SOIL SURVEY OF

Nobles County, Minnesota

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

Major fieldwork for this soil survey was done in the period 1955–68. Soil names and descriptions were approved in 1968. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1968. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Nobles Soil and Water Conservation District.

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

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

All the soils of Nobles 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 capability unit and windbreak suitability 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 the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Suitability of Soils for Wildlife Habitat."

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

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

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

Cover: **Contour stripcropping on Everly soils.**

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SOIL SURVEY OF NOBLES COUNTY, MINNESOTA

BY DALE LORENZEN AND DONALD W. CALKINS, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MINNESOTA AGRICULTURAL EXPERIMENT STATION [1]

NOBLES COUNTY is in the southwestern part of Minnesota (fig. 1). It has a total land area of 455,680 acres. Worthington is the county seat.

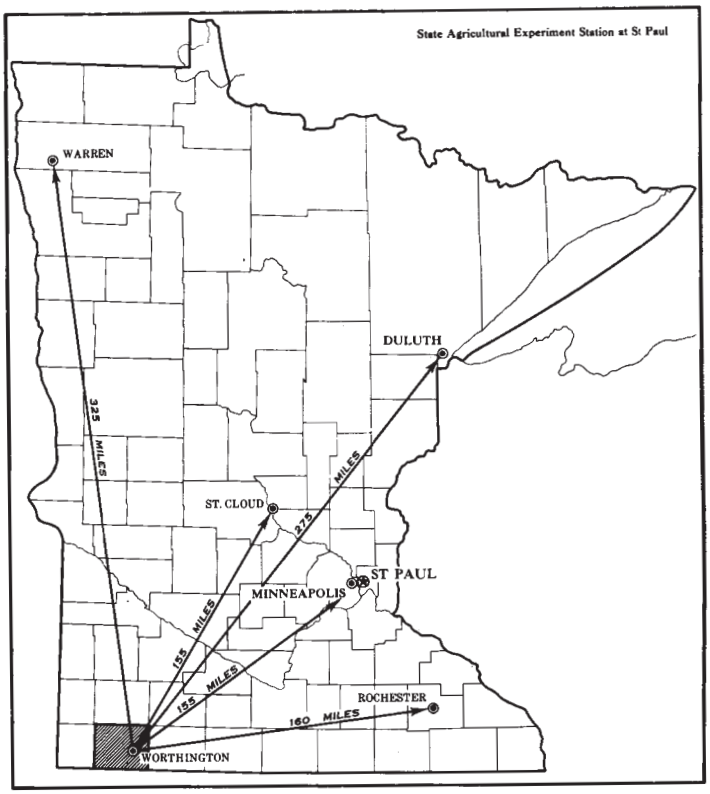

Figure 1.—**Location of Nobles County in Minnesota.**

The main enterprise in Nobles County is farming, and the main crops are corn, soybeans, oats, flax, hay, and pasture. Cattle feeding, hog production, dairying, and poultry raising are the most important livestock enterprises. Cash grain farming, however, is the main farm enterprise.

Nobles County is characterized by dark-colored, nearly level to steep soils that formed in glacial material. The original vegetation was tall grass prairie.

[1] JOSEPH F. CUMMINS, HARLAN R. FINNEY, KEITH W. HEIN, HILDING L. HOKANSON, JAMES J. MURRAY, RICHARD O. PAULSON, and ALEX R. ROBERTSON, Soil Conservation Service, assisted in preparing this survey.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Nobles 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. Clarion and Sac, 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, Clarion loam, 2 to 6 percent slopes, is one of several phases within the Clarion 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 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. One such kind of mapping unit shown on the soil map of Nobles County is the soil complex.

A soil complex consists of areas of two or more soils, so intricately intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Clarion-Storden loams, 6 to 12 percent slopes, eroded, is an example.

In most areas surveyed, there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land is a land type in this county.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or coverings for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a specific soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a specific soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

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

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Nobles County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of association 1, the words clay loam and loam refer to the texture of the surface layer.

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

1. Webster-Clarion-Nicollet association

Poorly drained, well drained, and moderately well drained, nearly level to rolling clay loam and loam soils formed in friable glacial till on uplands

This association consists of nearly level to rolling soils on ground moraines. These soils have complex slopes that generally range from 0 to 12 percent, but they are steeper along the major streams. This association occupies about 33 percent of the county.

About 25 percent of the association is Webster soils, 25 percent is Clarion soils, 20 percent is Nicollet soils, and the remaining 30 percent is minor soils.

The Webster soils are poorly drained. These nearly level soils are on low, wide flats and in draws. They have a surface layer of black, very dark gray, and dark olive-gray clay loam and silty clay loam about 20 inches thick. The subsoil is mottled, olive-gray and olive, friable clay loam about 10 inches thick. Olive-gray, grayish-brown, and yellowish-brown, calcareous clay loam till occurs at a depth of about 30 inches.

The Clarion soils are deep and well drained. These soils have slopes of 2 to 12 percent (fig. 2). They have a surface layer of black and very dark grayish-brown loam about 19 inches thick. The subsoil is dark yellowish-brown loam about 13 inches thick. The underlying material is light yellowish-brown and olive-brown, friable, calcareous loam.

The Nicollet soils are deep and moderately well drained. They have slopes of 0 to 3 percent. These soils have a surface layer of black and very dark gray clay loam about 15 inches thick. The subsoil is very dark grayish-brown and olive-brown clay loam. It is underlain by calcareous, olive-brown, light olive-brown, and grayish-brown clay loam at a depth of about 28 inches.

Among the minor soils are the poorly drained Waldorf soils, the very poorly drained Lura soils, and the somewhat poorly drained Collinwood soils. These soils have slopes of 0 to 4 percent. Other minor soils are the rolling

Figure 2.—Typical area of Clarion soils in association 1.

***Figure 3.*—Typical area of Sac soils in association 2.**

to steep Storden soils, the Wadena and Estherville soils on terraces, the poorly drained Comfrey and Millington soils on bottom lands, and the very poorly drained Glencoe and Blue Earth soils.

Most of this soil association is cultivated and is suited to all crops commonly grown in the county. Erosion on the sloping soils and wetness in the low areas are the main concerns in the use of these soils.

2. *Everly-Sac-Rushmore association*

Well-drained and poorly drained, nearly level to strongly sloping clay loam and silty clay loam soils formed in firm glacial till and loess on uplands

This association consists of nearly level to strongly sloping soils on loess and glacial till ground moraines. Slopes are long and uniform, and they are steeper along the major drainageways. This association occupies about 32 percent of the county.

About 29 percent of the association is Everly soils, about 22 percent is Sac soils, about 9 percent is Rushmore soils, and the remaining 40 percent is minor soils.

The Everly soils are well drained. These soils formed in loess-influenced glacial till and have slopes of 2 to 12 percent. They have a surface layer of black and very dark grayish-brown clay loam about 16 inches thick. The subsoil is dominantly brown and dark yellowish-brown clay loam about 17 inches thick. The underlying material is grayish-brown and light olive-brown, calcareous heavy loam. The Everly soils are associated with the moderately well drained Wilmonton soils and the poorly drained Letri soils.

The Sac soils also are well drained. They formed in moderately thick loess over glacial till and have slopes of 1 to 5 percent (fig. 3). These soils have a black to very dark brown silty clay loam surface layer about 12 inches thick. The subsoil is dark-brown and dark yellowish-brown silty clay loam about 18 inches thick. The underlying material is mottled, yellowish-brown clay loam. The Sac soils are associated with the moderately well drained Ransom soils and the somewhat poorly drained Rushmore soils.

The Rushmore soils are poorly drained. They formed in moderately thick loess over glacial till and have slopes of 0 to 2 percent. These soils have a surface layer of black and dark olive-gray silty clay loam about 18 inches thick. The subsoil is olive-gray and olive silty clay loam about 10 inches thick. The underlying material is calcareous, light olive-brown, firm loam.

Among the minor soils in this association are the well-drained Fairhaven, Galva, and Wadena soils, the somewhat poorly drained Primghar soils, the poorly drained Marcus soils, and the somewhat excessively drained Kanaranzi and Dickman soils. The Millington, Comfrey, and Spillville soils are on bottom lands.

The soils of this association generally are suited to all crops commonly grown in the county. The sloping soils are subject to soil loss caused by runoff. The poorly drained soils require adequate drainage for sustained plant growth.

3. *Webster-Nicollet association*

Poorly drained and moderately well drained, nearly level clay loam soils formed in friable glacial till on uplands

This association consists of nearly level soils on ground moraines on uplands (fig. 4). These soils have slopes that generally range from 0 to 3 percent, but they are steeper along major drainageways. This association occupies about 20 percent of the county.

About 28 percent of the association is Webster soils, 25 percent is Nicollet soils, 15 percent is Clarion soils, and the remaining 32 percent is minor soils.

The Webster soils are poorly drained. These nearly level soils are on low, wide flats and in draws. They have a surface layer of black, very dark gray, and dark olive-gray clay loam and silty clay loam about 20 inches thick. The subsoil is mottled, olive-gray and olive, friable clay loam about 10 inches thick. Olive-gray, grayish-brown, and yellowish-brown, calcareous clay loam till occurs at a depth of about 30 inches.

The Nicollet soils are moderately well drained and have slopes of 0 to 3 percent. These soils have a surface layer of black and very dark gray clay loam about 15 inches thick. The subsoil is very dark grayish-brown and olive-brown, friable clay loam. It is underlain by calcareous, olive-brown, light olive-brown, and grayish-brown clay loam till at a depth of about 28 inches.

Figure 4.—Typical landscape in association 3.

The Clarion soils are well drained. These soils have slopes of 2 to 12 percent. They have a surface layer of black and very dark grayish-brown loam about 19 inches thick. The subsoil is dark yellowish-brown loam about 13 inches thick. The underlying material is light yellowish-brown and olive-brown, friable, calcareous loam.

The minor soils are the very poorly drained Lura soils, the poorly drained Waldorf soils, the somewhat poorly drained Collinwood soils, and the moderately well drained Kingston soils. These soils occur on old lake plains. Other minor soils are the rolling to steep Storden soils, the well-drained Wadena soils, the somewhat excessively drained Estherville soils, and the poorly drained Comfrey and Millington soils on bottom lands. Small areas of the Blue Earth, Glencoe, and Spillville soils also are in this association.

Most of this soil association is cultivated, and under proper management the soils are suited to all crops commonly grown in the county. Erosion on the sloping soils and wetness in the low areas are the main concerns in the use of these soils.

4. *Fairhaven-Kanaranzi-Wadena association*

Well-drained and somewhat excessively drained, nearly level to gently sloping silt loam and loam soils formed in loamy material over sand and gravel, on terraces and outwash plains

This association consists of nearly level to gently sloping soils along the drainageways and creeks. These soils have slopes of 0 to 6 percent along major drainageways, but they are steeper along small drainageways and creeks. This association occupies about 5 percent of the county.

About 50 percent of the association is Fairhaven soils, 20 percent is Kanaranzi soils, 20 percent is Wadena soils, and the remaining 10 percent is minor soils.

The Fairhaven soils are well drained. These soils generally have a surface layer of very dark gray and very dark grayish-brown silt loam about 12 inches thick. The subsoil is brown light silty clay loam about 10 inches thick. The underlying material is yellowish-brown, calcareous loam, about 4 inches thick, underlain by strong-brown and brown, calcareous, stratified sand and gravel. The Fairhaven silt loam, deep, in this association is similar, but the surface layer is 2 to 4 inches thicker and the depth to the coarse-textured underlying material is more than 40 inches.

The Kanaranzi soils are somewhat excessively drained. These soils have a surface layer of very dark brown loam about 6 inches thick. The subsoil is dark-brown and brown loam and sandy loam about 16 inches thick. The underlying material is gray and yellowish-brown, loose sand and gravel.

The Wadena soils are well drained. These soils have a surface layer of black loam about 12 inches thick. The subsoil is dark yellowish-brown, friable loam about 16 inches thick. The underlying material is yellowish-brown and pale-brown, stratified sand and gravel.

Among the minor soils are the poorly drained Comfrey and Millington soils on bottom land, the moderately well drained Spillville soils, the poorly drained Biscay soils, and small areas of Everly and Sac soils.

Most of this soil association is cultivated. Most areas are suited to all crops commonly grown in the county.

Droughtiness and erosion are the main concerns in the use of these soils.

5. *Comfrey-Millington-Spillville association*

Poorly drained and moderately well drained silty clay loam and loam soils formed in alluvial materials on bottom lands

This association consists of soils on bottom lands of the major streams in the county. These soils have slopes of 0 to 2 percent. This association occupies about 6 percent of the county.

About 40 percent of the association is Comfrey soils, 24 percent is Millington soils, 6 percent is Spillville soils, and the remaining 30 percent is minor soils.

The Comfrey soils are deep and poorly drained. These soils have a surface layer of black and very dark gray silty clay loam about 36 inches thick. The upper 8 inches of the underlying material is dark grayish-brown silty clay loam. Below this is dark grayish-brown and light olive-brown loam.

The Millington soils are deep, calcareous, and poorly drained (fig. 5). These soils have a surface layer of black and very dark gray silty clay loam about 30 inches thick. The subsoil is dark-gray clay loam and loam about 10 inches thick. The underlying material is gray, light-gray, and olive-gray loam.

The Spillville soils are deep and moderately well drained. These soils have a surface layer of black, very dark gray, and very dark grayish-brown loam and sandy loam about 38 inches thick. The underlying material is dark grayish-brown loam.

Among the minor soils are the poorly drained Biscay soils and the very poorly drained Talcot soils. Alluvial land is on the bottom lands.

Except for the Spillville soils, wetness and flooding are severe limitations to the management of the soils in this association. If properly drained and protected from flooding, many of these soils are suited to all crops commonly grown in the county.

Figure 5.—**Typical area of Millington silty clay loam in association 5.**

6. *Everly-Storden association*

Well-drained and somewhat excessively drained, gently sloping to steep clay loam and loam soils formed in firm glacial till on uplands

This association consists of soils that occur on uplands as glacial terminal moraines and along major streams. These soils have slopes of 2 to 24 percent. This association occupies about 3 percent of the county.

About 30 percent of the association is Everly and Storden soils that are intermingled in about equal proportions, about 20 percent is Everly soils, about 15 percent is Wilmonton soils, about 15 percent is Letri soils, and the remaining 20 percent is minor soils.

The Everly soils are well drained and gently sloping to steep. These soils have a surface layer of black and very dark grayish-brown clay loam about 16 inches thick. The subsoil is dominantly brown and dark yellowish-brown clay loam about 17 inches thick. The underlying material is grayish-brown and light olive-brown, calcareous heavy loam.

The Storden soils are somewhat excessively drained and sloping to steep. These soils have a surface layer of very dark brown and dark-brown loam about 7 inches thick. The underlying material is yellowish-brown, grayish-brown, dark yellowish-brown, light olive-brown, and light brownish-gray, calcareous loam or clay loam.

The Wilmonton soils are nearly level and moderately well drained. These soils have a surface layer of black silty clay loam about 17 inches thick. The subsoil is light olive-brown and olive-brown clay loam. The underlying material is light olive-brown, calcareous loam.

The Letri soils are nearly level and poorly drained. These soils have a surface layer of black and very dark gray silty clay loam and clay loam about 18 inches thick. The subsoil is dark grayish-brown and grayish-brown clay loam about 14 inches thick. The underlying material is calcareous, grayish-brown and olive clay loam.

Among the minor soils are the Estherville, Dickman, Kanaranzi, and Wadena soils, small areas of the poorly drained Millington and Comfrey soils on bottom lands, and small areas of moderately well drained Spillville soils.

The soils in this association are cultivated on the lower slopes. Soil loss caused by runoff is a major concern on the sloping and moderately steep soils. The steep and moderately steep soils are used for pasture. If they are properly managed, the less sloping soils are suited to all crops commonly grown in the county.

7. *Dickman-Fairhaven association*

Somewhat excessively drained and well-drained, nearly level to sloping sandy loam to silt loam soils formed in loamy or sandy materials over sand, on uplands

This association consists of soils on uplands in areas of glacial drift and on outwash plains. These soils have slopes of 0 to 12 percent. This association makes up about 1 percent of the county.

About 55 percent of the association is Dickman soils, about 35 percent is Fairhaven soils, and the remaining 10 percent is minor soils.

The somewhat excessively drained Dickman soils have a very dark brown sandy loam surface layer about 12 inches thick. The subsoil is mostly dark-brown and dark yellowish-brown loamy sand about 19 inches thick. The underlying material is dark-brown and pale-brown sand.

The well-drained Fairhaven soils have a very dark gray and very dark grayish-brown silt loam surface layer about 12 inches thick. The subsoil is brown silt loam about 10 inches thick. The underlying material is brown and strong-brown fine sand.

The minor soils are the poorly drained Millington and Biscay soils and small areas of Rushmore soils.

The main limitation in the use of these soils is droughtiness, especially on the Dickman soils. Erosion is a hazard on the sloping Dickman soils. If the soils in this association are properly managed, however, they are suited to all crops commonly grown in the county.

Descriptions of the Soils

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

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

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

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and windbreak suitability group in which the mapping unit has been placed. The page for the description of each capability unit and windbreak suitability group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).[2]

[2] Italic numbers in parentheses refer to Literature Cited, p. 77.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Alluvial land	622	0.1	Fairhaven silt loam, 2 to 6 percent slopes	1,933	.4
Alluvial land, frequently flooded	2,367	.5	Fairhaven silt loam, 2 to 6 percent slopes, eroded	1,106	.2
Biscay silty clay loam	8,663	1.9	Fairhaven silt loam, deep, 0 to 2 percent slopes	3,494	.8
Blue Earth silt loam	2,330	.5	Fairhaven silt loam, deep, 2 to 6 percent slopes	966	.2
Canisteo clay loam	8,108	1.8	Fairhaven silt loam, sandy subsoil, 0 to 2 percent slopes	724	.2
Clarion loam, 2 to 6 percent slopes	32,967	7.2	Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes	636	.1
Clarion loam, 2 to 6 percent slopes, eroded	12,330	2.7	Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes, eroded	554	.1
Clarion loam, 6 to 12 percent slopes	838	.2	Galva silty clay loam, 1 to 3 percent slopes	2,277	.5
Clarion loam, 6 to 12 percent slopes, eroded	4,680	1.0	Glencoe silty clay loam	9,641	2.1
Clarion-Storden loams, 6 to 12 percent slopes, eroded	1,762	.4	Gravel pits	548	.1
Clarion-Storden loams, 12 to 18 percent slopes, eroded	1,005	.2	Kanaranzi loam, 0 to 2 percent slopes	1,972	.4
Clarion-Storden loams, 18 to 24 percent slopes	149	(1)	Kanaranzi loam, 2 to 6 percent slopes	2,626	.6
Clarion-Storden-Estherville loams, 2 to 6 percent slopes, eroded	484	.1	Kingston silty clay loam	2,998	.7
Clarion-Storden-Estherville loams, 6 to 12 percent slopes, eroded	634	.1	Kingston silty clay loam, loamy subsoil variant, 0 to 2 percent slopes	2,866	.6
Clarion-Storden-Estherville loams, 12 to 18 percent slopes, eroded	213	(1)	Kingston silty clay loam, loamy subsoil variant, 2 to 6 percent slopes	10,493	2.3
Collinwood silty clay, 1 to 4 percent slopes	8,352	1.8	Lake beaches	285	.1
Comfrey silty clay loam	7,382	1.6	Letri silty clay loam	7,861	1.7
Comfrey silty clay loam, frequently flooded	2,395	.5	Lura silty clay	2,224	.5
Comfrey silty clay loam, depressional	1,270	.3	Marcus-Spicer silty clay loams	7,841	1.7
Dickman sandy loam, 0 to 6 percent slopes	3,590	.8	Marsh	915	.2
Dickman sandy loam, 6 to 12 percent slopes, eroded	725	.2	Millington silty clay loam	4,270	.9
Estherville coarse sandy loam, 2 to 6 percent slopes	997	.2	Millington silty clay loam, frequently flooded	1,931	.4
Estherville coarse sandy loam, 6 to 12 percent slopes, eroded	450	.1	Millington silty clay loam, depressional	279	.1
Estherville loam, 0 to 6 percent slopes	1,637	.4	Nicollet clay loam	55,489	12.2
Everly clay loam, 2 to 6 percent slopes	24,230	5.3	Primghar silty clay loam	2,880	.6
Everly clay loam, 2 to 6 percent slopes, eroded	14,592	3.2	Ransom silty clay loam	18,086	4.0
Everly clay loam, 6 to 12 percent slopes	784	.2	Rushmore silty clay loam	19,108	4.2
Everly clay loam, 6 to 12 percent slopes, eroded	4,770	1.1	Sac silty clay loam, 1 to 3 percent slopes	28,759	6.3
Everly-Storden complex, 6 to 12 percent slopes, eroded	1,648	.4	Sac silty clay loam, 3 to 5 percent slopes, eroded	3,471	.8
Everly-Storden complex, 12 to 18 percent slopes, eroded	1,194	.3	Spicer silty clay loam	748	.2
Everly-Storden complex, 18 to 24 percent slopes	417	.1	Spillville loam	1,741	.4
Everly-Storden-Estherville complex, 2 to 6 percent slopes	403	.1	Talcot silty clay loam	665	.1
Everly-Storden-Estherville complex, 6 to 12 percent slopes, eroded	924	.2	Terril loam, 2 to 6 percent slopes	1,129	.3
Everly-Storden-Estherville complex, 12 to 18 percent slopes, eroded	357	.1	Wadena loam, 0 to 2 percent slopes	3,143	.7
Fairhaven silt loam, 0 to 2 percent slopes	3,759	.8	Wadena loam, 2 to 6 percent slopes	3,704	.8
			Waldorf silty clay	12,123	2.7
			Webster clay loam	52,938	11.6
			Webster silty clay loam	9,538	2.1
			Wilmonton silty clay loam	12,748	2.8
			Open water	3,942	.9
			Total	455,680	100.0

[1] Less than 0.05 percent.

