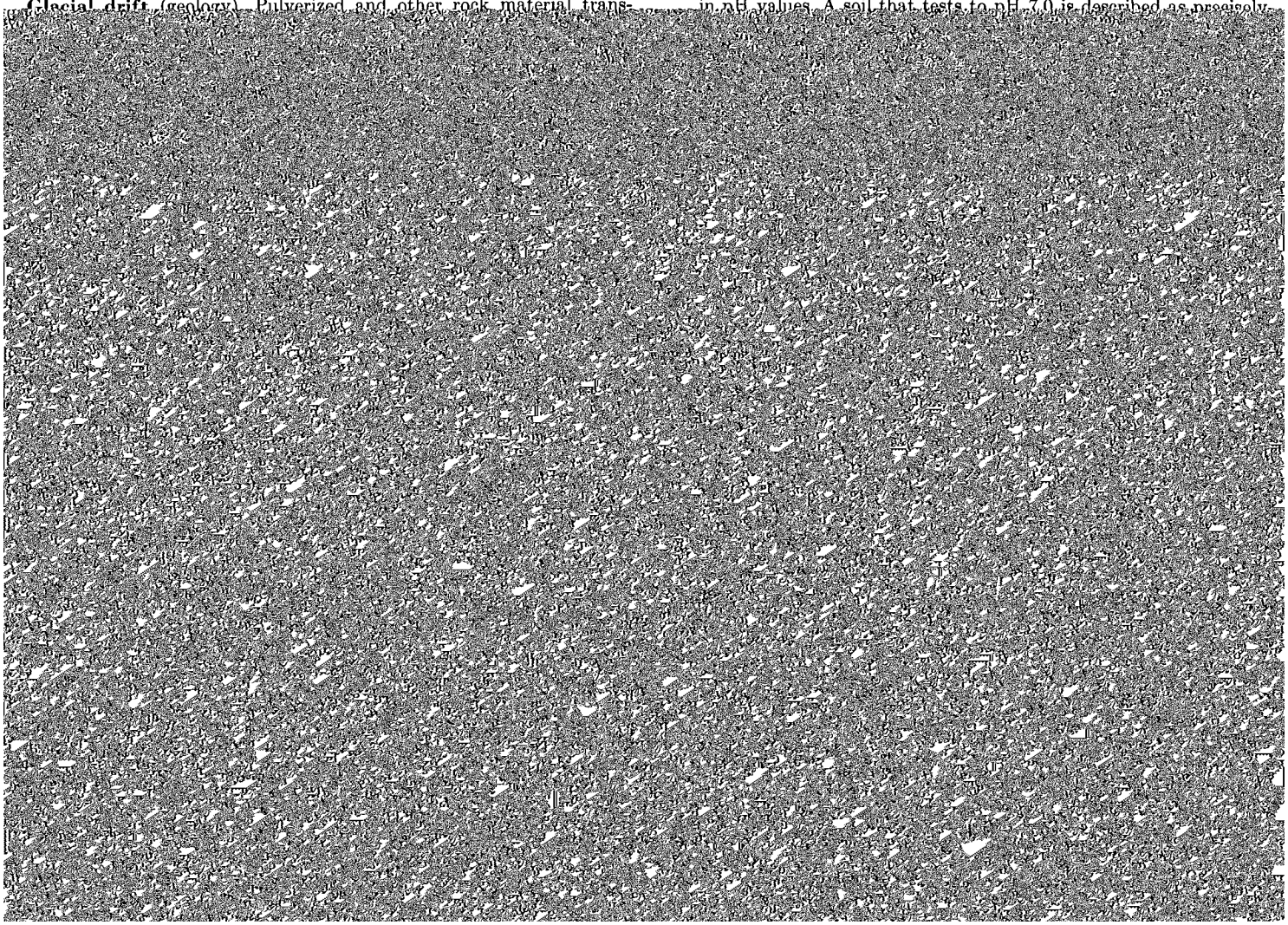
Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely



Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, 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, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

Absence of a capability unit, pasture group, or windbreak group designation indicates that the mapping unit is not placed in a specified grouping or that the individual soils of a mapping unit are designated separately For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs.

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Windbreak group
			Symbol	Page	Letter	Number
Ab	Albaton silt loam, overwash	9	IIw-1	42	A	2
Ac	Albaton silty clay	9	IIIw-2	44	A	2
Ad	Albaton silty clay, depressional	9	Vw-2	46	B	10
Ae	Alcester silt loam, 2 to 6 percent slopes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Pasture group	Windbreak group
			Symbol	Page	Letter	Number
Pa	Percival silty clay----------	32	IIw-3	43	A	2
Sa	Salix silty clay loam----------	32	I-1	41	F	3
Sb	Salmo silty clay loam, somewhat poorly drained------	33	IIIw-3	44	J	10
ScB	Sarpy loamy fine sand, 3 to 9 percent slopes--------	34	VIs-1	47	H	7
SdA	Sarpy silty clay overwash, 0 to 1 percent slopes----	34	IVs-1	46	H	7
SeA	Sarpy soils, 0 to 3 percent slopes----------	34	IVs-1	46	H	7
ShD	Shindler clay loam, 9 to 15 percent slopes----------	35	VIe-3	46	G	10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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