Alluvial Land

Alluvial land is made up of Alluvial land (Ad) and Alluvial land, frequently flooded (Af). It is on bottom land throughout the county.

Alluvial land (0 to 2 percent slopes) (Ad) consists of soil material that is deep and moderately deep and is poorly drained. The soil material varies in texture and in reaction.

Included with this land type in mapping are areas where a discontinuous, coarse-textured substratum is present and areas that are sandy in the upper part and finer textured in the lower part.

This land type is suited to crops and pasture. Crops are damaged about 1 year in 5 by flooding. Corn and soybeans are the main cultivated crops, and bluegrass is the main pasture grass. Capability unit IIw–2; windbreak suitability group 2.

Alluvial land, frequently flooded (0 to 2 percent slopes) (Af) is deep and moderately deep to underlying sand. The texture is variable but is dominantly medium and moderately fine. Reaction also is variable. Many areas are cut by oxbows of winding stream channels and old channels.

The use of this land type is severely limited by frequent flooding. Most areas are enclosed by fences and are used as permanent pasture. The low position of this land type on the bottom lands makes protection from flooding impractical in most areas. Capability unit VIw–1; windbreak suitability group 7.

495–476—75——2

Biscay Series

The Biscay series consists of moderately deep, nearly level, moderately fine textured soils that are poorly drained and are underlain by sand and gravel. These soils are on low terraces and outwash plains. The native vegetation was tall grass prairie and sedges.

In a representative profile, the surface layer is black and very dark gray silty clay loam about 20 inches thick. The subsoil is olive-gray loam about 10 inches thick. The underlying material is grayish-brown loam, about 4 inches thick, that overlies light olive-brown, loose, calcareous sand and gravel.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Available water capacity is moderate. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Most of the acreage is cultivated. Wetness is the main limitation to the use of these soils. If the soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Biscay silty clay loam, in a permanent pasture, 60 feet east of road, in NW¼SW¼ NW¼SW¼ sec. 4, T. 102 N., R. 43 W.:

A11—0 to 14 inches, black (10YR 2/1) silty clay loam high in content of sand; weak, medium and fine, angular blocky structure; very friable; sticky; neutral; gradual, smooth boundary.

A12—14 to 18 inches, very dark gray (10YR 3/1) silty clay loam high in content of sand; moderate, medium, angular blocky structure; very friable; sticky; neutral; gradual, smooth boundary.

A3—18 to 20 inches, very dark grayish-brown (2.5Y 3/2) and very dark gray (5Y 3/1) silty clay loam high in content of sand; moderate, very fine, angular blocky structure; very friable; sticky; neutral; gradual, smooth boundary.

B2g—20 to 30 inches, olive-gray (5Y 4/2) loam; few, fine, faint, brownish-yellow (10YR 6/6) mottles; moderate, fine, angular blocky structure; very friable; sticky; mildly alkaline; slight effervescence; gradual, smooth boundary.

C1—30 to 34 inches, grayish-brown (2.5Y 5/2) loam; common, coarse, distinct, light olive-brown (2.5Y 5/6) mottles; massive; very friable; sticky; mildly alkaline; slight effervescence; abrupt, smooth boundary.

IIC2—34 to 60 inches, light olive-brown (2.5Y 5/6) sand and gravel; single grain; loose; mildly alkaline; strong effervescence.

Thickness of the solum and depth to coarse sand and gravel commonly range from 30 to 36 inches. Depth to free carbonates ranges from 20 to 30 inches. The A horizon ranges from 16 to 24 inches in thickness. It is silty clay loam or clay loam. The B horizon ranges from 8 to 16 inches in thickness. The B2g and C1 horizons are loam to heavy sandy loam or sandy clay loam. The C1 horizon ranges from 0 to 6 inches in thickness.

The Biscay soils are associated with the Wadena and Talcot soils. They have a grayer B horizon than the well-drained Wadena soils. Biscay soils lack free carbonates in the A horizon, but the very poorly drained Talcot soils have free carbonates in that horizon.

Biscay silty clay loam (0 to 2 percent slopes) (Bc).—This poorly drained soil is on low stream terraces and outwash plains and in a few areas on glacial till upland plains. It is in areas that range from 10 to 40 acres in size.

Included with this soil in mapping are small areas of Comfrey and Talcot soils and small areas of soils that are calcareous throughout.

Most areas of this soil are cultivated. Wetness is the major limitation to the use of this soil. Where it is properly drained, the soil is suited to all crops commonly grown in the county. Capability unit IIw–4; windbreak suitability group 2.

Blue Earth Series

The Blue Earth series consists of deep, nearly level, very poorly drained soils that are medium textured and calcareous. These soils are on drained lake bottoms. The native vegetation was cattails and sedges.

In a representative profile, the surface layer is black silt loam about 42 inches thick. This layer is calcareous throughout. The underlying material is very dark gray and dark olive-gray, friable, calcareous clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content is very high, and fertility is high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main limitation to the use of these soils. If the soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Blue Earth silt loam, in a cultivated field, 75 feet southeast of State Highway 60, near the center of NW¼NW¼, sec. 25, T. 102 N., R. 40 W.:

Ap—0 to 7 inches, black (10YR 2/1), very dark gray (10YR 3/1), and dark-brown (10YR 3/3) silt loam; moderate, medium, subangular blocky structure; very friable; many clam shell fragments; mildly alkaline; strong effervescence; abrupt, smooth boundary.

A11—7 to 22 inches, black (10YR 2/1) silt loam; weak, medium, angular blocky structure; very friable; common dark reddish-brown (5YR 3/4) stains in root channels; many clam shell fragments; many white threads of lime; mildly alkaline; strong effervescence; gradual, smooth boundary.

A12—22 to 36 inches, black (10YR 2/1) silt loam; weak, coarse, subangular blocky structure; very friable; mildly alkaline; strong effervescence; gradual, smooth boundary.

A13—36 to 42 inches, black (10YR 2/1) silt loam; weak, coarse, subangular blocky structure; very friable; mildly alkaline; strong effervescence; clear, smooth boundary.

Cg—42 to 60 inches, very dark gray (5Y 3/1) and dark olive-gray (5Y 3/2) clay loam; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; sticky; mildly alkaline; strong effervescence.

The A horizon ranges from 24 to 50 inches in thickness. This horizon is 1 to 5 percent calcareous shells, by volume. The upper 10 inches of the horizon is 10 to 20 percent organic matter. The horizon typically is silt loam, but it is silty clay loam in some places. The C horizon ranges from clay loam to loam.

The Blue Earth soils are similar to the Glencoe soils, but they have free carbonates throughout the A horizon, and these are lacking in Glencoe soils.

Blue Earth silt loam (0 to 2 percent slopes) (Br).—This very poorly drained soil is in drained lakebeds on glacial till uplands. Areas range from 10 to 500 acres in size.

Included with this soil in mapping are small areas of soils that have 12 to 18 inches of muck on the surface. Also included are small areas of soils that have a silty clay loam surface layer.

Wetness is the main limitation to the use of this soil. If the soil is properly drained, it is suited to all crops commonly grown in the county. Capability unit IIIw–1; windbreak suitability group 3.

Canisteo Series

The Canisteo series consists of deep, nearly level, poorly drained soils that are calcareous. These soils formed in glacial till on upland till plains. The native vegetation was mainly sedges and grasses.

In a representative profile, the surface layer is black and very dark gray, calcareous clay loam about 17 inches thick. The subsoil is mottled, olive-gray and olive, friable, calcareous clay loam about 15 inches thick. The underlying material is mottled, light olive-brown and grayish-brown, friable, calcareous clay loam and loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main limitation to the use of these soils. In addition, the availability of phosphate and potash is low because of the high content of lime. These soils are suited to all crops commonly grown in the county.

Representative profile of Canisteo clay loam, in a cultivated field, in SE¼SW¼SE¼ sec. 13, T. 102 N., R. 40 W.:

Ap—0 to 8 inches, black (N 2/0) clay loam; moderate, fine, subangular blocky structure; friable; about 2 percent coarse fragments; mildly alkaline; strong effervescence; gradual, smooth boundary.

A1—8 to 14 inches, black (5Y 2/1) clay loam; weak, fine, subangular blocky structure; friable, sticky; about 2 percent coarse fragments; mildly alkaline; strong effervescence; gradual, smooth boundary.

A3—14 to 17 inches, very dark gray (5Y 3/1) clay loam; common, medium, distinct, olive (5Y 4/4) mottles; weak, fine and medium, subangular blocky structure; sticky; about 2 percent coarse fragments; mildly alkaline; slight effervescence; gradual, smooth boundary.

B1g—17 to 22 inches, olive-gray (5Y 4/2) clay loam; many, medium, distinct, olive (5Y 5/6) mottles; weak and moderate, fine and medium, subangular blocky structure; sticky; few very dark gray (5Y 3/1) worm channels; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual, smooth boundary.

B21—22 to 27 inches, olive (5Y 5/4) clay loam; weak and moderate, fine and medium, subangular blocky structure; sticky; common gypsum crystals; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear, smooth boundary.

B22—27 to 32 inches, olive (5Y 5/4 and 5Y 5/6) clay loam; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; sticky; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual, smooth boundary.

C1—32 to 38 inches, light olive-brown (2.5Y 5/6) clay loam; common, medium, distinct, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) mottles; massive; sticky; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear, smooth boundary.

C2—38 to 60 inches, grayish-brown (2.5Y 5/2) loam; common, medium, distinct, light olive-brown (2.5Y 5/6) mottles; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence.

The A horizon is typically clay loam, but it is silty clay loam in some places. The A horizon ranges from 12 to 24 inches in thickness. The B horizon ranges from 8 to 18 inches in thickness and is typically clay loam but ranges to silty clay loam or loam in some places. The C1 horizon is loam in some places.

The Canisteo soils are associated with the Webster soils and are similar to the Spicer soils. They have free carbonates throughout the profile, but the Webster soils lack free carbonates in the A horizon and in at least part of the B horizon. Canisteo soils have more sand and less silt than the Spicer soils.

Canisteo clay loam (0 to 2 percent slopes) (Ca).—This poorly drained, calcareous soil is in bands around depressions and in low, wide flats on upland glacial till plains. The areas range from 5 to more than 40 acres in size.

Included with this soil in mapping are small areas of Webster soils.

Wetness is the main limitation to the use of this soil. Most areas are used for corn and soybeans. If this soil is properly drained, it is suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 3.

Clarion Series

The Clarion series consists of deep, gently undulating to steep, well-drained soils that are medium textured. These soils formed in calcareous glacial till in ground moraines on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark grayish-brown loam about 19 inches thick. The subsoil is dark yellowish-brown and yellowish-brown, friable loam about 13 inches thick. The lower 6 inches of the subsoil is calcareous. The underlying material is mottled, light olive-brown and light yellowish-brown, friable, calcareous loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high in uneroded areas. Depth to a seasonal high water table is more than 5 feet.

Most of the acreage of these soils is cultivated. Erosion is the main limitation to use. These soils are suited to all crops commonly grown in the county.

Representative profile of Clarion loam, 2 to 6 percent slopes, in a cultivated field, 100 feet east of road, in NW¼SE¼NW¼ sec. 21, T. 102 N., R. 40 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, medium, subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; clear, smooth boundary.

A1—7 to 13 inches, black (10YR 2/1) loam, very dark brown (10YR 2/2) crushed; weak, coarse, prismatic structure parting to weak, fine and very fine, subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; gradual, smooth boundary.

A3—13 to 19 inches, very dark grayish-brown (10YR 3/2) loam; weak, coarse, prismatic structure parting to weak to moderate, medium, subangular blocky structure; very friable; many black (10YR 2/1) worm casts; about 5 percent coarse fragments; neutral; gradual, smooth boundary.

B2—19 to 26 inches, dark yellowish-brown (10YR 4/4) loam; weak, coarse, prismatic structure parting to weak to moderate, medium, subangular blocky structure; friable; very few thin clay films on faces of peds; few very dark gray (10YR 3/1) and dark-gray (10YR 4/1) worm casts; about 5 percent coarse fragments; neutral; gradual, smooth boundary.

B3—26 to 32 inches, yellowish-brown (10YR 5/4) loam; weak, coarse, prismatic structure parting to weak to moderate, medium, subangular blocky structure; very friable; few dark-gray (10YR 4/1) worm casts; about 5 percent coarse fragments; mildly alkaline; slight effervescence; gradual boundary.

C1—32 to 39 inches, light olive-brown (2.5Y 5/4) loam; few, fine, distinct, yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) mottles; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

C2—39 to 60 inches, light olive-brown (2.5Y 5/4) and light yellowish-brown (2.5Y 6/4) loam; common, fine, distinct, strong-brown (7.5YR 5/6) and light brownish-gray (10YR 6/2) mottles; massive; friable; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 20 to 42 inches but average about 32 inches. The A horizon ranges from 10 to 20 inches in thickness, except in eroded areas. This horizon is typically loam, but in some places it is clay loam. The horizon is neutral to slightly acid. The B horizon is loam or clay loam and ranges from 4 to 16 inches in thickness. The B3 horizon is neutral or mildly alkaline.

The Clarion soils are associated with the Nicollet, Webster, and Storden soils. They lack grayish-colored mottles in the B horizon that are characteristic of the wetter Nicollet soils. They have a B horizon, but Storden soils do not. Clarion soils have a brighter colored B horizon than the poorly drained Webster soils.

Clarion loam, 2 to 6 percent slopes (ClB).—This gently undulating, well-drained soil is on glacial till uplands. Slopes are convex. The areas range from 3 to 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of soils that have an eroded surface layer and a few small areas that have pockets of sand and gravel. Also included are small areas of Storden soils.

Most areas of this soil are cultivated. Erosion is the main limitation to use. This soil is suited to all crops comonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Clarion loam, 2 to 6 percent slopes, eroded (ClB2).—This gently undulating, well-drained soil is on glacial till uplands. Slopes are convex. The areas range from 5 to 20 acres in size. This soil has a profile similar to that described for the series, except that the surface layer ranges from 5 to 7 inches in thickness and has a lower organic-matter content.

Included with this soil in mapping are small areas of soils that have an uneroded surface layer and a few small areas that have pockets of sand and gravel. The uneroded soils have a higher organic-matter content and fertility than this eroded soil. Also included are small areas of Storden soils.

Nearly all of the acreage is cultivated. Erosion is the main limitation to the use of this soil. This soil is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Clarion loam, 6 to 12 percent slopes (ClC).—This rolling, well-drained soil is on glacial till uplands. Slopes are convex. Areas range from 3 to 10 acres in size.

Included with this soil in mapping are small areas of Storden soils and small areas of eroded soils. Also included are a few small areas that have pockets of sand and gravel.

Most of the acreage is in meadow and permanent pasture. If this soil is cultivated, the hazard of erosion is severe. If properly managed, however, the soil is suited to all crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Clarion loam, 6 to 12 percent slopes, eroded (ClC2).—This rolling, well-drained soil is on glacial till uplands. Slopes are convex. The areas range from 3 to 20 acres in size. This soil has a profile similar to that described for the series, except that the surface layer ranges from 5 to 7 inches in thickness and has a lower organic-matter content.

Included with this soil in mapping are small areas of Storden soils and small areas of soils that have a thicker surface layer. Also included are a few small areas that have pockets of sand and gravel.

Most of the acreage is cultivated. The hazard of erosion is severe. If properly managed, this soil is suited to most crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Clarion-Storden loams, 6 to 12 percent slopes, eroded (CnC2).—This complex consists of rolling soils on glacial till uplands. About half of the complex is Clarion loam, and half is Storden loam. The Clarion soil has a darker colored surface layer than the Storden soil. These soils have a profile similar to those described for their respective series, except that the surface layer of the Clarion soil ranges from 4 to 7 inches in thickness and has a lower organic-matter content.

Included with these soils in mapping are small areas of soils that have steeper slopes, a few small areas that have pockets of sand and gravel, and small areas of uneroded soils. The uneroded soils have a higher organic-matter content and fertility than these eroded soils.

Most of the acreage of these soils is cultivated. The hazard of erosion is severe. If properly managed, the soils are suited to most crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Clarion-Storden loams, 12 to 18 percent slopes, eroded (CnD2).—This complex is on terminal moraines in the glacial till uplands and on banks along major drainageways. About half of the complex is Clarion loam, and half is Storden loam. The Clarion soil has a darker colored surface layer than the Storden soil. Its profile is similar to the one described as representative for the Clarion series, except that the surface layer is 4 to 7 inches thick and has a lower organic-matter content. The Storden soil has the profile described as representative for the Storden series.

Included with these soils in mapping are small areas of uneroded soils and a few small areas that have pockets of sand and gravel. The uneroded soils have a higher organic-matter content and fertility than these eroded soils.

Some less sloping areas of these soils are cultivated, but most areas are in permanent pasture. The hazard of erosion is severe. These soils are better suited to controlled grazing and hay than to other farm uses. Capability unit IVe–1; windbreak suitability group 5.

Clarion-Storden loams, 18 to 24 percent slopes (CnE).—This complex is on terminal moraines of the upland till plains and on banks along major drainageways. About half of the complex is Clarion loam, and half is Storden loam. The Clarion soil has a thicker and darker colored surface layer than the Storden soil. These soils have a profile similar to those described for their respective series, except that the surface layer in the Clarion soil is somewhat thinner.

Included with these soils in mapping are small areas of steeper soils and a few areas of eroded soils.

The soils in this complex are suited to controlled grazing and are used mainly for pasture. Capability unit VIe–1; windbreak suitability group 5.

Clarion-Storden-Estherville loams, 2 to 6 percent slopes, eroded (CoB2).—This complex consists of gently undulating soils on glacial till ground moraines. About one-third of the complex is Clarion loam, one-third is Storden loam, and the other third is Estherville loam. The Clarion soil has a darker colored surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. These soils have a profile similar to those described for their respective series, except that the surface layer of the Clarion and Estherville soils ranges from 4 to 7 inches in thickness and has a lower organic-matter content.

Included with these soils in mapping are small areas of Estherville coarse sandy loam. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than these eroded soils.

Most of the acreage is cultivated. The hazard of erosion is the main limitation to the use of these soils. Low available water capacity in the Estherville soil limits crop production in most years. These soils are suited to all crops commonly grown in the county. All three soils are in capability unit IIIe–2; Clarion and Storden soils are in windbreak suitability group 1; Estherville soil is in windbreak suitability group 4.

Clarion-Storden-Estherville loams, 6 to 12 percent slopes, eroded (CoC2).—This complex consists of rolling soils on glacial till ground moraines. About one-third of the complex is Clarion loam, one-third is Storden loam, and the other third is Estherville loam. The Clarion soil has a darker surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. The Clarion, Storden, and Estherville soils in this complex have a profile similar to those described as representative for their respective series, except that the surface layer of Clarion and Estherville soils ranges from 4 to 7 inches in thickness and has a lower organic-matter content.

Included with these soils in mapping are small areas of Estherville coarse sandy loam. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than these eroded soils.

Most of the acreage is cultivated. The hazard of erosion is severe. Low available water capacity in the Estherville soil limits crop production in most years. These soils are suited to all crops commonly grown in the county. All three soils are in capability unit IVe–2; Clarion and Storden soils are in windbreak suitability group 1; Estherville soil is in windbreak suitability group 4.

Clarion-Storden-Estherville loams, 12 to 18 percent slopes, eroded (CoD2).—This complex consists of hilly soils on glacial till terminal moraines and on banks along major drainageways. About one-third of the complex is Clarion loam, one-third is Storden loam, and the other third is Estherville loam. The Clarion soil has a darker surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. These soils have a profile similar to those described for their respective series, except that the surface layer is only 4 to 7 inches thick and other layers also are somewhat thinner.

Included with these soils in mapping are small areas of steeper soils and areas of soils that are gravelly near the surface. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than these eroded soils.

Most of the acreage is in permanent pasture, but some crops are grown in less sloping areas. The hazard of erosion is severe. These soils are suited to controlled grazing and hay. All three soils are in capability unit VIe–2; Clarion and Storden soils are in windbreak suitability group 5; Estherville soil is in windbreak suitability group 4.

Collinwood Series

The Collinwood series consists of deep, nearly level to gently sloping, fine-textured soils that are somewhat poorly drained. These soils formed in lacustrine sediment on old lake plains and glacial till plains. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black silty clay about 17 inches thick. The subsoil is mottled, dark grayish-brown and olive-brown, firm silty clay about 17 inches thick. The underlying material is grayish-brown and light olive-brown silty clay and silty clay loam.

Permeability is moderately slow. Available water capacity is moderate to high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

The main concerns in the use of these soils are controlling erosion and maintaining good tilth. Most of the acreage is cultivated. These soils are suited to all crops commonly grown in the county.

Representative profile of Collinwood silty clay, 1 to 4 percent slopes, in an area of bluegrass sod, midway between powerpoles on northwest side of State Highway 60, in NE¼NE¼SW¼ sec. 34, T. 103 N., R. 39 W.:

A11—0 to 10 inches, black (10YR 2/1) silty clay; moderate, medium and fine, subangular blocky structure; friable; sticky; slightly acid; gradual, wavy boundary.

A12—10 to 17 inches, black (10YR 2/1), silty clay; moderate to strong, fine, subangular blocky structure; friable; sticky; few very dark grayish-brown (10YR 3/2) worm channels; slightly acid; clear, irregular boundary.

B1—17 to 23 inches, dark grayish-brown (2.5Y 4/2) silty clay; moderate, medium, prismatic structure parting to moderate, fine, subangular structure; firm; sticky; slightly acid; gradual, smooth boundary.

B2—23 to 28 inches, olive-brown (2.5Y 4/4) silty clay; dark grayish-brown (2.5Y 4/2) coatings on peds; moderate, medium, subangular blocky structure; sticky; neutral; gradual, smooth boundary.

B3—28 to 34 inches, dark grayish-brown (2.5Y 4/2) silty clay; common, medium, distinct, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/6) mottles; weak, coarse, prismatic structure; sticky; neutral; clear, smooth boundary.

C1—34 to 42 inches, grayish-brown (2.5Y 5/2) silty clay; common, medium, distinct, light olive-brown (2.5Y 5/4) mottles; massive with some vertical and horizontal cleavage; sticky; mildly alkaline; slight effervescence; gradual, smooth boundary.

C2—42 to 60 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) silty clay loam; common, medium, distinct, brown (7.5YR 5/4) mottles; massive; sticky; mildly alkaline; strong effervescence.

Thickness of the solum and depth to free lime range from 24 to 40 inches. This range in thickness occurs within a very short horizontal distance. The upper part of the A horizon is silty clay loam in some places. The horizon ranges from 12 to 20 inches in thickness. The B horizon ranges from 12 to 20 inches in thickness. The B1 and B2 horizons are slightly

acid or neutral. The C horizon typically is silty clay or silty clay loam, but it is loam or clay loam below a depth of 48 inches in some places.

The Collinwood soils are associated with the Waldorf and Nicollet soils. They lack the mottles in the A horizon that are characteristic of the wetter Waldorf soils, and they have a browner colored B horizon than those soils. Collinwood soils have less sand and more clay than the Nicollet soils.

Collinwood silty clay, 1 to 4 percent slopes (CrB).—This soil is on old lake plains and glacial till plains. It is in slightly convex areas that range from 5 to 20 acres in size and are on wide, low, poorly drained flats.

Included with this soil in mapping are small areas of Nicollet soils.

The hazard of erosion is slight in the more sloping areas of this soil. Maintaining good tilth is difficult because of the fine texture. Nearly all of the acreage is cultivated. This soil is suited to all crops commonly grown in the county. Capability unit IIs–2; windbreak suitability group 1.

Comfrey Series

The Comfrey series consists of deep, nearly level, moderately fine textured soils that are poorly drained and very poorly drained. These soils formed in alluvial material on bottom lands. The native vegetation was tall grass prairie and water grass.

In a representative profile, the surface layer is black and very dark gray to dark grayish-brown silty clay loam about 36 inches thick. The upper 8 inches of the underlying material is friable, mottled, dark grayish-brown silty clay loam. Below this, the underlying material is dark grayish-brown and light olive-brown, friable, calcareous loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness and a hazard of flooding are the main concerns in the use of these soils. These soils are suited to all crops commonly grown in the county.

Representative profile of Comfrey silty clay loam, in a sodded area, 100 feet south of road, 200 feet west of half section line in NE¼NE¼NW¼ sec. 27, T. 101 N., R. 40 W.:

A11—0 to 10 inches, black (N 2/0) silty clay loam high in content of sand; moderate, medium, granular structure; firm; sticky; neutral; gradual, wavy boundary.

A12—10 to 28 inches, very dark gray (N 3/0) silty clay loam high in content of sand; few, medium, faint, light olive-brown (2.5Y 5/4) mottles; moderate, medium, angular blocky structure; friable; sticky; neutral; gradual, wavy boundary.

A3—28 to 36 inches, very dark gray (N 3/0) to dark grayish-brown (2.5Y 4/2) silty clay loam high in content of sand, very dark grayish brown (2.5Y 3/2) crushed; common medium, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine to very fine, angular blocky structure; friable; sticky; mildly alkaline; slight effervescence; clear, smooth boundary.

C1g—36 to 44 inches, dark grayish-brown (2.5Y 4/2) silty clay loam high in content of sand; common, medium, distinct, yellowish-brown (10YR 4/4) mottles; moderate, fine to very fine, angular blocky structure; friable; mildly alkaline; slight effervescence; clear, smooth boundary.

C2g—44 to 60 inches, dark grayish-brown (2.5Y 4/2) and light olive-brown (2.5Y 5/4) loam; massive; friable; mildly alkaline; strong effervescence.

Depth to free carbonates ranges from 24 to 36 inches. The A horizon ranges from 24 to 40 inches in thickness. It is silty clay loam that has a high content of sand or, in some places, clay loam. The C horizon ranges from clay loam to loam to sandy loam with increasing depth.

Comfrey silty clay loam, depressional, in this county is outside the defined range of the series because it is very poorly drained.

The Comfrey soils are associated with the Millington and Spillville soils. They have lower chroma in the A horizon than the moderately well drained Spillville soils. They lack free carbonates in the upper part of the A horizon, but the Millington soils have free carbonates throughout the A horizon.

Comfrey silty clay loam (0 to 2 percent slopes) (Cs).—This poorly drained soil is on flat bottom lands along major streams and drainageways. The areas range from a few acres to a few hundred acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Millington soils. Also included are a few areas of soils that have underlying material of clay loam or loam glacial till.

Wetness and occasional flooding are the main concerns in the use of this soil. Crop damage by flooding occurs about once in every 5 years. This soil is suited to all crops commonly grown in the county. Capability unit IIw–2; windbreak suitability group 2.

Comfrey silty clay loam, frequently flooded (0 to 2 percent slopes) (Ct).—This poorly drained soil is on flat bottom lands along major streams and drainageways. The areas range from a few acres to a few hundred acres in size.

Included with this soil in mapping are small areas of Millington soils.

Frequent flooding is the main concern in the use of this soil. Flooding during the crop growing season occurs nearly every year. This soil is mainly used for permanent pasture and is well suited to this use. Capability unit VIw–1; windbreak suitability group 7.

Comfrey silty clay loam, depressional (0 to 2 percent slopes) (Cu).—This very poorly drained soil is in low depressions on bottom lands along major streams and drainageways. In many of the depressions the surface is hummocky. The areas range from 3 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is thicker in most places.

Included with this soil in mapping are small areas of Millington and Talcot soils. Also included are a few areas of soils that have underlying material of loam or clay loam glacial till.

This soil is used for pasture and wild hay. Capability unit VIw–2; windbreak suitability group 7.

Dickman Series

The Dickman series consists of very deep, moderately coarse textured, somewhat excessively drained soils that formed in deep glacial drift on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is very dark brown sandy loam about 12 inches thick. The subsoil is mostly dark-brown and dark yellowish-brown, friable loamy sand about 19 inches thick. The underlying material is dark-brown and pale-brown sand.

Permeability is moderately rapid in the upper part of these soils and rapid in the underlying material. The available water capacity is low. Organic-matter content is high in uneroded areas, and fertility is medium. Depth to a seasonal high water table is more than 5 feet.

The hazard of erosion and low available water capacity are the main limitations to the use of these soils. These soils are suited to all crops commonly grown in the county.

Representative profile of Dickman sandy loam, 0 to 6 percent slopes, in a cultivated field, 300 feet east of road and 200 feet north of creek fence, in SW¼SW¼NW¼ sec. 5, T. 101 N., R. 43 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) sandy loam; weak, fine, granular structure; friable; slightly acid; gradual boundary.

A1—8 to 12 inches, very dark brown (10YR 2/2) sandy loam; weak, coarse, subangular blocky structure parting to weak, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

B1—12 to 16 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B2—16 to 23 inches, dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) heavy loamy sand; weak, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B3—23 to 31 inches, dark yellowish-brown (10YR 4/4) and dark-brown (10YR 4/3) loamy sand; weak, fine, subangular blocky structure; friable; neutral; clear boundary.

C1—31 to 48 inches, dark-brown (10YR 4/3) sand; single grain; mildly alkaline; slight effervescence; clear boundary.

C2—48 to 60 inches, pale-brown (10YR 6/3) sand; single grain; mildly alkaline; strong effervescence.

The A horizon ranges from 5 to 18 inches in thickness. It ranges from black to very dark gray or very dark brown in color and from sandy loam to loam in texture. It is neutral or slightly acid. The depth to the loamy sand or coarser texture of the B horizon ranges from 12 to 20 inches. The C horizon is fine sand or sand. The depth to free carbonates ranges from 24 to 50 inches but is typically about 30 inches.

The Dickman soils in this county are outside the defined range of the series because they have free carbonates at a shallower depth, but this difference does not alter their usefulness or behavior.

The Dickman soils are associated mainly with the Fairhaven soils that have a sandy subsoil. They are shallower to a coarse-textured horizon than those soils.

Dickman sandy loam, 0 to 6 percent slopes (DcB).—This soil is on glacial outwash in the uplands. The areas range in size from 5 to 20 acres. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Fairhaven silt loam, sandy subsoil.

Most of this Dickman soil is cultivated. Low available water capacity and the hazards of soil blowing and water erosion are the main concerns in the use of this soil. The soil is suited to all crops commonly grown in the county. Capability unit IIIe–2; windbreak suitability group 4.

Dickman sandy loam, 6 to 12 percent slopes, eroded (DcC2).—This soil occurs on glacial outwash on uplands. Areas range from 3 to 10 acres in size. This soil has a profile similar to the one described as representative for the series, except that the surface layer ranges from 4 to 7 inches in thickness and has a lower organic-matter content.

Included with this soil in mapping are small areas of uneroded soils that have a higher organic-matter content and fertility than this eroded soil.

Most of this Dickman soil is cultivated. The hazards of soil blowing and water erosion and a low available water capacity are the main limitations to the use of this soil. This soil is suited to all crops commonly grown in the county. Capability unit IVe–2; windbreak suitability group 4.

Estherville Series

The Estherville soils consist of nearly level to gently sloping, medium-textured and moderately coarse textured soils that are somewhat excessively drained. These soils are shallow to sand and gravel. They formed in glacial drift on stream terraces and uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is very dark brown loam that has a high content of silt and is about 10 inches thick. The subsoil is brown, very dark grayish-brown, strong-brown, and dark yellowish-brown loam and sandy loam about 10 inches thick. The underlying material is pale-brown and yellowish-brown, loose, calcareous sand and gravel.

Permeability is moderately rapid in upper part of these soils and is rapid to very rapid in the underlying material. The available water capacity is low. Organic-matter content is moderate, and fertility is medium. Depth to a seasonal high water table is more than 5 feet.

The hazard of erosion and low available water capacity are the main limitations to the use of these soils. These soils are suited to all crops commonly grown in the county.

Representative profile of Estherville loam, 0 to 6 percent slopes, in an area of bromegrass sod, in NE¼NW¼-NE¼ sec. 34, T. 101 N., R. 40 W.:

A1—0 to 10 inches, very dark brown (10YR 2/2) loam high in content of silt; weak, fine, granular structure; very friable; slightly acid; clear, smooth boundary.

B1—10 to 14 inches, brown (10YR 4/3) and very dark grayish-brown (10YR 3/2) loam high in content of silt; moderate, medium, subangular blocky structure; very friable; slightly acid; clear, smooth boundary.

B21—14 to 16 inches, strong-brown (7.5YR 4/4) sandy loam; very weak, coarse, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

B22—16 to 20 inches, very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 4/4) sandy loam; many medium-size pebbles; weak, fine, subangular blocky structure; neutral; abrupt, smooth boundary.

IIC—20 to 60 inches, pale-brown (10YR 6/3) and yellowish-brown (10YR 5/8), stratified sand and gravel; 60 percent sand and 40 percent gravel; single grain; loose; strata about 1 to 2 inches thick; mildly alkaline; strong effervescence.

The A horizon ranges from 8 to 12 inches in thickness, except in eroded areas. It is very dark brown coarse sandy loam to loam that has a high content of silt and ranges from neutral to medium acid. The B horizon is neutral or slightly acid and ranges from 6 to 12 inches in thickness. Depth to calcareous sand and gravel ranges from 16 to 24 inches.

Estherville coarse sandy loam soils are outside the range of the Estherville series because of the higher content of coarse sand in the solum, but this difference does not alter their usefulness and behavior.

The Estherville soils are associated with the Wadena soils and are similar to the Kanaranzi soils. They are more shallow to the coarse-textured IIC horizon than the Wadena soils. They have less clay and more silt and sand in the solum than the Kanaranzi soils.

Estherville coarse sandy loam, 2 to 6 percent slopes (EaB).—This soil is on stream terraces and uplands. The areas range from 3 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is coarse sandy loam and the subsoil is coarse sandy loam to loamy coarse sand. The surface layer ranges from 6 to 12 inches in thickness, and the subsoil ranges from 8 to 12 inches in thickness. The underlying material is calcareous coarse sand that has small amounts of fine gravel.

Included with this soil in mapping are small areas of Wadena soils.

Most of the acreage is cultivated. The low available water capacity and the hazards of soil blowing and water erosion are the main limitations to the use of this soil. This soil is suited to all the crops commonly grown in the county. Capability unit IIIe–2; windbreak suitability group 4.

Estherville coarse sandy loam, 6 to 12 percent slopes, eroded (EaC2).—This soil is on stream terraces and uplands. Areas range from 3 to 15 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer and subsoil are coarse sandy loam and the surface layer ranges from 5 to 7 inches in thickness.

Included with this soil in mapping are small areas of moderately steep soils. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than this eroded soil.

Most of the acreage of this soil is cultivated. The hazards of soil blowing and water erosion and a low available water capacity are severe limitations to use. This soil is suited to all crops commonly grown in the county. Capability unit IVe–2; windbreak suitability group 4.

Estherville loam, 0 to 6 percent slopes (EbB).—This soil occurs on stream terraces and uplands. The areas range from 3 to 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of soils that have an eroded surface layer and small areas of Wadena soils.

Most of this Estherville soil is cultivated. The hazards of soil blowing and water erosion and a low available water capacity are the major limitations to use. This soil is suited to all crops commonly grown in the county. Capability unit IIIe–2; windbreak suitability group 4.

Everly Series

The Everly series consists of deep, gently sloping to steep, well-drained soils that are moderately fine textured. These soils are on uplands. They formed in glacial till that has a loessial influence on the surface in some places. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark grayish-brown clay loam about 16 inches thick. The subsoil is mainly brown and dark yellowish-brown, friable clay loam about 17 inches thick. The lower 6 inches of the subsoil is yellowish brown, grayish brown, and light yellowish brown. The underlying material is grayish-brown and light olive-brown, calcareous, firm heavy loam.

Permeability is moderate, and available water capacity is high. Organic-matter content and fertility are high in uneroded areas. Depth to a seasonal high water table is more than 5 feet.

The hazard of erosion is the main limitation to the use of these soils. These soils are suited to all crops commonly grown in the county.

Representative profile of Everly clay loam, 2 to 6 percent slopes, in a cultivated field, 200 feet east of road intersection, in SW¼SW¼SW¼ sec. 34, T. 101 N., R. 42 W.:

A1—0 to 8 inches, black (10YR 2/1) clay loam; moderate, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

A12—8 to 11 inches, black (10YR 2/1) and very dark brown (10YR 2/2) clay loam; moderate and weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

A3—11 to 16 inches, very dark grayish-brown (10YR 3/2) and black (10YR 2/1) clay loam; weak, moderate, medium, subangular blocky structure; friable; few, thin, patchy clay films or coatings on faces of peds; many very dark gray (10YR 3/1) and dark-brown (10Y 3/3) worm casts; neutral; clear, wavy boundary.

IIB21—16 to 23 inches, brown (10YR 4/3) clay loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky structure; few, thin, patchy clay films or coatings on faces of peds; friable; neutral; gradual boundary.

IIB22—23 to 27 inches, dark yellowish-brown (10YR 4/4) clay loam; weak, coarse, prismatic structure parting to weak to moderate, fine, subangular blocky structure; friable; few, soft, white lime segregations; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear, smooth boundary.

IIB3—27 to 33 inches, yellowish-brown (10YR 5/4), grayish-brown (2.5Y 5/2), and light olive-brown (2.5Y 5/4) clay loam; weak, fine, subangular blocky structure; firm; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear, smooth boundary.

IIC—33 to 60 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) heavy loam; massive; firm; about 5 percent coarse fragments; moderately alkaline; slight effervescence.

Thickness of the solum ranges from 30 to 42 inches. Depth to free carbonates ranges from 20 to 30 inches. Depth to clay loam glacial till ranges from 10 to 30 inches. The A horizon ranges from 12 to 18 inches in thickness, except where it is severely eroded. The B horizon formed in glacial till in most places, but in some places only the B3 horizon formed in that material. It is clay loam, silty clay loam, or loam. The IIC horizon is loam or clay loam.

The Everly soils are associated with the Wilmonton, Storden, and Letri soils and are similar to Sac soils. They lack the mottles in the upper part of the B horizon that are characteristic of the moderately well drained Wilmonton soils. They have a thicker solum than the somewhat excessively drained Storden soils. Everly soils have higher chroma in the B horizon than the poorly drained Letri soils. They have more sand and less silt in the solum than the Sac soils.

Everly clay loam, 2 to 6 percent slopes (EcB).—This well-drained soil is on ground moraines in the glacial till uplands. Areas range from 3 to more than 80 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas that have an eroded surface layer and small areas that have pockets of sand and gravel.

Most of the acreage is cultivated. Erosion is a slight limitation to the use of this soil. This soil is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Everly clay loam, 2 to 6 percent slopes, eroded (EcB2).—This well-drained soil occurs on ground moraines

in the glacial till uplands. The areas range from 3 to more than 40 acres in size. This soil has a profile similar to the one described as representative of the series, but the surface layer ranges from 5 to 7 inches in thickness and has a lower organic-matter content.

Included with this soil in mapping are small areas of Sac soils and small areas that have pockets of sand and gravel. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than this eroded soil.

Most of this soil is cultivated. Erosion is a hazard. If properly managed, this soil is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Everly clay loam, 6 to 12 percent slopes (EcC).—This well-drained soil is along drainageways and on glacial till moraines on uplands. The areas range from 2 to 20 acres in size.

Included with this soil in mapping are small areas of soils that have an eroded surface layer and small areas that have pockets of sand and gravel.

Most of the acreage is in pasture and other areas that are protected from erosion. If this soil is cultivated, it is subject to erosion. If properly managed, it is suited to all crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Everly clay loam, 6 to 12 percent slopes, eroded (EcC2)—This well-drained soil is along drainageways and on glacial till moraines on uplands. The areas range from 5 to more than 80 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer ranges from 5 to 7 inches in thickness and has a lower organic-matter content.

Included with this soil in mapping are small areas of Sac soils and small areas that have pockets of sand and gravel. Also included are areas of uneroded soils that have a higher organic-matter content and fertility than this eroded soil.

Most of this soil is cultivated. Erosion is the main hazard that limits use. If properly managed, this soil is suited to all crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Everly-Storden complex, 6 to 12 percent slopes, eroded (EsC2).—This complex is on upland glacial moraines and along drainageways. About half of the complex is Everly clay loam, and half is Storden loam. The organic-matter content and fertility are lower than in uneroded Everly and Storden soils. The Everly soil has a darker surface layer than the Storden soil. Both soils have a profile similar to those described as representative of their respective series, except that the surface layer of the Everly soil is 4 to 6 inches thick and the underlying material of the Storden soil is firm.

Included with these soils in mapping are small areas of soils where erosion is slight and severe, and small areas that have pockets of sand and gravel.

Most of this complex is cultivated. Erosion is a major limitation to the use of the soils. If properly managed, the soils are suited to all crops commonly grown in the county. Capability unit IIIe–1; windbreak suitability group 1.

Everly-Storden complex, 12 to 18 percent slopes, eroded (EsD2).—This complex is on upland glacial moraines and along major drainageways. About half of the complex is Everly clay loam, and half is Storden loam. The organic-matter content and fertility are lower than in uneroded Everly and Storden soils. Both soils have a profile similar to those described as representative of their respective series, except that the surface layer of the Everly soil ranges from 4 to 6 inches in thickness and the underlying material of the Storden soil is firm.

Included with these soils in mapping are small areas of soils where erosion is slight and severe, and small areas that have pockets of sand and gravel.

Most of this complex is used for pasture or hay. Some crops are grown, but they are not well suited to these soils because erosion is a severe hazard. These soils are suited to controlled grazing and to hay. Capability unit IVe–1; windbreak suitability group 5.

Everly-Storden complex, 18 to 24 percent slopes (EsE).—This complex is on upland glacial moraines and along major drainageways. About half of the complex is Everly clay loam, and half is Storden loam. The Everly soil has a thicker and darker surface layer than the Storden soil. Both soils have a profile similar to those described as representative of their respective series, except that the soil layers are thinner and the underlying matrial of the Storden soil is firm.

Included with these soils in mapping are small areas of soils that have slopes of more than 24 percent and small areas that have pockets of sand and gravel.

The soils of this complex are suited to controlled grazing, and all the acreage is used for pasture. The severe hazard of erosion is the main limitation to the use of these soils. Capability unit VIe–1; windbreak suitability group 5.

Everly-Storden-Estherville complex, 2 to 6 percent slopes (EvB).—This complex is on glacial ground moraines. About one-third of the complex is Everly clay loam, one-third is Storden loam, and the other third is Estherville loam. The Everly soil has a thicker and darker surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. All the soils have a profile similar to those described as representative of their respective series, but the underlying material of the Storden soil is firm.

Included with these soils in mapping are small areas of Estherville coarse sandy loam.

Most of this complex is cultivated. Erosion is the main limitation to the use of the soils. Low available water capacity is a minor limitation to the use of Estherville soil. If properly managed, these soils are suited to all crops commonly grown in the county. All three soils are in capability unit IIIe–2; Everly and Storden soils are in windbreak suitability group 1; Estherville soil is in windbreak suitability group 4.

Everly-Storden-Estherville complex, 6 to 12 percent slopes, eroded (EvC2).—This complex is on upland glacial morianes and along drainageways. About one-third of the complex is Everly clay loam, one-third is Storden loam, and the other third is Estherville loam. The organic-matter content and fertility are lower than in uneroded Everly and Storden soils. The Everly soil in the complex has a darker surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. These soils have a profile similar to those described as representative of

their respective series, except that the surface layer of the Everly soil ranges from 4 to 7 inches in thickness and the underlying material of the Storden soil is firm.

Included with these soils in mapping are small areas of soils that have slopes of more than 12 percent or of less than 6 percent. Also included are areas of Estherville coarse sandy loam.

Most of this complex is cultivated. The hazard of erosion and droughtiness are the main limitations to the use of the soils. If properly managed, these soils are suited to most crops commonly grown in the county. All three soils are in capability unit IVe–2; Everly and Storden soils are in windbreak suitability group 1; Estherville soil is in windbreak suitability group 4.

Everly-Storden-Estherville complex, 12 to 18 percent slopes, eroded (EvD2).—This complex is on upland glacial moraines and banks along major drainageways. About one-third of the complex is Everly clay loam, one-third is Storden loam, and the other third is Estherville loam. The Everly soil has a darker surface layer than the Storden soil. The underlying material of the Estherville soil is loose sand and gravel at a depth of 16 to 24 inches. These soils have a profile similar to those described as representative of their respective series, except that they have a thinner surface layer and the underlying material of the Storden soil is firm.

Most of this complex is in bluegrass or native grass and is used for pasture. Small areas are cultivated, but the soils are not well suited to crops. They are suited to controlled grazing and hay. Erosion and droughtiness are severe hazards that limit use of these soils. All three soils are in capability unit VIe–2; Everly and Storden soils are in windbreak suitability group 5; Estherville soil is in windbreak suitability group 4.

Fairhaven Series

The Fairhaven series consists of well-drained, medium-textured, nearly level to gently sloping soils. These soils are moderately deep to sand and gravel on stream terraces and outwash plains. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is very dark gray and very dark grayish-brown silt loam about 12 inches thick. The subsoil is brown, friable light silty clay loam about 10 inches thick. The underlying material, to a depth of 26 inches, is yellowish-brown, friable loam. Below this is brown and strong-brown, calcareous sand and gravel.

Permeability is moderate in the upper part of these soils and rapid in the underlying material. The available water capacity is moderate to high. Organic-matter content and fertility are high. Depth to a seasonal high water table is more than 5 feet.

Most areas of these soils are cultivated. The hazards of drought and erosion are the main limitations to the use of these soils.

Representative profile of Fairhaven silt loam, 0 to 2 percent slopes, in a cultivated field, in NE¼NW¼NW¼ sec. 7, T. 101 N., R. 43 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; weak, very fine, subangular blocky structure; very friable; neutral; gradual, smooth boundary.

A1—7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, very fine, subangular blocky structure; very friable; neutral; gradual, wavy boundary.

B1—12 to 18 inches, brown (10YR 4/3) light silty clay loam; dark grayish-brown (10YR 4/2) coatings on peds; weak, fine, subangular blocky structure; very friable; neutral; gradual boundary.

B2—18 to 22 inches, brown (10YR 5/3) light silty clay loam; weak, fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

C1—22 to 26 inches, yellowish-brown (10YR 5/4) loam; massive; very friable; mildly alkaline; slight effervescence; abrupt, smooth boundary.

IIC2—26 to 60 inches, brown (7.5YR 4/4) and strong-brown (7.5YR 5/6) loose sand and gravel; strong effervescence.

The A horizon ranges from 8 to 16 inches in thickness and is neutral or slightly acid. Depth to free carbonates ranges from 20 to 30 inches. The B horizon is light silty clay loam to loam and is 6 to 14 inches thick. The C1 horizon ranges from 0 to 12 inches in thickness. Depth to the underlying coarse sand and gravel is 24 to 40 inches. The IIC horizon ranges from fine sand to stratified gravel and sand or gravelly coarse sand.

The Fairhaven silt loam, deep, soils typically have the sand and gravel in the IIC horizon beginning at depths ranging from 40 to 60 inches. They are outside the defined range of the series because of this feature, but it does not significantly alter their usefulness or behavior.

The Fairhaven soils are associated with the Kanaranzi and Dickman soils and are similar to the Wadena soils. They have a coarse-textured IIC horizon beginning at a greater depth than the Kanaranzi soils. They have more silt and clay and less sand in the solum than the Dickman soils. Fairhaven soils have more silt and less sand in the solum than the Wadena soils.

Fairhaven silt loam, 0 to 2 percent slopes (FaA).—This well-drained soil is on stream terraces and outwash plains. The areas range from 10 to 100 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Kanaranzi soils and areas of soils where the depth to the coarse-textured underlying material is more than 40 inches.

Most of this soil is cultivated. Moderate available water capacity limits crop production during periods of light rainfall. This soil is suited to all crops commonly grown in the county. Capability unit IIs–1; windbreak suitability group 6.

Fairhaven silt loam, 2 to 6 percent slopes (FaB).—This well-drained soil is on stream terraces and outwash plains. The areas range from 5 to 20 acres in size.

Included with the soil in mapping are small areas of Kanaranzi soils.

Most areas of this soil are cultivated. Moderate available water capacity limits crop production during periods of below-normal rainfall. The hazard of erosion is a concern in the use of this soil. This soil is suited to all crops commonly grown in the county. Capability unit IIe–2; windbreak suitability group 6.

Fairhaven silt loam, 2 to 6 percent slopes, eroded (FaB2).—This well-drained soil is on stream terraces and outwash plains. The areas range from 3 to 10 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer ranges from 5 to 7 inches in thickness. Organic-matter content and fertility are lower than in uneroded Fairhaven soils.

Included with this soil in mapping are small areas of Kanaranzi soils.

Most of this soil is cultivated. The hazard of erosion is a concern in the use of this soil. Moderate available water capacity limits crop production during periods of below-normal rainfall. Capability unit IIe–2; windbreak suitability group 6.

Fairhaven silt loam, deep, 0 to 2 percent slopes (FbA).—This well-drained soil is on stream terraces and outwash plains. The areas range from 5 to 40 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is typically 2 to 4 inches thicker and the depth to the coarse-textured underlying material is more than 40 inches.

Included with this soil in mapping are small areas of Kanaranzi soils and small areas of Fairhaven silt loam.

Most of the acreage is cultivated. This soil has few limitations and is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Fairhaven silt loam, deep, 2 to 6 percent slopes (FbB).—This well-drained soil is on stream terraces and outwash plains. The areas range from 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is typically 2 to 4 inches thicker and the depth to the coarse-textured underlying material is more than 40 inches.

Included with this soil in mapping are small areas of Kanaranzi soils and small areas of Fairhaven silt loam.

Most of the acreage is cultivated. The hazard of erosion is a concern, but the soil is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Fairhaven silt loam, sandy subsoil, 0 to 2 percent slopes (FeA).—This well-drained soil is on upland plains that are adjacent to some of the larger streams. The areas range from 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the underlying material is fine sand rather than sand and gravel.

Included with this soil in mapping are small areas of Dickman and Sac soils.

Most of this soil is cultivated. Moderate available water capacity limits crop production during periods of below-normal rainfall. This soil is suited to all crops commonly grown in the county. Capability unit IIs–1; windbreak suitability group 6.

Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes (FeB).—This well-drained soil is on upland plains that are adjacent to some of the larger streams. The areas range from 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the underlying material is fine sand rather than sand and gravel.

Included with this soil in mapping are small areas of Dickman and Sac soils.

Most of this soil is cultivated. The hazard of erosion is a concern in the use of this soil. Moderate available water capacity limits crop production during periods of below-normal rainfall. This soil is suited to all crops commonly grown in the county. Capability unit IIe–2; windbreak suitability group 6.

Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes, eroded (FeB2).—This well-drained soil is on upland plains that are adjacent to some of the larger streams. The areas range from 5 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the underlying material is fine sand rather than sand and gravel and the surface layer ranges from 4 to 7 inches in thickness. The organic-matter content and fertility of this soil are lower than in uneroded areas.

Included with this soil in mapping are small areas of Dickman and Sac soils.

Most of this soil is cultivated. The hazard of erosion is a limitation in the use of this soil. Moderate available water capacity limits crop production during periods of below-normal rainfall. This soil is suited to all crops commonly grown in the county. Capability unit IIe–2; windbreak suitability group 6.

Galva Series

The Galva series consists of deep, nearly level, well-drained soils that are moderately fine textured. These soils formed in deep loess over glacial till on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark brown silty clay loam about 15 inches thick. The subsoil is mostly dark-brown and brown, friable silty clay loam about 21 inches thick. The underlying material is brown and light brownish-gray silt loam in the upper part, and it is olive-brown and light olive-brown, friable clay loam in the lower part. This layer typically is calcareous.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is more than 5 feet.

There are few limitations to the use of these soils. Most areas are cultivated. These soils are suited to all crops commonly grown in the county.

Representative profile of Galva silty clay loam, 1 to 3 percent slopes, in a sodded area at edge of railroad right-of-way, 100 feet east of road, in NW¼SW¼SW¼ sec. 31, T. 101 N., R. 43 W.:

Ap—0 to 11 inches, black (10YR 2/1) to very dark brown (10YR 2/2) silty clay loam; moderate, very fine and fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

A3—11 to 15 inches, very dark brown (10YR 2/2) silty clay loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky structure; friable; many dark grayish-brown (10YR 4/2) worm casts; neutral; clear, wavy boundary.

B1—15 to 20 inches, very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) light silty clay loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky structure; friable; few black (10YR 2/1) worm casts; neutral; clear, wavy boundary.

B21—20 to 30 inches, dark-brown (10YR 3/3) and brown (10YR 4/3) light silty clay loam; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky structure; few very dark brown (10YR 2/2) worm casts; friable; neutral; clear, wavy boundary.

B22—30 to 36 inches, brown (10YR 4/3) silty clay loam; moderate to weak, medium, prismatic structure parting to weak to moderate, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

C1—36 to 44 inches, brown (10YR 5/3) and light brownish-gray (10YR 6/2) silt loam; weak, coarse, prismatic structure; friable; mildly alkaline; strong effervescence; abrupt, wavy boundary.

IIC2—44 to 60 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) clay loam; massive; friable; mildly alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 30 to 42 inches. The A horizon ranges from 10 to 20 inches in thickness in uneroded areas. The lower part of the B horizon is calcareous in some places. The C1 horizon is typically silt loam, but it is silty clay loam in some places. The IIC horizon is typically between depths of 42 and 60 inches. This horizon is friable to firm.

The Galva soils are associated with the Primghar and Marcus soils and are similar to the Sac soils. They have a redder hue in the B horizon than the somewhat poorly drained Primghar soils and the poorly drained Marcus soils. They have a IIC horizon of glacial till at a greater depth than the Sac soils.

Galva silty clay loam, 1 to 3 percent slopes (GaB).—This well-drained soil is on loess-covered glacial till plains. Areas range from 5 to 40 acres in size.

Included with this soil in mapping are small areas of Sac and Fairhaven soils.

This soil has few limitations, and most of the acreage is cultivated. The soil is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Glencoe Series

The Glencoe series consists of deep, nearly level, moderately fine textured soils that are very poorly drained. These soils formed in glacial till in low, wet draws and in depressional areas on the upland till plains. The native vegetation was water grass and sedges.

In a representative profile, the surface layer is black, very dark gray, and very dark grayish-brown silty clay loam about 28 inches thick. The subsoil is dark grayish-brown, grayish-brown, and olive silty clay loam about 10 inches thick. The underlying material is calcareous, olive clay loam.

Permeability is moderate. The available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Most areas of Glencoe soils have been drained and are cultivated. If these soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Glencoe silty clay loam, in a cultivated field, in SE¼SW¼SE¼ sec. 13, T. 102 N., R. 40 W.:

Ap—0 to 7 inches, black (N 2/0) silty clay loam high in content of sand; moderate, medium, subangular blocky structure; friable; sticky; neutral; gradual, smooth boundary.

A1—7 to 15 inches, black (5Y 2/1) silty clay loam high in content of sand; weak, fine, subangular blocky structure; sticky; neutral; gradual, smooth boundary.

A31g—15 to 20 inches, very dark gray (5Y 3/1) silty clay loam high in content of sand; few, fine, distinct, grayish-brown (5Y 5/2) mottles; weak, fine, subangular blocky structure; sticky; neutral; gradual, smooth boundary.

A32g—20 to 28 inches, very dark grayish-brown (2.5Y 3/2) silty clay loam high in content of sand; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, fine, subangular blocky structure; sticky; neutral; clear, smooth boundary.

B2g—28 to 32 inches. dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) silty clay loam high in content of sand; weak, fine, subangular blocky structure; sticky; neutral; clear, smooth boundary.

B3g—32 to 38 inches, olive (5Y 5/3) silty clay loam high in content of sand; few, fine, faint, light olive-brown (2.5 5/6) mottles; weak, fine, subangular blocky structure; neutral; gradual boundary.

C1—38 to 45 inches, olive (5Y 4/3) clay loam; massive; sticky; about 5 percent coarse fragments; mildly alkaline; slight effervescence; clear boundary.

C2—45 to 60 inches, olive (5Y 5/3) clay loam; massive; sticky; about 5 percent coarse fragments; mildly alkaline; strong effervescence.

The A horizon ranges from 20 to 40 inches in thickness. This horizon typically is silty clay loam, but it is clay loam in some places. In a few places an O horizon (organic layer) up to 6 inches thick is present. The B horizon typically is silty clay loam, but it is clay loam in some places. Depth to free carbonates ranges from 30 to 48 inches. The C horizon typically is clay loam, but it is loam in some profiles.

The Glencoe soils are associated with the Webster soils and are similar to the Blue Earth and Lura soils. They have a thicker A horizon and are more poorly drained than the Webster soils. They have more silt and sand and less clay in the solum than the Lura soils. Glencoe soils lack the free carbonates in the A horizon that are present in the Blue Earth soils.

Glencoe silty clay loam (0 to 2 percent slopes) (Gc).—This very poorly drained soil is in low depressions and wet draws in glacial till ground moraines. The areas range from 1 to 40 acres in size.

Included with this soil in mapping are small areas of soil that have up to 12 inches of muck on the surface.

The main limitation to the use of this soil is wetness. If the soil is properly drained, however, it is suited to all crops commonly grown in the county. Capability unit IIIw–1; windbreak suitability group 2.

Gravel Pits

Gravel pits (Gp) are areas where gravelly material has been removed. These areas are normally associated with Estherville, Kanaranzi, and Wadena soils that occupy terraces and outwash plains. The surface layer has been stripped from these areas and deposited around the edge of the excavation. The coarser, gravelly materials have been removed, leaving an open pit. The size and shape of these pits is influenced largely by the quantity and quality of gravel at each site. Many pits have been abandoned because the supply of suitable gravel has been exhausted. Many of the abandoned deeper pits are filled with water.

Introduced and native grasses grow in and around the abandoned pits. Willow, poplar, and cottonwood trees grow in these areas. Limited grazing is available on the spoil of these pits, and water for stock is available in the deeper ones. Not assigned to a capability unit or windbreak suitability group.

Kanaranzi Series

The Kanaranzi series consists of nearly level to gently sloping, medium-textured, somewhat excessively drained soils that are shallow to moderately deep to sand and gravel. These soils formed on stream terraces, outwash plains, and glacial till uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is very dark brown loam about 6 inches thick. The subsoil is friable, dark-brown and brown loam and sandy loam about 16 inches thick. The underlying material is gray and yellowish-brown, calcareous, loose sand and gravel.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material. Available water capacity is low. Organic-matter content and fertility are high. Depth to a seasonal high water table is more than 5 feet.

Droughtiness is the main concern in the use of these soils. The soils are suited to all crops commonly grown in the county.

Representative profile of Kanaranzi loam, 0 to 2 percent slopes, 200 feet south and 200 feet east of intersection of township roads, in NW¼NW¼NW¼ sec. 5, T. 103 N., R. 43 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) loam high in content of silt; weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

B1—6 to 12 inches, dark-brown (10YR 3/3) loam high in content of silt; very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, prismatic structure parting to weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B2—12 to 19 inches, brown (10YR 4/3) heavy loam; very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, prismatic structure; friable; few, thin, patchy clay films and iron stains on faces of peds; neutral; clear, wavy boundary.

IIB3—19 to 22 inches, dark-brown (10YR 3/3) and brown (10YR 4/3) sandy loam; weak, coarse, subangular blocky structure; mildly alkaline; slight effervescence; abrupt, smooth boundary.

IIC—22 to 60 inches, gray (10YR 5/1 and 10YR 6/1) mixed with yellowish-brown (10YR 5/4) sand and gravel; single grain; loose; mildly alkaline; strong effervescence.

Depth to the coarse-textured substratum and depth to free carbonates range from 16 to 24 inches. The A horizon ranges from 6 to 15 inches in thickness and from silt loam to loam in texture. The B horizon ranges from 6 to 16 inches in thickness. The IIC horizon typically consists of alternate layers of sand and of gravel. Generally, the gravel is brown and yellowish brown and the sand is gray. In some places this horizon is gravelly coarse sand.

The Kanaranzi soils are associated with the Fairhaven soils and are similar to the Estherville soils. They have a coarse-textured IIC horizon beginning at a shallower depth than the Fairhaven soils. They have more silt and clay and less sand in the solum than the Estherville soils.

Kanaranzi loam, 0 to 2 percent slopes (KaA).—This somewhat excessively drained soil is on stream terraces, outwash plains, and glacial drift in uplands. The areas range from 5 to 20 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Fairhaven silt loam.

Most areas of this Kanaranzi soil are cultivated. This soil has a tendency to be droughty, and soil blowing is a hazard if the surface is bare. The soil is suited to all crops commonly grown in the county. Capability unit IIIs–1; windbreak suitability group 4.

Kanaranzi loam, 2 to 6 percent slopes (KaB).—This somewhat excessively drained soil is on stream terraces, outwash plains, and glacial drift in uplands. Slopes range from 2 to 6 percent but average 3 or 4 percent. The areas range from 3 to 10 acres in size.

Included with this soil in mapping are small areas of Fairhaven silt loam.

Most of this Kanaranzi soil is cultivated. The main limitations to use are droughtiness, soil blowing, and water erosion. This soil is suited to all crops commonly grown in the county. Capability unit IIIe–2; windbreak suitability group 4.

Kingston Series

The Kingston series consists of deep, nearly level, moderately fine textured soils that are moderately well drained. These soils formed in lacustrine sediment on old lake plains and on glacial till plains. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black, very dark gray, and very dark grayish-brown silty clay loam about 19 inches thick. The subsoil is dark grayish-brown and olive-brown, friable silty clay loam about 18 inches thick. The underlying material is olive-brown to light brownish-gray, friable, calcareous silty clay loam.

Permeability in these soils is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

Kingston soils are suited to all crops commonly grown in the county.

Representative profile of Kingston silty clay loam, in a field of bromegrass, 25 feet east of driveway to field, in NW¼SW¼NW¼ sec. 4, T. 103 N., R. 41 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure; friable; abundant roots; neutral; gradual, smooth boundary.

A1—8 to 13 inches, black (10YR 2/1) silty clay loam; moderate, fine, subangular blocky structure; friable; common roots; neutral; gradual, wavy boundary.

A3—13 to 19 inches, mixed very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silty clay loam; weak, fine, subangular blocky structure; friable; few roots neutral; gradual, wavy boundary.

B1—19 to 26 inches, dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) silty clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts; neutral; gradual, wavy boundary.

B2—26 to 30 inches, olive-brown (2.5Y 4/4) silty clay loam; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky structure; friable; grayish-brown (2.5Y 5/2) coatings on faces of peds; few, soft, white lime segregations; mildly alkaline; slight effervescence; gradual, wavy boundary.

B3ca—30 to 37 inches, olive-brown (2.5Y 4/4) silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; many, soft, white lime segregations; mildly alkaline; slight effervescence; gradual, wavy boundary.

C1ca—37 to 48 inches, light olive-brown (2.5Y 5/4) and olive-brown (2.5Y 4/4) silty clay loam; few, fine, distinct, olive-yellow (2.5Y 6/6) mottles; very weak, medium, subangular blocky structure; friable; mildly alkaline; strong effervescence; gradual, wavy boundary.

C2—48 to 54 inches, olive-gray (5Y 5/2) silty clay loam; common, fine, distinct, light olive-brown (2.5Y 5/6) and light-gray (2.5Y 7/2) mottles; massive; firm; mildly alkaline; strong effervescence; gradual, wavy boundary.

C3—54 to 60 inches, light brownish-gray (5Y 6/1), stratified silt loam and silty clay; many, coarse, prominent, strong-brown (7.5YR 5/8) mottles; massive; firm; mildly alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 20 to 40 inches but typically are from 24 to 36 inches. The A horizon ranges from 12 to 24 inches in thickness. The B horizon typically is silty clay loam, but the lower part of the B horizon is silt loam in some places. The C horizon typically is silty clay loam or silt loam but has finer textured layers in some profiles.

The Kingston soils are associated with the Nicollet soils and the Kingston, loamy subsoil variant, soils. They have more silt and less sand in the solum and C horizon than the Nicollet soils. They have more silt and less sand in the lower part of the B horizon or in the C horizon, or both, than the Kingston, loamy subsoil variant, soils.

Kingston silty clay loam (0 to 3 percent slopes) (Kc).—This moderately well drained soil is on old lake plains and on glacial till plains on uplands. The areas range from 2 to more than 80 acres in size.

Included with this soil in mapping are small areas of Waldorf soils.

This Kingston soil has few limitations. It is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Kingston Series, Loamy Subsoil Variant

The Kingston series, loamy subsoil variant, consists of deep, nearly level to gently sloping, moderately fine textured soils that are moderately well drained. These soils formed in 24 to 40 inches of lacustrine sediment over glacial till. They are on glacial till plains. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark gray silty clay loam about 15 inches thick. The subsoil is brown, dark-brown, and olive-brown, friable silty clay loam about 15 inches thick. The underlying material is limy, grayish-brown and light olive-brown clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils are suited to all crops commonly grown in the county.

Representative profile of Kingston silty clay loam, loamy subsoil variant, 2 to 6 percent slopes, in a cultivated field, 50 feet east of road, in SW¼NW¼NW¼ sec. 22, T. 101 N., R. 39 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; slightly acid; gradual, smooth boundary.

A1—8 to 12 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; neutral; clear, smooth boundary.

A3—12 to 15 inches, very dark gray (10YR 3/1) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; neutral; clear, smooth boundary.

B1—15 to 20 inches, brown (10YR 4/3) and dark-brown (10YR 3/3) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; neutral; clear, smooth boundary.

B2—20 to 30 inches, olive-brown (2.5Y 4/4) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; many very dark grayish-brown (2.5Y 3/2) worm casts; slight effervescence at a depth of 28 inches or more; mildly alkaline; clear, smooth boundary.

IIC—30 to 60 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/8) clay loam; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 24 to 40 inches. The A horizon is black, very dark gray, or very dark grayish-brown silty clay loam or silt loam. This horizon ranges from 12 to 20 inches in thickness. The B horizon typically is silty clay loam, but it is silt loam in some places. The lower part of the B horizon is clay loam glacial till in some places. Thickness of this horizon ranges from 6 to 20 inches. The IIC horizon typically is clay loam or loam till, but a silty clay loam C1 horizon is present in some places.

The Kingston, loamy subsoil variant, soils are associated with normal Kingston soils and with Nicollet soils. They differ from normal Kingston soils because they have a IIC horizon of glacial till at a depth of less than 40 inches. They have less sand and more silt in the solum than the Nicollet soils.

Kingston silty clay loam, loamy subsoil variant, 0 to 2 percent slopes (KlA).—This moderately well drained soil is on old lake plains and upland glacial till plains. The areas range from 3 to 80 acres or more in size.

Included with this soil in mapping are small areas of Nicollet and Collinwood soils.

This soil has few limitations. It is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Kingston silty clay loam, loamy subsoil variant, 2 to 6 percent slopes (KlB).—This soil has convex slopes that range from 2 to 6 percent but average 3 or 4 percent. It is on old lake plains and upland glacial till plains that are covered by lacustrine deposits. The areas range from 3 to 20 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Collinwood and Clarion soils.

This soil is subject to only slight erosion and is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Lake Beaches

Lake beaches (0 to 2 percent slopes) (Lc) are around the borders of lakes and the edges of large ponds. They consist of mixed soil material that is sandy in most places. Most areas are nearly level, but some have short, steep, stony escarpments. Natural soil drainage ranges from excessively drained to very poorly drained.

This land type is farmed with adjacent soils because it is in bands that are too narrow to be managed separately. Areas of Lake beaches generally are too wet to be used for crops, but some areas are too droughty. Capability unit IVw–1; windbreak suitability group 7.

Letri Series

The Letri series consists of deep, moderately fine textured, poorly drained soils. These soils formed in glacial till that has been influenced somewhat by loess in the upper layers. They are on wide, low flats and in draws on uplands. The native vegetation was mostly tall grass prairie and sedges.

In a representative profile, the surface layer is black and very dark gray silty clay loam and clay loam about 18 inches thick. The subsoil is friable, mottled, dark grayish-brown and grayish-brown clay loam about 14 inches thick. The underlying material is limy, firm, grayish-brown and olive clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main concern in the use of these soils. The soils are suited to all crops commonly grown in the county.

Representative profile of Letri silty clay loam, in a cultivated field, 1,050 feet west of half section line and 10 feet north of road ditch, in SW¼SE¼SW¼ sec. 6, T. 101 N., R. 41 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, fine, subangular blocky structure; friable, sticky; neutral; abrupt, smooth boundary.

A1—8 to 14 inches, black (5YR 2/1) clay loam; weak, fine, subangular blocky structure; friable; sticky; neutral; gradual, irregular boundary.

A3—14 to 18 inches, very dark gray (10YR 3/1 to 5Y 3/1) clay loam; weak, fine, subangular blocky structure; friable; sticky; neutral; clear, irregular boundary.

B1g—18 to 23 inches, dark grayish-brown (2.5Y 4/2) clay loam; common, medium, distinct, olive-brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; neutral; clear, irregular boundary.

IIB2g—23 to 28 inches, grayish-brown (2.5Y 5/2) clay loam; many, fine, distinct, light olive-brown (2.5Y 5/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine, subangular blocky structure; friable; sticky; about 5 percent coarse fragments; neutral; clear, wavy boundary.

IIB3g—28 to 32 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) clay loam; weak, fine, subangular blocky structure; firm; sticky; about 5 percent coarse fragments; mildly alkaline; slight effervescence; clear, wavy boundary.

IICca—32 to 60 inches, grayish-brown (2.5Y 5/4) and olive (5Y 5/6) clay loam; massive; firm; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of the solum ranges from 20 to 36 inches. Depth to free carbonates ranges from 26 to 30 inches. Depth to glacial till is 10 to 30 inches. The A horizon ranges from 12 to 20 inches in thickness and is silty clay loam or clay loam. The B horizon is friable or firm and ranges from 10 to 20 inches in thickness.

The Letri soils are associated with the Wilmonton and Everly soils and are similar to the Rushmore soils. They have lower chroma in the B horizon than the moderately well drained Wilmonton and the well drained Everly soils. They have more sand and less silt in the solum than the Rushmore soils.

Letri silty clay loam (0 to 2 percent slopes) (le).—This soil is on low flats and in draws on upland glacial till plains. The areas range from 10 to more than 100 acres in size.

Included with this soil in mapping are small areas of soils that have a surface layer of clay loam and small areas of Rushmore soils.

Wetness is the main concern in the use of this soil. If the soil is properly drained, however, it is suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 2.

Lura Series

The Lura series consists of deep, fine-textured, very poorly drained soils that formed in water-laid sediment on old lake plains and on glacial till plains. The native vegetation was water grass and sedges.

In a representative profile, the surface layer is black, very dark gray, and very dark grayish-brown silty clay about 31 inches thick. Next is a layer of mottled, dark greenish-gray, firm silty clay about 7 inches thick. Below this is mottled, dark greenish-gray, firm silty clay.

Permeability is slow. Available water capacity is moderately high to high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness and fine texture are main concerns in the use of these soils.

Representative profile of Lura silty clay, in a sodded depression, in SW¼SE¼NE¼NW¼ sec. 4, T. 103 N., R. 41. W:

A11—0 to 12 inches, black (N 2/0) silty clay; moderate, very fine, angular blocky structure; firm; plastic; neutral; gradual, wavy boundary.

A12—12 to 18 inches, black (N 2/0) silty clay; very fine angular blocky structure; firm; plastic; few olive (5Y 5/6) stains along root channels; neutral; gradual, wavy boundary.

A13g—18 to 26 inches, very dark gray (5Y 3/1) and dark-gray (5Y 4/1) silty clay; common, fine, prominent, strong-brown (7.5YR 5/8) mottles; weak, fine, prismatic structure parting to moderate, fine and very fine, angular blocky structure; firm; plastic; neutral; clear, wavy boundary.

A14g—26 to 31 inches, very dark grayish-brown (2.5Y 3/2) silty clay; many, fine, distinct, light olive-brown (2.5Y 5/6) mottles; weak, fine, prismatic structure parting to moderate, fine, angular blocky structure; firm; plastic; neutral; clear, wavy boundary.

C1g—31 to 38 inches, dark greenish-gray (5BG 4/1) silty clay; many, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine, prismatic structure parting to moderate, fine, angular blocky structure; firm; plastic; neutral; gradual boundary.

C2g—38 to 54 inches, dark greenish-gray (5BG 4/1) silty clay; many, medium, prominent, yellowish-brown (10YR 5/8) mottles; massive; firm; plastic; neutral; clear, smooth boundary.

C3g—54 to 60 inches, greenish-gray (5GY 6/1) and olive (5Y 5/6) silty clay; few iron and manganese segregations; massive; firm; plastic; mildly alkaline; slight effervescence.

Depth to free carbonates ranges from 30 to 60 inches. The A horizon typically is silty clay or clay, but it is silty clay loam in the upper 8 to 10 inches in some places. The C horizon typically is silty clay or clay, but it is loam or clay loam in the lower part in some profiles.

The Lura soils are associated with the Webster and Waldorf soils and are similar to the Glencoe soils. They have a thicker A horizon and are more poorly drained than the Webster and Waldorf soils. They have more clay and less sand and silt than the Glencoe soils.

Lura silty clay (0 to 2 percent slopes) (lu).—This soil is in depressions on old glacial lake plains and upland glacial till plains. In places it is on low, wide flats or in draws. The areas range from 3 to 40 acres in size.

Included with this soil in mapping are small areas of Glencoe soils.

Wetness and fine texture are the main concerns in the use of this soil. If the soil is properly drained and well managed, however, it is suited to all crops commonly grown in the county. Capability unit IIIw–1; windbreak suitability group 2.

Marcus Series

The Marcus series consists of deep, nearly level, moderately fine textured soils that are poorly drained. These soils formed in deep loess on wide, low upland flats and in draws. The native vegetation was mostly tall grass prairie and sedges.

In a representative profile, the surface layer is black and dark olive-gray silty clay loam about 19 inches thick. The subsoil is friable, mottled, olive-gray and olive silty clay loam about 17 inches thick. The underlying material is friable, calcareous, light olive-brown and grayish-brown silty clay loam to a depth of about 43 inches. Below this is light olive-brown and grayish-brown, calcareous clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main concern in the use of these soils. Marcus soils are suited to all crops commonly grown in the county.

Representative profile of Marcus silty clay loam in an area of Marcus-Spicer silty clay loams, in a cultivated field, 100 feet south of the road, in NW¼NW¼SE¼ sec. 28, T. 101 N., R. 43 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak to moderate, medium, subangular blocky structure; friable; sticky; neutral; gradual, smooth boundary.

A11—8 to 12 inches, black (N 2/0 to 5Y 2/1) silty clay loam; weak to moderate, fine, subangular blocky structure; friable; sticky; neutral; gradual, smooth boundary.

A12—12 to 16 inches, black (5Y 2/1) silty clay loam; weak to moderate, fine, subangular blocky structure; few thin clay films or coatings on faces of peds; friable; sticky; neutral; clear, smooth boundary.

A3g—16 to 19 inches, dark olive-gray (5Y 3/2) silty clay loam; common, medium, distinct, olive (5Y 4/3) mottles; weak to moderate, fine, subangular blocky structure; few thin clay films or coatings on faces of peds; friable; sticky; neutral; clear, smooth boundary.

B1g—19 to 22 inches, olive-gray (5Y 4/2) and olive (5Y 4/3) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; few dark-colored coatings on faces of peds; neutral; gradual, smooth boundary.

B21g—22 to 25 inches, olive-gray (5Y 4/2) and olive (5Y 4/3) silty clay loam; common, medium, distinct, olive (5Y 5/4) mottles; moderate, medium, prismatic structure parting to weak to moderate, fine, subangular blocky structure; friable; sticky; few dark-colored coatings on faces of peds; neutral; gradual, smooth boundary.

B22g—25 to 31 inches, olive-brown (2.5Y 4/4) and dark olive-gray (5Y 3/2) silty clay loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; sticky; few dark-colored coatings on faces of peds; neutral; clear, smooth boundary.

B3g—31 to 36 inches, olive (5Y 4/3) silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; sticky; few dark-colored coatings on faces of peds; mildly alkaline; slight effervescence.

C1—36 to 43 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; friable; sticky; moderately alkaline; strong effervescence; clear, smooth boundary.

IIC2—43 to 62 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) clay loam; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; massive; firm; sticky; moderately alkaline; strong effervescence.

Thickness of the solum ranges from 28 to 40 inches. Depth to free carbonates ranges from 24 to 36 inches. The A horizon ranges from 14 to 24 inches in thickness. It is slightly acid to mildly alkaline. The B horizon ranges from silty clay loam to silt loam in texture and from 14 to 24 inches in thickness. The C1 horizon is silty clay loam or silt loam. The IIC2 horizon is below a depth of 40 inches, typically between depths of 40 and 60 inches. It is loam or clay loam.

The Marcus soils are associated with the Galva, Spicer, and Primghar soils and are similar to the Rushmore soils. They have more olive colors in the B horizon and are more poorly drained than the Galva and Primghar soils. They lack free carbonates in the A horizon and in most of the B horizon, but the Spicer soils have free carbonates throughout the solum. Marcus soils formed in loess that is more than 40 inches in thickness, but the Rushmore soils formed in 20 to 40 inches of loess over glacial till.

Marcus-Spicer silty clay loams (0 to 2 percent slopes) (Ma).—This complex is on low flats and in draws of the loess-covered glacial till plains. About two-thirds of the complex is Marcus silty clay loam, and one-third is Spicer silty clay loam. These soils have a profile similar to those described as representative of their respective series.

Included with these soils in mapping are small areas of Rushmore and Ransom soils.

Wetness and the high content of lime are the main limitations to the use of these soils. If the soils are properly drained and fertilized, however, they are suited to all crops commonly grown in the county. Both soils are in capability unit IIw–1; Marcus soil is in windbreak suitability group 2; Spicer soil is in windbreak suitability group 3.

Marsh

Marsh (0 to 2 percent slopes) (Mb) consists of closed undrained depressions and ponds that have 1 to 3 feet of water, except in dry years. Cattails, reeds, sedges, and other water plants grow in scattered places in the water. The soils under the water have not been identified, but Glencoe, Blue Earth, and Lura soils are in most of the marshes. Most areas of Marsh are idle and provide good habitat for such wildlife as waterfowl and muskrat. Capability unit VIIIw–1; windbreak suitability group 7.

Millington Series

The Millington series consists of deep, nearly level, moderately fine textured soils that are poorly drained. These soils formed in alluvial material on bottom lands. They are limy throughout the profile. The native vegetation was tall grass prairie and sedges.

In a representative profile, the surface layer is black and very dark gray silty clay loam about 30 inches thick. The subsoil is very friable, dark-gray clay loam and loam about 10 inches thick. The underlying material is gray, light-gray, and olive-gray loam.

Permeability in these soils is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness, flooding, and a high content of lime are the major limitations to the use of these soils. If these soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Millington silty clay loam, in a cultivated field, 100 feet north and 30 feet east of roadgate, in SW¼SW¼NE¼ sec. 6, T. 103 N., R. 43 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; gradual, smooth boundary.

A1—8 to 14 inches, black (10YR 2/1) silty clay loam; weak, very fine, subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts; moderately alkaline; strong effervescence; gradual, smooth boundary.

A3—14 to 30 inches, very dark gray (10YR 3/1) silty clay loam; weak, very fine and fine, subangular blocky structure; very friable; moderately alkaline; strong effervescence; gradual, smooth boundary.

B1—30 to 35 inches, dark-gray (10YR 4/1) clay loam; weak, fine, subangular blocky structure; very friable; moderately alkaline; strong effervescence; gradual boundary.

B2—35 to 40 inches, dark-gray (10YR 4/1) loam; weak, fine and very fine, subangular blocky structure; very friable; few gray (10YR 5/1) worm casts; moderately alkaline; strong effervescence; clear, smooth boundary.

C1—40 to 50 inches, mixed gray (5Y 5/1) and light-gray (5Y 6/1) heavy loam; few, medium, distinct, light olive-brown (2.5Y 5/6) mottles; weak, fine, subangular blocky structure; friable; many manganese segregations; moderately alkaline; strong effervescence; clear, smooth boundary.

C2—50 to 60 inches, mixed gray (5Y 5/1) and olive-gray (5Y 5/2) light loam; few, coarse, prominent, light olive-brown (2.5Y 5/4 and 5/6) mottles; massive; friable; content of sand increases with depth; mildly alkaline; slight effervescence.

The A horizon ranges from 24 to 36 inches in thickness. The B horizon ranges from silty clay loam or clay loam to loam in texture and from 0 to 16 inches in thickness. The C horizon is loam to sandy loam. This horizon ranges from slightly to strongly effervescent.

The Millington soils are associated with the Comfrey and Spillville soils. They have free carbonates throughout the profile, but the Comfrey soils lack free carbonates in at least a part of the A horizon. They have lower chroma in the A horizon than the moderately well drained Spillville soils.

Millington silty clay loam (0 to 2 percent slopes) (Mn).—This limy, poorly drained soil is on bottom lands along major streams and drainageways. The areas range from a few acres to a few hundred acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of the Comfrey soils.

Wetness, occasional flooding, and a high content of lime are the main limitations to the use of this soil. If the soil is properly drained and fertilized, it is suited to all crops commonly grown in the county. Crop damage by flooding occurs about once in every 5 years. Capability unit IIw–2; windbreak suitability group 3.

Millington silty clay loam, frequently flooded (0 to 2 percent slopes) (Mo).—This limy, poorly drained soil is on bottom lands along major streams and drainageways. The areas range from several acres to several hundred acres in size. This soil is cut by meandering stream channels in many places.

Included with this soil in mapping are small areas of Comfrey soils.

Flooding during the growing season occurs in most years and limits use of this soil for cultivated crops. The soil is well suited to permanent pasture and is used for this purpose. Capability unit VIw–1; windbreak suitability group 7.

Millington silty clay loam, depressional (0 to 2 percent slopes) (Mp).—This limy soil is in low depressions on bottom lands along major streams and drainageways. The areas range from 3 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is thicker in most places. In depressions the surface is hummocky in some places.

Included with this soil in mapping are small areas of Comfrey and Talcot soils.

Wetness and flooding limit the use of this soil. The soil is used for pasture and wild hay. Capability unit VIw–2; windbreak suitability group 7.

Nicollet Series

The Nicollet series consists of deep, nearly level, moderately well drained soils that formed in friable glacial till on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark gray clay loam about 15 inches thick. The subsoil is dark olive-brown and olive-brown clay loam about 13 inches thick. The underlying material is calcareous, olive-brown, light olive-brown, and grayish-brown clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils have few limitations to their use. They are suited to all crops commonly grown in the county.

Representative profile of Nicollet clay loam, in a cultivated field, 100 feet east of road, in NW¼SW¼NW¼ sec. 21, T. 102 N., R. 40 W.:

Ap—0 to 7 inches, black (10YR 2/1) clay loam; weak, fine, subangular blocky structure; friable; about 2 percent coarse fragments; many roots; neutral; gradual, smooth boundary.

A1—7 to 10 inches, black (10YR 2/1) clay loam; weak to moderate, fine, subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual, smooth boundary.

A3—10 to 15 inches, very dark gray (10YR 3/1) clay loam; weak to moderate, fine, subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual, smooth boundary.

B1—15 to 20 inches, very dark grayish-brown (10YR 3/2) clay loam; moderate, fine, subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear, smooth boundary.

B2—20 to 28 inches, olive-brown (2.5Y 4/4) clay loam; few fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; about 5 percent coarse fragments; mildly alkaline; slight effervescence; clear, smooth boundary.

C1—28 to 35 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) clay loam; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

C2—35 to 60 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) clay loam; massive; friable; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Depth to free carbonates ranges from 20 to 40 inches but typically is 26 to 36 inches. The A horizon is clay loam, loam, or silty clay loam and ranges from 10 to 20 inches in thickness. It is neutral or slightly acid. The B horizon is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. The C horizon is clay loam or loam.

The Nicollet soils are associated with the Clarion and Webster soils and are similar to the Wilmonton soils. They have a thicker A horizon than the Clarion soils and have a more olive, less brown B horizon. They have brighter colors in the B horizon than the poorly drained Webster soils. Nicollet soils are friable in the lower part of the B horizon and in the C horizon, but the Wilmonton soils are firm in those horizons.

Nicollet clay loam (0 to 3 percent slopes) (Nc).—This moderately well drained soil occurs on glacial till plains in slightly elevated areas on low, wide flats and on lower slopes in the uplands. The areas range from 3 to 40 acres in size.

Included with this soil in mapping are small areas of Clarion and Webster soils.

This soil has few limitations. It is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Primghar Series

The Primghar series consists of deep, nearly level, somewhat poorly drained soils that formed in thick loess over glacial till on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark brown silty clay loam about 16 inches thick. The subsoil is mottled, dark grayish-brown, olive-brown, light olive-brown, and very dark grayish-brown, friable silty clay loam about 14 inches thick. The underlying material is mottled, grayish-brown and olive-brown, friable silty clay loam and firm clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils have few limitations that affect their use. They are suited to all crops commonly grown in the county.

Representative profile of Primghar silty clay loam, in a field of alfalfa and bromegrass, in SE¼NE¼SE¼ sec. 17, T. 102 N., R. 43 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; many roots; neutral; gradual, smooth boundary.

A1—8 to 12 inches, black (10YR 2/1) and very dark brown (10YR 2/2) silty clay loam; weak, fine, subangular blocky structure; friable, sticky; many roots; neutral; gradual, smooth boundary.

A12—12 to 16 inches, very dark brown (10YR 2/2) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; common roots; neutral; clear, smooth boundary,

B1—16 to 20 inches, olive-brown (2.5Y 4/4) and very dark grayish-brown (2.5Y 3/2) silty clay loam; moderate, medium, prismatic structure parting to weak, fine, subangular blocky structure; friable, sticky; many very dark brown (10YR 2/2) worm casts; few roots; neutral; clear, smooth boundary.

B21—20 to 24 inches, olive-brown (2.5YR 4/4) and dark grayish-brown (2.5Y 4/2) silty clay loam; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; friable; sticky; many very dark brown (10YR 2/2) worm casts; neutral; clear, smooth boundary.

B22—24 to 30 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) silty clay loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky structure; friable; sticky; neutral; gradual, smooth boundary.

C1—30 to 44 inches, grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) silty clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; friable; sticky; mildly alkaline; strong effervescence; clear, smooth boundary.

IIC2—44 to 60 inches, olive-brown (2.5Y 4/4) and grayish-brown (2.5Y 5/2) clay loam; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; massive; firm; sticky; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Depth to free carbonates ranges from 20 to 36 inches. The A horizon ranges from 14 to 20 inches in thickness and is black, very dark brown, or very dark gray. The B horizon is 10 to 24 inches thick. The depth of the IIC horizon typically ranges from 40 to 55 inches. The horizon ranges from loam to clay loam.

The Primghar soils are associated with the Galva and Marcus soils and are similar to the Ransom soils. They have more olive colors in the B horizon than the well-drained Galva soils. They have brighter colors in the B horizon than the poorly drained Marcus soils. Primghar soils formed entirely in loess, but the Ransom soils have glacial till beginning at a depth of 20 to 40 inches.

Primghar silty clay loam (0 to 3 percent slopes) (Pr).—This soil occurs on ground moraines in slightly elevated areas on low, wide flats and on lower slopes in the uplands. These areas range from 3 to 40 acres in size.

Included with this soil in mapping are small areas of Ransom and Galva soils.

This soil has few limitations. Most of the acreage is cultivated. This soil is suited to all crops commonly grown in the county. Capability unit I–1; woodland suitability group 1.

Ransom Series

The Ransom series consists of deep, nearly level, moderately fine textured soils that are moderately well drained. These soils formed in moderately thick loess over glacial till on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark grayish-brown silty clay loam about 16 inches thick. The subsoil layer is mottled, dark brown and olive-brown, friable silty clay loam about 17 inches thick. The underlying material is olive-brown and grayish-brown, firm, calcareous heavy silt loam till.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils have very few limitations that affect their use. They are suited to all crops commonly grown in the county.

Representative profile of Ransom silty clay loam, in a cultivated field, in SE¼SW¼SE¼ sec. 34, T. 101 N., R. 41 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; neutral; gradual boundary.

A1—8 to 12 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; neutral; clear, smooth boundary.

A3—12 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; black (10YR 2/1) and brown (10YR 3/3) worm casts; neutral; gradual, wavy boundary.

B1—16 to 19 inches, dark-brown (10YR 3/3) and brown (10YR 5/3) silty clay loam, brown (10YR 4/3) crushed; moderate, fine, subangular blocky structure; friable; sticky; common very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) worm casts; neutral; gradual, wavy boundary.

B2—19 to 29 inches, olive-brown (2.5Y 4/4) silty clay loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; moderate, fine and medium, subangular blocky structure; friable; common very dark brown (10YR 2/2) worm casts; neutral; clear, wavy boundary.

B3—29 to 33 inches, olive-brown (2.5Y 4/4) silty clay loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; few very dark brown (10YR 2/2) worm casts; thin stone line in lower part; mildly alkaline; slight effervescence; clear, wavy boundary.

IIC1—33 to 40 inches, olive-brown (2.5Y 4/4) and grayish-brown (2.5Y 5/2) heavy silt loam; massive; firm; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

IIC2—40 to 60 inches, grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) heavy silt loam; massive; firm; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of loess over the glacial till ranges from 20 to 40 inches but typically is 26 to 36 inches. Thickness of the solum and depth to free carbonates range from 22 to 40 inches. The A horizon ranges from 12 to 20 inches in thickness. The B horizon is 10 to 27 inches thick. The lower part of this horizon is silty clay loam, silt loam, loam, or clay loam. The IIC horizon is loam, silt loam, or clay loam till. In some profiles a thin C1 horizon of silt loam is present in the loess.

The Ransom soils are associated with the Sac and Rushmore soils and are similar to the Primghar soils. They have mottles in the B horizon, but the well-drained Sac soils do not. They have brighter colors in the B horizon than the poorly drained Rushmore soils. Ransom soils have glacial till beginning at a depth of 20 to 40 inches, but the Primghar soils formed in thick loess.

Ransom silty clay loam (0 to 3 percent slopes) (Ra).—This soil is on ground moraines and occurs in slightly elevated areas on low, wide flats and on lower slopes in gently sloping areas. The areas range from 3 to 30 acres in size.

Included with this soil in mapping are small areas of the Wilmonton and Primghar soils.

This soil has few limitations. It is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Rushmore Series

The Rushmore series consists of deep, nearly level. moderately fine textured soils that are poorly drained. These soils formed in moderately thick loess over glacial till. They are on wide, low, upland flats and in draws. The native vegetation was mostly tall grass prairie and sedges.

In a representative profile, the surface layer is black and dark olive-gray silty clay loam about 18 inches thick. The subsoil is mottled, olive-gray and olive, friable silty clay loam about 10 inches thick. The underlying material is calcareous, mottled, light olive-brown, firm loam.

Permeability is moderately slow. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main concern in the use of these soils. Rushmore soils are suited to all crops commonly grown in the county.

Representative profile of Rushmore silty clay loam, 535 feet south of east-west township road and 150 feet west of north-south township road, in a cultivated field, in SE¼SE¼NE¼NE¼ sec. 29, T. 102 N., R. 42 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A1—8 to 14 inches, black (5Y 2/2) silty clay loam; moderate, fine, subangular blocky structure; friable; neutral; gradual, wavy boundary.

A3—14 to 18 inches, dark olive-gray (5Y 3/2) silty clay loam; moderate, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B1g—18 to 21 inches, olive-gray (5Y 4/2) silty clay loam; many, fine, distinct, olive (5Y 5/3) mottles; weak, fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B2g—21 to 24 inches, olive (5Y 5/3) silty clay loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; abrupt, wavy boundary.

B3g—24 to 28 inches, olive (5Y 5/4) silty clay loam; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; mildly alkaline; slight effervescence; clear, smooth boundary.

IIC—28 to 60 inches, light olive-brown (2.5 5/4) loam; many, fine and medium, distinct, grayish-brown (2.5Y 5/2) mottles; firm; thin stone line in upper part; about 5 percent coarse fragments in rest of horizon; mildly alkaline; strong effervescence.

The thickness of loess over glacial till ranges from 20 to 40 inches. The thickness of the solum and depth to free carbonates range from 24 to 40 inches. The A horizon ranges from 16 to 24 inches in thickness. The B horizon is 6 to 16 inches thick. The lower part of the B horizon ranges from loam or silt loam to clay loam. The IIC horizon in glacial till is loam or silt that is high in content of sand. In some places a C1 horizon of silt loam or silty clay loam is present in the loess.

The Rushmore soils are associated with the Sac and Ransom soils and are similar to the Marcus soils. They have lower chroma in more of the B horizon than the well drained Sac soils and the moderately well drained Ransom soils. They have glacial till beginning at a depth of 20 to 40 inches, but the Marcus soils formed in loess and have glacial till at a depth of more than 40 inches.

Rushmore silty clay loam (0 to 2 percent slopes) (Ru).—This soil is on low flats and in draws on loess-covered glacial till uplands. The areas range from 10 to more than 100 acres in size.

Included with this soil in mapping are small areas of Letri and Marcus soils.

Wetness is the main concern in the use of this soil. The soil is suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 2.

Sac Series

The Sac series consists of deep, nearly level to gently sloping, moderately fine textured soils that are well drained. These soils formed in moderately thick loess overlying glacial till on uplands. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black, very dark brown, and dark-brown silty clay loam about 12 inches thick. The subsoil is dark-brown, dark yellowish-brown, and yellowish-brown, friable silty clay loam about 18 inches thick. The underlying material is mottled, yellowish-brown, firm clay loam.

Permeability in these soils is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 5 to more than 10 feet.

The hazard of erosion is moderate in the gently sloping areas. These soils are suited to all crops commonly grown in the county.

Representative profile of Sac silty clay loam, 1 to 3 percent slopes, in a cultivated field, 75 feet south of road, in NW¼NW¼NE¼NE¼ sec. 15, T. 101 N., R. 43 W.:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam; moderate, fine and medium, subangular blocky structure; friable; sticky; slightly acid; gradual boundary.

A1—7 to 12 inches, very dark brown (10YR 2/2) and dark-brown (10YR 3/3) silty clay loam; moderate, medium, subangular blocky structure; friable; sticky; neutral; gradual boundary.

B1—12 to 15 inches, dark yellowish-brown (10YR 4/4) and dark-brown (10YR 3/3) silty clay loam, brown (10YR 4/3) crushed; weak, fine, subangular blocky structure; friable; sticky; slightly acid; gradual boundary.

B2—15 to 20 inches, yellowish-brown (10YR 5/6) and dark-brown (10YR 3/3) silty clay loam; weak, fine, subangular blocky structure; friable; sticky; slightly acid; clear boundary.

B3—20 to 30 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) silty clay loam; few, fine, faint, light yellowish-brown (2.5Y 6/4) mottles; massive; friable; sticky; neutral: clear boundary.

IIC—30 to 60 inches, yellowish-brown (10YR 5/6) clay loam; common, medium, distinct, light yellowish-brown (2.5Y 6/4) mottles; massive; firm; sticky; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

Thickness of loess over glacial till, thickness of the solum, and the depth to free carbonates range from 20 to 40 inches. The A horizon ranges from 6 to 16 inches in thickness and is slightly acid or neutral. The B horizon typically is silty clay loam, but in some places the lower part of the B horizon is clay loam. This horizon is neutral or slightly acid and ranges from 8 to 24 inches in thickness. The IIC horizon ranges from clay loam to loam or silt loam that is high in content of sand.

The Sac soils are associated with the moderately well drained Ransom soils and the poorly drained Rushmore soils and are similar to the Galva and Everly soils. They have a redder hue in the B horizon than the Ransom and Rushmore soils. They formed in 20 to 40 inches of loess over glacial till, but the Everly soils formed mostly in glacial till and the Galva soils formed entirely in loess.

Sac silty clay loam, 1 to 3 percent slopes (SaA).—This soil is on loess-covered uplands. The areas range from 5 to 20 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Ransom and Everly soils.

This soil has few limitations. It is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Sac silty clay loam, 3 to 5 percent slopes, eroded (SaB2).—This soil is on loess-covered uplands. The areas range from 3 to 40 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer is only 6 to 8 inches thick because of erosion. The organic-matter content and fertility are lower than in uneroded Sac soils.

Included with this soil in mapping are small areas of Everly soils.

This soil is suited to all crops commonly grown in the county, but erosion is a slight to moderate hazard. Capability unit IIe–1; windbreak suitability group 1.

Spicer Series

The Spicer series consists of deep, nearly level, calcareous soils that are moderately fine textured and poorly drained. These soils are on loess-covered uplands. The native vegetation was tall grass prairie and wetland grasses.

In a representative profile, the surface layer is black silty clay loam about 20 inches thick. The subsoil is mottled, dark olive-gray, olive-gray, dark-gray, and olive silty clay loam about 14 inches thick. The upper part of the subsoil is very friable and the lower part is sticky. The underlying material is mottled, olive-gray and olive silty clay loam and silt loam to a depth of about 48 inches. Below that is olive-gray and olive clay loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness and a high content of lime are the main limitations to the use of these soils. If the soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Spicer silty clay loam, in a cultivated field, 500 feet southwest of corn cribs, in NE¼ SE¼SE¼ sec. 7, T. 102 N., R. 43 W.:

Ap—0 to 8 inches, black (5Y 2/1) silty clay loam; moderate, coarse, angular blocky structure parting to moderate, fine, subangular blocky structure; very friable; sticky; many roots; moderately alkaline; strong effervescence; gradual boundary.

A1—8 to 20 inches, black (10YR 2/1) silty clay loam; moderate, fine, subangular blocky structure; very friable; sticky; many roots; moderately alkaline; strong effervescence; clear, smooth boundary.

B1g—20 to 28 inches, olive-gray (5Y 4/2) and dark olive-gray (5Y 3/2) silty clay loam; few, fine, faint, light olive-gray (5Y 6/2) mottles; moderate, fine, subangular blocky structure; very friable; sticky; few roots; moderately alkaline; strong effervescence; gradual boundary.

B2g—28 to 34 inches, dark-gray (5Y 4/1) and olive (5Y 4/3) silty clay loam; common, fine, prominent, light olive-gray (5Y 6/2) mottles; moderate, fine, subangular blocky structure; sticky; moderately alkaline; strong effervescence; gradual boundary.

C1—34 to 38 inches, olive-gray (5Y 4/2) silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; massive; sticky; mildly alkaline; slight effervescence; clear boundary.

C2—38 to 48 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) silt loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; massive; slightly sticky; mildly alkaline; slight effervescence; clear boundary.

IIC3—48 to 60 inches, olive-gray (5YR 6/2) and olive (5Y 5/4) clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; sticky; about 5 percent coarse fragments; mildly alkaline; slight effervescence.

Thickness of loess over glacial till is typically 40 to 60 inches. The sand content in the solum is less than 15 percent. The A horizon ranges from 14 to 24 inches in thickness. The B horizon ranges from silty clay loam to silt loam in texture and from 8 to 16 inches in thickness. The IIC horizon is loam or clay loam.

The Spicer soils are associated with the Marcus soils and are similar to the Canisteo soils. They have free carbonates throughout, but the Marcus soils lack free carbonates in the A horizon and in at least part of the B horizon. The Spicer soils have more and less sand than the Canisteo soils, which formed mostly in glacial till.

Spicer silty clay loam (0 to 2 percent slopes) (Sp).—This poorly drained, calcareous soil is on low, level flats, on rims adjacent to depressions in loess-covered plains, and in areas of low-sand lacustrine sediment of the glacial till plains. The areas range from 5 to 40 acres in size.

Included with this soil in mapping are small areas of Marcus soils and small areas where thin layers of sand and gravel occur in the underlying material.

Wetness and a high content of lime are the main limitations to the use of this soil. If the soil is properly drained, it is suited to all crops commonly grown in the county Capability unit IIw–1; windbreak suitability group 3.

Spillville Series

The Spillville series consists of deep, nearly level, medium-textured soils that are moderately well drained. These soils are on bottom land. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black and very dark gray loam and dark grayish-brown sandy loam about 38 inches thick. The underlying material is dark grayish-brown loam.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 5 feet.

Occasional flooding is the main limitation to the use of these soils. Spillville soils are suited to all crops commonly grown in the county.

Representative profile of Spillville loam, in a cultivated field, 100 feet west of road, in NE¼SE¼ sec. 32, T. 104 N., R. 39 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; weak, fine, subangular blocky structure; friable; many roots; neutral; gradual boundary.

A11—7 to 12 inches, black (10YR 2/1) loam; weak, fine, subangular blocky structure; friable; common roots; neutral; gradual boundary.

A12—12 to 20 inches, very dark gray (10YR 3/1) loam; moderate, medium, subangular blocky structure; friable; few roots; neutral; gradual boundary.

A13—20 to 28 inches, very dark gray (10YR 3/1) loam; weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

A14—28 to 38 inches, dark grayish-brown (10YR 3/2) sandy loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

C—38 to 60 inches, dark grayish-brown (2.5Y 4/2) loam; common pebbles, mostly limestone; massive; mildly alkaline; strong effervescence.

Depth to free carbonates ranges from 30 to 40 inches in most places. The A horizon is silt loam to loam and is 24 to 50 inches thick. The C horizon contains 3- to 6-inch layers of sand and gravel in some places. This horizon ranges from dark grayish brown to olive brown.

The Spillville soils are associated with the Comfrey and Millington soils. They have higher chroma in the A horizon than those poorly drained soils.

Spillville loam (0 to 2 percent slopes) (Sv).—This soil is at the slightly higher elevations on bottom land along streams. Areas range from 2 to 40 acres in size.

Included with this soil in mapping are small areas that have free lime in the surface layer and small areas of Comfrey soils.

Occasional flooding is the main hazard that affects the use of this soil. Most flooding occurs early in spring from snowmelt runoff, but flooding later in the year is likely to damage crops about 1 year in 5. This soil is suited to all crops commonly grown in the county. Capability unit IIw–3; windbreak suitability group 1.

Storden Series

The Storden series consists of deep, gently undulating to steep, medium-textured soils that are somewhat excessively drained. These soils formed in calcareous glacial till on terminal moraines and along streambanks. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is very dark grayish-brown and dark-brown loam about 7 inches thick. The underlying material is grayish-brown, yellowish-brown, light olive-brown, dark yellowish-brown, and light brownish-gray, friable loam. This material is calcareous and is many feet thick.

Permeability is moderate. Available water capacity is high. Organic-matter content and fertility are moderate. Depth to a seasonal high water table is 5 to more than 10 feet.

Erosion is a severe hazard that affects the use of these soils. Runoff is rapid on the steeper slopes. Under good management, however, these soils are suited to all crops commonly grown in the county.

Representative profile of Storden loam in an area of Clarion-Storden loams, 12 to 18 percent slopes, eroded, in a field of alfalfa, in NW¼NW¼SW¼ sec. 23, T. 101 N., R. 40 W.:

Ap—0 to 7 inches, dark-brown (10YR 3/3) rubbed loam; moderate, medium, subangular blocky structure; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; abrupt, smooth boundary.

C1ca—7 to 15 inches, yellowish-brown (10YR 5/4) loam; massive; friable; very dark brown (10YR 3/2) worm casts; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

C2ca—15 to 20 inches, yellowish-brown (10YR 5/4) and grayish-brown (10YR 5/2) loam; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

C3—20 to 37 inches, dark yellowish-brown (10YR 4/4) and grayish-brown (10YR 5/2) loam; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual boundary.

C4—37 to 42 inches, light olive-brown (2.5Y 5/4) loam; common, medium, distinct, yellowish-red (5YR 4/8) and light brownish-gray (2.5Y 6/2) mottles; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear boundary.

C5—42 to 60 inches, light olive-brown (2.5Y 5/6) and light brownish-gray (2.5Y 6/2) loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; massive; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence.

The A horizon ranges from loam to clay loam. The thickness of this horizon is as much as 12 inches in the more protected areas, but the horizon is absent in some areas that are steeper and more eroded. In a few places a thin B horizon is present. The C horizon ranges from loam to clay loam. Thin lenses of sand or small pockets of gravel occur in this horizon in some places.

The Storden soils that are mapped in complexes with the Everly soils are outside the range defined for the series because they have firm consistence in part or all of the C horizon. This difference does not significantly alter their usefulness and behavior.

The Storden soils are associated with the Clarion and Everly soils. They have a thinner solum than those soils.

In Nobles County the Storden soils are mapped only in a complex with the Clarion and Estherville soils in the eastern part of the county and with the Everly and Estherville soils in the western part.

Talcot Series

The Talcot series consists of nearly level, moderately fine textured, very poorly drained soils. These soils formed in water-laid silts and are moderately deep over limy sand and gravel. The native vegetation was tall grass prairie and wetland grasses.

In a representative profile, the surface layer is black and very dark gray, limy silty clay loam about 20 inches thick. The subsoil, about 11 inches thick, is mottled, dark-gray and olive silty clay loam in the upper part and loam in the lower part. The underlying material is dark yellowish-brown and brown sand and gravel.

Permeability is moderate in the upper part of these soils and rapid in the underlying material. Available water capacity is moderate. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main concern in the use of these soils. If the soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Talcot silty clay loam, in a cultivated field, 800 feet north of railroad in the west center of SE¼NW¼ sec. 19, T. 101 N., T. 43 W.:

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, very fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; abrupt, smooth boundary.

A1—8 to 14 inches, black (5Y 2/1) silty clay loam; few, fine, faint, very dark gray (5Y 3/1) mottles; weak, very fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; gradual, wavy boundary.

A3—14 to 20 inches, very dark gray (5Y 3/1) silty clay loam; weak, very fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; gradual, wavy boundary.

B1g—20 to 27 inches, dark-gray (5Y 4/1) and olive (5Y 5/3) silty clay loam high in content of sand; weak, fine and very fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; gradual, wavy boundary.

B2g—27 to 31 inches, olive (5Y 5/3) and some dark-gray (5Y 4/1) loam; common, fine, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; clear, wavy boundary.

C1—31 to 33 inches, olive (5Y 5/4) gravelly loam; many, medium, distinct, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/8) mottles; massive; very friable; mildly alkaline; slight effervescence; abrupt, wavy boundary.

IIC2—33 to 60 inches, dark yellowish-brown (10YR 4/4) and brown (10YR 4/3) coarse sand and gravel; moderately alkaline; strong effervescence.

Thickness of the solum and depth of the IIC horizon range from 26 to 40 inches. The A horizon ranges from loam to silty clay loam or clay loam in texture and from 12 to 24 inches in thickness. The B horizon is silty clay loam, clay loam, or loam and ranges from 6 to 16 inches in thickness.

The Talcot soils are associated with the Biscay soils. They have free carbonates throughout their solum, but the Biscay soils lack free carbonates in the A horizon and in at least part of the B horizon.

Talcot silty clay loam (0 to 2 percent slopes) (Ta).—This soil is in depressions on bottom lands and outwash plains. The areas range from 20 to 200 acres in size.

Included with this soil in mapping are small areas of Biscay and Millington soils.

Wetness is a major concern in the use of the soil. If the soil is properly drained, it is suited to all crops commonly grown in the county. Capability unit IIIw–1; windbreak suitability group 3.

Terril Series

The Terril series consists of deep, gently sloping, medium-textured soils that are moderately well drained. These soils are on glacial till uplands. They formed in concave areas at the base of the steeper slopes. Native vegetation was tall grass prairie.

In a representative profile, the surface layer is black, very dark brown, and very dark grayish-brown loam and clay loam about 27 inches thick. The subsoil is brown, very dark grayish-brown, light olive-brown, and olive-brown, friable clay loam about 9 inches thick. The underlying material is calcareous, light olive-brown and grayish-brown, friable clay loam.

Permeability is moderate, and the available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils are suited to all crops commonly grown in the county.

Representative profile of Terril loam, 2 to 6 percent slopes, in a field of alfalfa and clover, 20 feet south of Interstate 90 right-of-way, in NW¼NW¼SE¼ sec. 16, T. 102 N., R. 41 W.:

Ap—0 to 8 inches, black (10YR 2/1) loam high in content of silt; weak, fine, subangular blocky structure; very friable; slightly acid; gradual boundary.

A1—8 to 20 inches, black (10YR 2/1) and very dark brown (10YR 2/2) loam high in content of silt; weak, fine, subangular blocky structure; very friable; sticky; neutral; gradual boundary.

A3—20 to 27 inches, black (N 2/0) and very dark grayish-brown (10YR 3/2) clay loam; weak, fine, subangular blocky structure; sticky; neutral; clear boundary.

B2—27 to 30 inches, brown (10YR 4/3) and very dark grayish-brown (10YR 3/2) clay loam; very weak, fine, subangular blocky structure; friable; mildly alkaline; slight effervescence; clear boundary.

B3ca—30 to 36 inches, light olive-brown (2.5Y 5/4) and olive-brown (2.5Y 4/4) clay loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; very weak, fine, subangular blocky structure; friable; moderately alkaline; strong effervescence; gradual boundary.

C—36 to 60 inches, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) clay loam; massive; friable; about 5 percent coarse fragments; moderately alkaline; strong effervescence.

The A horizon ranges from light loam to silt loam in texture and from 24 to 40 inches in thickness. Thin lenses of sand occur in the upper part of this horizon in some profiles. In some places the horizon is very dark brown in the upper part and grades to black with increasing depth. Depth to free lime ranges from 24 to 36 inches. The B horizon ranges from loam to clay loam in texture and from 6 to 14 inches in thickness.

The Terril soils are associated with the Clarion, Everly, and Storden soils. They have a thicker A horizon than those soils.

Terril loam, 2 to 6 percent slopes (TeB).—This soil formed in colluvial material that accumulated at the base of steep soils on glacial till uplands. Slopes range from 25 to 100 feet in length.

Included with this soil in mapping are small areas of poorly drained Webster, Letri, and Rushmore soils.

This soil is suited to all crops commonly grown in the county. Capability unit IIe–1; windbreak suitability group 1.

Wadena Series

The Wadena series consists of nearly level to gently sloping, well-drained soils that are moderately deep to sand and gravel. These soils are on stream terraces and upland glacial till plains. Native vegetation was tall grass prairie.

In a representative profile, the surface layer is black loam about 12 inches thick. The subsoil is dark yellowish-brown, friable loam about 16 inches thick. The underlying material is yellowish-brown and pale-brown, stratified sand and gravel.

Permeability is moderate in the upper part of these soils and rapid in the underlying material. The available water capacity is moderate. Organic-matter content and fertility are high. Depth to a seasonal high water table is 5 to more than 10 feet.

Erosion and droughtiness are the major limitations to the use of these soils. These soils are suited to all crops commonly grown in the county.

Representative profile of Wadena loam, 0 to 2 percent slopes, in a field of bromegrass, 12 feet north and 200 feet west of road intersection, in SE¼SE¼SE¼ sec. 27, T. 101 N., R. 40 W.:

A1—0 to 12 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; many roots; slightly acid; clear, smooth boundary.

B1—12 to 20 inches, dark yellowish-brown (10YR 3/4) loam; weak, medium and coarse, subangular blocky structure; friable; common roots; slightly acid; clear boundary.

B2—20 to 28 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium and coarse, subangular blocky structure; friable; few roots; neutral; clear boundary.

IIC—28 to 60 inches, mixed yellowish-brown (10YR 5/8) strata of gravel and pale-brown (10YR 6/3) strata of coarse sand; single grain; loose; many gravel particles coated with lime on undersides; mildly alkaline; strong effervescence.

The thickness of solum, depth to the IIC horizon, and depth to free carbonates range from 24 to 40 inches. The A horizon ranges from 8 to 15 inches in thickness and is black, very dark gray, or very dark brown. It is slightly acid or neutral. The IIC horizon ranges from stratified sand and gravel to gravelly coarse sand.

The Wadena soils are associated with the Estherville and Biscay soils and are similar to the Fairhaven soils. They have a coarse-textured IIC horizon beginning at a greater depth than the Estherville soils. They have higher chroma (brighter colors) in the B horizon than the poorly drained Biscay soils. Wadena soils have more sand and less silt in the solum than the Fairhaven soils.

Wadena loam, 0 to 2 percent slopes (WaA).—This soil is on stream terraces, outwash plains, and glacial till ground moraines in the uplands. The areas range from 2 acres to more than 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Estherville soils.

Erosion is a slight hazard on this soil. Also, the soil is droughty during periods of below-normal rainfall. Nevertheless, it is suited to all crops commonly grown in the county. Capability unit IIs–1; windbreak suitability group 6.

Wadena loam, 2 to 6 percent slopes (WaB).—This soil is on stream terraces, outwash plains, and glacial till ground moraines in the uplands. The areas range from 2 to 20 acres in size. This soil has a profile similar to the one described as representative of the series, except that the surface layer ranges from 7 to 12 inches in thickness. Slopes average about 3 percent in gradient and about 150 feet in length.

Included with this soil in mapping are small areas of Estherville soils and small areas of soils that have steeper slopes.

The hazard of erosion is a moderate limitation to the use of this soil. Also, the soil is droughty during periods of below-normal rainfall. Nevertheless, it is suited to all crops commonly grown in the county. Capability unit IIe–2; windbreak suitability group 6.

Waldorf Series

The Waldorf series consists of deep, nearly level, poorly drained soils that are moderately fine textured. These soils formed in lacustrine sediment on lake plains and water-modified glacial till moraines. They are on low flats. The native vegetation was tall grass prairie and water grasses.

In a representative profile, the surface layer is black and dark olive-gray silty clay 23 inches thick. The subsoil, about 12 inches thick, is olive, olive-gray, and olive-yellow, sticky silty clay. The underlying material is olive-gray silty clay.

Permeability is moderately slow. Available water capacity is moderate to high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the main limitation to the use of these soils. If the soils are drained and well managed, they are suited to all crops commonly grown in the county.

Representative profile of Waldorf silty clay, in a field of alfalfa, in SW¼SW¼SE¼SE¼ sec. 18, T. 102 N., R. 39 W.:

Ap—0 to 7 inches, black (5Y 2/1) silty clay; moderate, fine, subangular blocky structure; friable; sticky; neutral; gradual boundary.

A11—7 to 15 inches, black (5Y 2/1) silty clay; moderate to strong, medium, subangular blocky structure; friable; sticky; neutral; gradual boundary.

A12—15 to 20 inches, black (5Y 2/1) silty clay; moderate, fine, subangular blocky structure; friable; sticky; neutral; gradual boundary.

A3—20 to 23 inches, dark olive-gray (5Y 3/2) silty clay; medium, distinct, olive-gray (5Y 4/2) mottles; moderate, fine, subangular blocky structure; sticky; neutral; clear, smooth boundary.

B1—23 to 28 inches, olive (5Y 4/3 and 5/3) silty clay; moderate, fine, subangular blocky structure; sticky; neutral; clear, smooth boundary.

B2—28 to 35 inches, olive (5Y 5/4) silty clay; many, medium, distinct, olive-yellow (5Y 6/6) mottles; weak, fine, subangular blocky structure; sticky; neutral; gradual boundary.

B3g—35 to 40 inches, olive-gray (5Y 5/2) silty clay; many, fine, distinct, olive-yellow (5Y 6/6) mottles; massive; firm; neutral; gradual boundary.

C—40 to 60 inches, olive-gray (5Y 5/2) silty clay; massive; firm; mildly alkaline; strong effervescence.

Thickness of the solum and depth to free carbonates range from 26 to 48 inches. The A horizon ranges from 12 to 24 inches in thickness and is neutral or slightly acid. It is black, very dark gray, or dark olive gray. The B horizon is mottled olive to light olive-brown silty clay. It ranges from 6 to 24 inches in thickness. The C horizon is olive-gray, grayish-brown, light olive-brown, or olive-yellow silty clay or silty clay loam.

The Waldorf soils are associated with the Collinwood and Lura soils. They have mottles in the A horizon and olive colors in the B horizon that are lacking in the somewhat poorly drained Collinwood soils. They have a thinner A horizon than the very poorly drained Lura soils.

Waldorf silty clay (0 to 2 percent slopes) (Wb).—This soil in on low flats and on lake plains and glacial till ground moraines. Included with this soil in mapping are small areas of silty clay loam and small areas that have a calcareous surface layer.

Wetness is the main limitation to the use of this soil. If the soil is properly drained, it is suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 2.

Webster Series

The Webster series consists of deep, nearly level, poorly drained soils that are moderately fine textured. These soils formed in calcareous glacial till in low, wide flats and draws on uplands. The native vegetation was tall grass prairie and sedges.

In a representative profile, the surface layer is black, very dark gray, and dark olive-gray clay loam about 20 inches thick. The subsoil is mottled, olive-gray and olive, friable clay loam about 10 inches thick. The underlying material is olive-gray, grayish-brown, and yellowish-brown, calcareous clay loam.

Permeability is moderate, and the available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 0 to 2 feet.

Wetness is the major limitation to use of Webster soils. If the soils are drained and well managed they are suited to all crops commonly grown in the county.

Representative profile of Webster clay loam, in a cultivated field, 100 feet north of U.S. Highway 16, 100 feet east of north-south road, in SW¼SW¼SW¼ sec. 16, T. 102 N., R. 40 W.:

Ap—0 to 8 inches, black (5Y 2/1) clay loam; weak, fine, granular structure; friable; sticky; trace of coarse fragments; many roots; neutral; gradual boundary.

A1—8 to 13 inches, black (5Y 2/1) clay loam; weak to moderate, fine and medium, subangular blocky structure; friable; sticky; about 2 percent coarse fragments; common roots; neutral; gradual boundary.

A3g—13 to 20 inches, dark olive-gray (5Y 3/2) and very dark gray (5Y 3/1) clay loam; weak, fine, subangular blocky structure; friable; sticky; about 2 percent coarse fragments; common roots; neutral; clear, irregular boundary.

B1g—20 to 26 inches, olive (5Y 4/3) and olive-gray (5Y 5/2) clay loam; weak, medium, subangular blocky structure; friable; sticky; about 5 percent coarse fragments; few black (10YR 2/1) worm casts; neutral; gradual, smooth boundary.

B2g—26 to 30 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) clay loam; few, fine, distinct, light olive-brown (2.5Y 5/6) mottles; weak, fine, subangular blocky structure; friable; sticky; about 5 percent coarse fragments; few soft segragations of black manganese; mildly alkaline; slight effervescence; clear, smooth boundary.

C1g—30 to 48 inches, olive-gray (5Y 5/2) and yellowish-brown (10YR 5/8) clay loam; weak, fine, subangular blocky structure; friable; sticky; about 5 percent coarse fragments; moderately alkaline; strong effervescence; clear, smooth boundary.

C2g—48 to 60 inches, grayish-brown (2.5Y 5/2) clay loam; common, medium, distinct, yellowish-brown (10YR 5/8) mottles; massive; friable; sticky; moderately alkaline; strong effervescence; about 5 percent coarse fragments.

The thickness of solum and depth to free carbonates range from 24 to 36 inches. The A horizon is clay loam and silty clay loam and ranges from 14 to 24 inches in thickness. The B horizon is clay loam or silty clay loam that is high in content of sand and ranges from 6 to 18 inches in thickness. The C horizon is loam or clay loam.

The Webster soils are associated with the Clarion, Nicollet, Canisteo, and Glencoe soils. They have more olive and gray colors in the B horizon than the well drained Clarion and moderately well drained Nicollet soils. They lack the free carbonates in the A horizon that are typical of the Canisteo soils. Webster soils have a thinner A horizon than the very poorly drained Glencoe soils.

Webster clay loam (0 to 2 percent slopes) (We).—This soil is on low flats and in draws of upland glacial till plains. It has the profile described as representative of the series.

Included in mapping are small areas that have a silty clay loam or limy surface layer. Also included are small areas of Nicollet clay loam and small areas that have pockets of sand and gravel in the underlying material.

Wetness is the main limitation to the use of this soil. If the soil is properly drained, fertilized, and well managed, it is well suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 2.

Webster silty clay loam (0 to 2 percent slopes) (Wf).—This soil is on low flats and in draws of upland glacial till plains. It has a profile similar to the one described as representative of the series, except that it has been influenced by lacustrine material. The surface layer and part of the subsoil are silty clay loam. The surface layer ranges from 12 to 24 inches in thickness, and the silty clay loam extends to a depth of 24 to 30 inches.

Included with this soil in mapping are small areas of Waldorf and Canisteo soils.

Wetness is the major limitation to use of this soil. If the soil is properly drained and managed, it is well suited to all crops commonly grown in the county. Capability unit IIw–1; windbreak suitability group 2.

Wilmonton Series

The Wilmonton series consists of deep, nearly level, moderately well drained soils that are moderately fine textured. These soils formed in glacial till that has been influenced by loess. The native vegetation was tall grass prairie.

In a representative profile, the surface layer is black silty clay loam and clay loam about 17 inches thick. The subsoil is mottled, light olive-brown and olive-brown, firm clay loam about 14 inches thick. The underlying material is limy, light olive-brown loam.

Permeability is moderate, and the available water capacity is high. Organic-matter content and fertility are high. Depth to a seasonal high water table is 3 to 5 feet.

These soils are well suited to all crops commonly grown in the county.

Representative profile of Wilmonton silty clay loam, in a cultivated field, 100 feet south of road ditch, in NW¼ NE¼NE¼ sec. 20, T. 102 N., R. 42 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; trace of coarse fragments; neutral; gradual boundary.

A1—8 to 14 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure; friable; trace of coarse fragments; neutral; gradual, wavy boundary.

A3—14 to 17 inches, black (10YR 2/1) clay loam; moderate, fine, subangular blocky structure; friable; trace of coarse fragments; many very dark grayish-brown (10YR 3/2) and grayish-brown (2.5Y 5/2) worm casts; neutral; gradual, wavy boundary.

IIB2—17 to 25 inches, light olive-brown (2.5Y 5/4) clay loam; many, fine, faint, olive (5Y 5/4) and few, faint, grayish-brown 2.5Y 5/2) mottles; moderate, medium, subangular blocky structure; firm; few very dark grayish-brown (2.5Y 3/2) worm casts; thin stone line in upper part; about 5 percent coarse fragments in rest of horizon; few soft lime segregations; mildly alkaline; slight effervescence; abrupt, wavy boundary.

IIB3ca—25 to 31 inches, olive-brown (2.5Y 4/4) clay loam; many, fine, faint, light olive-brown (2.5Y 5/4) and grayish-brown (2.5Y 5/2) mottles; moderate; medium, subangular blocky structure; firm; about 5 percent coarse fragments; few soft lime segregations and soft powdery lime on pebbles and parting faces; moderately alkaline; strong effervescence; clear, wavy boundary.

IIC—31 to 60 inches, light olive-brown (2.5Y 5/4) loam; many, fine and medium, faint, grayish-brown (2.5Y 5/2) mottles; massive; firm; moderately alkaline; strong effervescence; about 5 percent coarse fragments.

Thickness of the solum and depth to free carbonates range from 20 to 40 inches. Depth to glacial till is less than 30 inches. The A horizon commonly is silty clay loam but ranges to loam and clay loam. The B horizon ranges from 8 to 18 inches in thickness. It typically is clay loam, but in some places the upper part is silty clay and in some places the lower part is loam. The IIC horizon is clay loam or loam.

The Wilmonton soils are associated with the Everly and Letri soils and are similar to the Ransom soils. They have mottles in the upper part of the B horizon that are lacking in the well-drained Everly soils. They have brighter colors (higher chroma) in the B horizon than the poorly drained Letri soils. Wilmonton soils have more sand and less silt in the solum than the Ransom soils.

Wilmonton silty clay loam (0 to 3 percent slopes) (Wm).—This soil is on glacial till ground moraines. The areas range from 2 to 20 acres in size. Included with this soil in mapping are small areas of Everly and Sac soils.

This soil has few limitations to intensive cropping, and it is suited to all crops commonly grown in the county. Capability unit I–1; windbreak suitability group 1.

Use and Management of the Soils

This section discusses the use and management of the soils in the Nobles County for crops. It also discusses the management of the soils for field and farmstead windbreaks, wildlife, engineering works, and recreation.

Use and Management of Soils for Crops

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

Most of the farmland in Nobles County is used for corn, soybeans, oats, flax, and alfalfa. The crops are sold or are fed to livestock.

The sloping soils are subject to water erosion if they are cultivated and not protected. Terracing. contour farming, stripcropping, and managing crop residue help to control erosion and to increase the amount of water that enters the soil and is available for crops.

Soil blowing occurs most readily on the sandy and clayey soils. It can be reduced by keeping vegetation on the surface or by leaving the plowed surface rough until time to prepare a seedbed.

Drainage is needed for intensive farming of the wet, level or depressed soils. Open ditches are commonly used to remove surface water from low areas and closed depressions and to provide outlets for tile drainage.

Crops on most of the soils in the county respond to applications of fertilizer. The soils are especially low in phosphorus. The need for fertilizer depends on the kind of soil, the past and present management, the crop that is grown, and the yield desired. Soil tests provide part of the information that is needed to choose the best kinds and amounts of fertilizer. These soil tests should be made for each soil that is used for crops.

Capability grouping

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

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

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical uses, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife. (None in Nobles County.)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife. (None in Nobles County.)

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes.

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

In class I there are no subclasses, because the soils of this class have a few limitations. Class V can contain,

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at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

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

Management by capability units

In the following pages the capability units in Nobles County are described and suggestions for the use and management of the soils are given. The names of soil series are mentioned in the description of each capability unit. This does not mean, however, that all the soils of a series are in a given capability unit. To find the capability classification of any given soil, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I–1

This unit consists of deep, nearly level, well drained and moderately well drained soils that are medium textured and moderately fine textured. These soils are on uplands and stream terraces. They are in the well drained Fairhaven, Galva, and Sac series and the Kingston series, loamy subsoil variant; the moderately well drained Kingston, Nicollet, Ransom, and Wilmonton series; and the somewhat poorly drained Primghar series. All of these soils have a high available water capacity and are high in fertility. Permeability is moderate. The soils have few limitations that restrict their use.

These soils are suited to all crops commonly grown in the county. The moderately well drained and somewhat poorly drained soils do not dry out so quickly in the spring as the well drained soils, and they cannot be worked so early.

The soils of this unit can be farmed intensively under a high level of management. Crop residue left on the surface of fields plowed in fall helps to control soil blowing. An occasional green-manure crop or sod crop helps to maintain good tilth.

CAPABILITY UNIT IIe–1

This unit consists of deep, undulating and gently sloping, well drained and moderately well drained soils that are medium textured and moderately fine textured. These soils are in the Clarion, Everly, Fairhaven, Sac, and Terril series and the Kingston series, loamy subsoil variant. They formed in calcareous glacial till, loess, and silty and loamy sediment on uplands and stream terraces. Available water capacity and fertility are high. Permeability is moderate. The hazard of erosion is slight to moderate if these soils are cultivated.

The soils in this unit are suited to all crops commonly grown in the county. Contour farming and terracing help to reduce soil and water losses by controlling runoff. Adequate fertilization and high plant populations increase the amount of crop residue returned to the soil. Crop residue left on the surface helps to reduce soil blowing and water erosion in areas that are plowed in fall.

CAPABILITY UNIT IIe–2

This unit consists of well-drained, medium-textured, gently sloping soils that are moderately deep to sand and gravel. These soils are on uplands, stream terraces, and outwash plains. They are in the Fairhaven and Wadena series. The soils in this unit developed in 2 to 3 feet of medium-textured loess, outwash material, or glacial till over sand or gravel. The hazard of erosion is slight to moderate. These soils are somewhat droughty, and crops may be adversely affected in periods of below-normal rainfall.

The available water capacity of these soils is moderate. Organic-matter content and fertility are high. These soils have moderate permeability in the upper part of the profile and rapid permeability in the underlying material. They are suited to all crops commonly grown in the county.

Terracing, contour farming, and similar practices of management help to control erosion. Crop residue left on the surface of plowed soils protects them from soil losses by soil blowing and water erosion. During winter, crop residue left on the surface of plowed soils catches snow and holds moisture. Crop residue returned to the soil helps to increase the organic-matter content and available water capacity.

The sandy or gravelly substratum is a hazard in construction of terraces and waterways. If proposed terraces are to cross these soils, the risk of exposing the sand and gravel should be investigated.

CAPABILITY UNIT IIw–1

This unit consists of deep, nearly level, poorly drained soils that are moderately fine textured and fine textured. These soils are on uplands and in drainageways. They are in the Canisteo, Letri, Marcus, Rushmore, Spicer, Waldorf, and Webster series. Available water capacity is high. The organic-matter content and fertility are high but in Canisteo and Spicer soils an imbalance of nutrients can occur because of the high content of lime. Permeability is moderate except in the Rushmore and Waldorf soils, which have moderately slow permeability. Wetness is the main limitation.

Drainage is needed before the soils in this unit can be farmed intensively. After the soils are drained, the increase in yield of all the common crops is substantial Tilling is needed for subsurface drainage, and open ditches or tile inlets remove surface water. Severe compaction and clodding of the surface layer occur if these soils are worked when wet. A tillage pan is likely to be formed under the plow layer. Fall plowing allows earlier seedbed preparation in spring. The Waldorf soil is somewhat finer textured than the other soils in this unit, and special care must be used in working this soil. Some areas of these soils are in narrow drainageways that carry runoff water from surrounding hillsides and uplands. Some of these drainageways need to be shaped and seeded

to grasses to prevent formation of gullies. Tile drains, installed before a grassed waterway is constructed, help to insure a good growth of grass.

If these soils are properly drained, they are suited to all crops commonly grown in the county. If they are adequately fertilized, they can be used intensively for row crops. Additional applications of phosphate and potash may be needed for Canisteo and Spicer soils.

CAPABILITY UNIT IIw–2

This unit consists of deep, nearly level, poorly drained, moderately fine textured soils of the Comfrey and Millington series. Also in the unit is Alluvial land. These soils are on bottom lands, where wetness is the main limitation. Available water capacity, organic-matter content, and fertility are high. In the Millington soil, however, an imbalance of nutrients can occur because of the high content of lime. Permeability is moderate.

If these soils are properly drained, they are suitable for all crops commonly grown in the county. They are flooded every spring by snowmelt runoff and occasionally by heavy rains during the growing season. Flooding results in crop damage about once in every 5 years. Draining these soils is difficult because outlets that have sufficient grade to remove water from the tile systems are hard to establish on the bottom lands. Shallow, random surface ditches are used in some places to remove excess surface water. Dikes to protect these soils from overflow are practical in some places.

Under a high level of management that includes minimum tillage, row crops can be grown for several years in succession. An occasional deep-rooted legume crop helps internal drainage. Returning crop residue to the soil helps to keep the surface soft and porous.

CAPABILITY UNIT IIw–3

Spillville loam is the only soil in this unit. This soil is deep, nearly level, moderately well drained, and medium textured. It is on bottom lands and is subject to occasional flooding. Flooding generally occurs every spring from snowmelt runoff. Because of heavy rains during the growing season, flooding causes crop damage about 1 year in every 5. Available water capacity, organic-matter content, and fertility are high. There is no hazard of erosion on this soil, and neither wetness nor drought is a limitation. Permeability is moderate.

This soil is suited to all the crops commonly grown in the county. If a high level of management is maintained, corn can be grown year after year. An occasional crop of legumes and grass helps to keep the surface layer loose and porous and the subsurface layer permeable. Many areas are in permanent pasture, and they furnish excellent grazing with a minimum of management. Stabilization of streambanks is needed where a creek or river makes a sharp turn.

CAPABILITY UNIT IIw–4

Biscay silty clay loam is the only soil in this unit. This nearly level, poorly drained, moderately fine textured soil is moderately deep to sand and gravel. It is on bottom lands and outwash plains, where it formed in 24 to 36 inches of wind- or water-modified silt or glacial till that is moderately permeable. The underlying material is limy sand and gravel that is rapidly permeable. Wetness is the main limitation. Available water capacity is moderate. Organic-matter content and fertility are high.

Under good management, this soil is suited to all crops commonly grown in the county. If it is adequately drained and fertilized, row crops can be grown several years in succession. Hay or green-manure crops will help to maintain the content of organic matter.

When tiling, the tile is generally placed in the underlying sand and gravel. Care must be taken to prevent the walls of the trench from slumping in before the tiles are in place. Grassed waterways are needed where water flows across this soil. Fall plowing makes it possible to prepare a good seedbed quickly in spring. This soil compacts and forms hard clods if it is worked when wet.

CAPABILITY UNIT IIs–1

This unit consists of nearly level, well-drained, medium-textured soils that are moderately deep to sand and and gravel. These soils are on uplands, stream terraces, and outwash plains. They formed in 2 to 3 feet of medium-textured loess, outwash material, or glacial till over sand or gravel. The soils in this unit are in the Fairhaven and Wadena series. Soil blowing occurs in large open areas. The available water capacity is moderate. Organic-matter content and fertility are high. Permeability is moderate in the upper part of the profile and rapid in the underlying material. These soils are somewhat droughty during periods of light rainfall.

These soils are suited to all crops commonly grown in the county. Crop residue left on the surface increases the organic-matter content and increases moisture in the soil by trapping snow during the winter. Rough tillage reduces soil loss by soil blowing.

CAPABILITY UNIT IIs–2

Collinwood silty clay, 1 to 4 percent slopes, is the only soil in this unit. It is a deep, somewhat poorly drained, fine-textured soil that formed in lake-laid sediment on glacial ground moraines. The available water capacity is moderate to high. Organic-matter content and fertility are high. Permeability is moderately slow. The main limitation to the use of this soil is the high content of clay, which makes the soil difficult to work. The soil compacts if it is worked when wet, and wide, deep cracks form in compacted areas as the soil dries out. Moisture for crops is adequate during most periods of drought. The drainage is slightly restricted but not enough to require tile drainage.

Under good management, this soil is suited to all crops commonly grown in the county. An occasional deep-rooted legume crop or a green-manure crop adds organic matter to the soil and helps to open up drainage channels in the subsoil.

CAPABILITY UNIT IIIe–1

This unit consists of deep, sloping and rolling, well-drained and somewhat excessively drained soils that are medium textured and moderately fine textured. These soils are on uplands. They are in the Clarion, Everly, and Storden series. Available water capacity is high. Organic-matter content and fertility are high in the Clarion and Everly soils and are moderate in the Storden soils. Permeability is moderate. The hazard of erosion is severe

if these soils are cultivated. Runoff is rapid on the steeper slopes.

Under good management that includes control of erosion, these soils are suited to corn, small grain, and meadow. In some areas diversion terraces are built to reduce the effective length of slope and the soils are contour farmed. In other areas, however, slopes are too irregular for terracing and contouring. Here, spring plowing, heavy applications of manure, returning crop residue to the soil, and disking rather than plowing for the small grain that follows corn are beneficial. Heavy applications of manure are beneficial on the severely eroded spots.

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

About 10 percent of the acreage of this unit is used for permanent pasture. Rotation grazing, fertilization, and prevention of overgrazing are among the practices that improve forage growth.

CAPABILITY UNIT IIIe–2

This unit consists of nearly level to undulating and gently sloping, well-drained and somewhat excessively drained soils that are medium textured, moderately fine textured, and coarse textured. These soils are on uplands and stream terraces. Most of them are deep, but some are moderately deep and some are shallow to sand and gravel. The soils in this unit are in the Clarion, Dickman, Estherville, Everly, Kanaranzi, and Storden series. The Clarion and Storden soils are mapped in complexes with Estherville loams, and the Everly soils are mapped in complexes with Storden and Estherville loams. Droughtiness and erosion are hazards. The Dickman, Estherville, and Kanaranzi are the limiting soils in this unit. Available water capacity is low, and organic-matter content and fertility are moderate. Permeability is moderate or moderately rapid in the upper horizons and moderate to rapid in the lower ones.

These soils are too droughty for corn, except during periods of adequate and timely rainfall. In most places, contour farming, rotation of crops, and spring plowing help to control erosion and conserve water. In areas that are too irregular for contour farming, sod crops or close-sown crops help to control erosion.

CAPABILITY UNIT IIIw–1

This unit consists of nearly level, very poorly drained soils that are medium textured and moderately fine textured. Most of these soils are deep, but some are moderately deep over sand and gravel. The soils in this unit are in closed depressions, in upland drainageways, on bottom lands, and in low, flat outwash areas. They are in the Blue Earth, Glencoe, Lura, and Talcot series. Wetness and ponding are the main limitations. The available water capacity is high except for the Talcot soils, which have moderate available water capacity. Organic-matter content and fertility are high. Permeability is moderate in the Blue Earth, Glencoe, and Talcot soils and slow in the Lura soils.

Drainage is needed before these soils can be cropped. Tile drainage is required to remove the subsurface water. Open ditches are needed to remove water from the tile systems and to remove excess surface water. Because some areas of these soils are ponded after heavy rains, tile intakes are needed to help remove excess surface water before ponding destroys the crops. Diversion terraces are built on some of the surrounding slopes to divert runoff, and these permit some areas of these soils to be cropped successfully.

These soils are usually too wet in spring to be plowed. Fall plowing allows earlier seedbed preparation in spring. Rough surface plowing that leaves crop residue exposed protects against soil blowing. These soils, especially the Lura soils, compress and clod readily if they are worked when wet.

If these soils are properly drained, they are suited to all crops commonly grown in the county. These soils should support a high plant population if they are properly fertilized. All crop residue should be returned to the soil to help maintain a high content of organic matter. Although these soils are high in natural fertility, application of a starter fertilizer is important because the soils are wet and warm up slowly in spring. Additional phosphate and potash are needed in many areas of the Talcot soils because of their high content of lime.

CAPABILITY UNIT IIIs–1

Kanaranzi loam, 0 to 2 percent slopes, is the only soil in this unit. It is a nearly level, somewhat excessively drained, medium-textured soil that is shallow to moderately deep to sand and gravel. The underlying limy sand or gravel is at a depth of 16 to 24 inches. This soil is on stream terraces and outwash plains on uplands. It is somewhat droughty during periods of normal rainfall. Soil blowing is a hazard. Available water capacity is low. Organic-matter content and fertility are high. Permeability is moderately rapid in the upper part of the soil and rapid in the underlying material.

This soil is suited to all the crops commonly grown in the county. All crop residue should be returned to the soil. Spring plowing reduces the risk of soil blowing. Stalks and stubble on the surface during winter help to trap and hold snow and conserve moisture. Heavy applications of manure help to maintain the content of organic matter. Legumes and grasses in the rotation also help to maintain the content of organic matter. This soil responds well to irrigation if it is adequately fertilized.

CAPABILITY UNIT IVe–1

This unit consists of deep, moderately steep, well-drained and somewhat excessivly drained soils that are medium textured and moderately fine textured. These soils are on uplands. They are in the Clarion, Everly, and Storden series. The hazard of erosion is very severe. Available water capacity is high. Organic-matter content and fertility are moderate in the Storden soils and high in the Clarion and Everly soils. Permeability is moderate.

Under good management, these soils are suited to small grain and alfalfa, but they tend to be droughty on the steeper slopes because of rapid runoff. Eroded spots can be made more productive by heavy applications of manure. These soils are too steep for terracing, but contour stripcropping helps to control erosion. If the soils are stripcropped, a higher percentage of small grain and

meadow and a lower percentage of row crops should be maintained in the cropping sequence. Spring plowing also reduces the hazard of erosion. Diversion terraces, in addition to contour stripcropping, are needed on the longer slopes. Waterways should be shaped, seeded, and maintained.

A considerable acreage of these soils is in permanent pasture. Native grasses can be maintained by careful management of grazing. Pastures that are mostly Kentucky bluegrass can be made more productive by renovating and reseeding to a suitable mixture of grasses and legumes.

CAPABILITY UNIT IVe–2

This unit consists of deep, rolling and sloping, somewhat excessively drained and well-drained soils on uplands. These soils are moderately coarse textured, medium textured, and moderately fine textured. Some of them are shallow to sand and gravel. They are in the Clarion, Dickman, Estherville, Everly, and Storden series. Slopes range from 6 to 12 percent. Available water capacity is low in the Estherville and Dickman soils, but it is high in the other soils. The hazards of erosion and drought are severe. Many areas of these soils are too droughty for many crops. Small grain, hay, and pasture plants are suitable crops. Drought generally affects corn production.

Terraces generally are not used on these soils, because the terrace cuts may expose sand or gravel. Gullies and draws should be shaped and seeded to form grassed waterways. Much of the acreage is in permanent pasture. The best production of forage is obtained if pastures are grazed lightly in a system of rotation grazing.

CAPABILITY UNIT IVw–1

Lake beaches make up this unit. The soil material in this land type is variable in texture and drainage. Most areas have a sandy surface layer that is underlain by finer or coarser material, and they are so wet or so sandy and droughty that they are poorly suited to crops. Where adjoining soils have been drained, Lake beaches generally are farmed with the drained soils because they are in bands too narrow to be farmed separately. In some places where the sandy surface is thin, deep plowing mixes finer textured soil material into it and improves its available water capacity.

Many areas of Lake beaches are used for pasture. Beaches around lakes and undrained ponds are used for recreation and for wildlife habitat. Some of the beaches could be further developed for these purposes.

CAPABILITY UNIT VIe–1

This unit consists of deep, steep, well-drained and somewhat excessively drained soils that are medium textured and moderately fine textured. These soils are on uplands and are in the Clarion, Everly, and Storden series. The hazard of erosion is very severe. Available water capacity is high, but little water is available for plant growth because of rapid runoff. Organic-matter content and fertility are moderate to high. Permeability is moderate.

These soils are suited to controlled grazing and wildlife habitat. Pastures of native grasses can be maintained by carefully managed grazing.

CAPABILITY UNIT VIe–2

This unit consists of moderately steep, somewhat excessively drained and well-drained, medium-textured and moderately fine textured soils on uplands. These soils are in the Clarion, Estherville, Everly, and Storden series. Estherville soils are underlain by sand and gravel at a depth of 16 to 24 inches. The hazard of drought is very severe. The available water capacity is low in the Estherville soils and high in the other soils. Runoff is rapid. Organic-matter content and fertility are low. Permeability is moderately rapid in the upper part of the soil and rapid in the underlying material. The other soils in this unit are better suited to plant growth than the Estherville soils.

Soils in this unit are suited to pasture and to wildlife habitat. If areas are developed for wildlife, a combination of adapted shrubs, grasses, and legumes can be planted. Small grain can be grown as a nurse crop for alfalfa and grass. Pastures of native grass can be protected, improved, and maintained by careful management of grazing.

CAPABILITY UNIT VIw–1

This unit consists of deep, nearly level, poorly drained soils that are moderately fine textured. These soils are on bottom lands. They are frequently flooded by rains throughout the growing season and by runoff from melting snow. Soils of the Comfrey and Millington series and Alluvial land, frequently flooded, are in this unit. The texture and drainage of Alluvial land are variable. Most areas are cut up by stream meanders.

Most areas of these soils are in permanent pasture. Frequent flooding makes the soils unsuitable for cropping. Many areas would be suitable for crops if major improvements to stream channels were made. These soils are well suited to hay and pasture. Some areas of Kentucky bluegrass are suitable for renovation and reseeding to more desirable grasses and legumes. These soils are also suitable for wildlife habitat.

Stabilization of streambanks is needed in places where a creek or river makes a sharp turn.

CAPABILITY UNIT VIw–2

This unit consists of deep, nearly level, poorly drained soils that are moderately fine textured. These soils are in low depressions. They are in the Comfrey and Millington series. The Millington soil is calcareous throughout the profile, but the Comfrey soil is leached to a depth of 24 to 30 inches. The hazards of wetness and flooding are severe.

It is difficult to manage or improve these soils. They are too low to be drained and used for crops. Some areas are used for pasture, and some areas provide food, water, and shelter for wildlife.

CAPABILITY UNIT VIIIw–1

Marsh makes up this unit. Draining most areas of this land type is not feasible, and the feasibility of draining other areas has not been determined.

Marsh produces little grazing or wild hay because in most years it is covered by 1 foot to 3 feet of water. Cattails and other wetland plants grow profusely along the edges and in scattered clusters in the open water.

Marsh provides good habitat for waterfowl and muskrats. Upland game birds find food, cover, and nesting places around the edges.

Predicted yields

Table 2 gives predicted average yields per acre of the principal crops grown on the soils in the county. Yields are listed for two levels of management. Those in columns A are obtained under an average level, and those in columns B are obtained under a high level. Yields are not given for Gravel pits.

The average level consists of the management followed by some farmers in the county. Under this level of management, oats, flax, hay, soybeans, and pasture crops are seldom fertilized. Starter fertilizer or manure is used for corn. Crops in the rotation are mainly corn, soybeans, and small grain; and the acreage of legume-grass hay on the farm is too small to permit effective rotation of crops. A green-manure crop sometimes is seeded with the small grain. Erosion control practices are not used extensively. The poorly drained soils contain only a small amount of tile drainage, if any. The stands of corn range from 10,000 to 15,000 plants per acre and generally are not adjusted to the kind of soil or the amount of moisture. The seedbed is prepared and cultivated in the usual manner. Rotation grazing is not practiced.

The high level of management, which produces yields given in columns B, is followed by many farmers. Under this level of management, fertilizer is applied according to soil tests. Manure normally is available and is used. An optimum stand of corn is planted; the number of plants in the stand is adjusted to the kind of soil and the supply of moisture. The rotation includes a legume-grass mixture of green-manure crops. Erosion control practices are used where they are needed. The wet soils are drained by means of adequate surface drainage and some tile, but not necessarily by a complete drainage system. Other practices are a minimum amount of tillage and the return of large amounts of crop residue to the soil. Weeds, diseases, and insects are controlled. Pastures are seeded to a suitable mixture of grasses and legumes, and grazing is rotated or well managed. The immediate response of crops to these practices depends on past management of the soils.

The yields predicted were based on information received from several sources. Yields were measured on experimental plots on some soils in the county. Records of yields and of soil management practices were reported by farmers for crops on some of the soils. Information was obtained from a study of the productivity of specific soils conducted jointly by the Soil Conservation Service, the Agricultural Extension Service, and the Department

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*

[Yields in columns A are those expected under common management; those in columns B are expected under improved management. Absence of figure indicates crop is not suited to the soil or ordinarily is not grown on it]

Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*A.U.D.*[2]	*A.U.D.*[2]	*A.U.D.*[2]	*A.U.D.*[2]
Alluvial land	50	70	18	24	35	60	2.0	3.5	90	160	60	120
Alluvial land, frequently flooded											60	120
Biscay silty clay loam	60	75	20	28	40	60	1.5	3.0	65	160	55	105
Blue Earth silt loam	55	80	20	28	50	70	2.0	3.5	90	160	60	120
Canisteo clay loam	60	85	24	35	55	75	2.5	3.5	110	160	90	120
Clarion loam, 2 to 6 percent slopes	65	95	24	35	55	80	3.0	4.0	135	180	105	145
Clarion loam, 2 to 6 percent slopes, eroded	60	85	22	32	50	75	2.5	3.5	110	160	90	130
Clarion loam, 6 to 12 percent slopes	55	75	20	30	50	75	2.5	3.0	110	135	90	105
Clarion loam, 6 to 12 percent slopes, eroded	50	75	20	30	50	75	2.5	3.0	110	135	90	105
Clarion-Storden loams, 6 to 12 percent slopes, eroded	45	70	20	28	50	75	2.0	3.0	90	135	75	105
Clarion-Storden loams, 12 to 18 percent slopes, eroded	40	65			40	60	2.0	3.0	90	135	75	105
Clarion-Storden loams, 18 to 24 slopes											30	70
Clarion-Storden-Estherville loams, 2 to 6 percent slopes, eroded	45	70	18	24	40	60	2.0	3.0	90	135	75	105
Clarion-Storden-Estherville loams, 6 to 12 percent slopes, eroded	35	60	16	22	35	55	2.0	3.0	90	135	75	105
Clarion-Storden-Estherville loams, 12 to 18 percent slopes, eroded					25	45	1.5	2.5	65	110	50	90
Collinwood silty clay, 1 to 4 percent slopes	65	90	26	38	55	75	3.0	4.5	135	200	105	145
Comfrey silty clay loam	65	90	26	38	50	75	3.0	4.0	135	200	105	145
Comfrey silty clay loam, frequently flooded											105	145
Comfrey silty clay loam, depressional											90	120
Dickman sandy loam, 0 to 6 percent slopes	40	60	16	22	40	60	1.5	3.0	65	135	55	105
Dickman sandy loam, 6 to 12 percent slopes, eroded	30	50	12	18	30	50	1.5	2.5	65	110	50	90
Estherville coarse sandy loam, 2 to 6 percent slopes	35	55	12	20	30	50	1.5	2.5	65	110	55	105

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under two levels of management*—Continued

Mapping unit	Corn		Soybeans		Oats		Rotation hay [1]		Rotation pasture		Permanent pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*A.U.D.*[2]	*A.U.D.*[2]	*A.U.D.*[2]	*A.U.D.*[2]
Estherville coarse sandy loam, 6 to 12 percent slopes, eroded	30	50	10	18	30	50	1. 5	2. 5	65	110	50	90
Estherville loam, 0 to 6 percent slopes	35	60	16	22	40	60	1. 5	3. 0	65	135	55	105
Everly clay loam, 2 to 6 percent slopes	60	80	24	36	55	75	3. 0	4. 5	135	200	105	145
Everly clay loam, 2 to 6 percent slopes, eroded	55	75	22	34	50	70	3. 0	4. 0	135	180	100	130
Everly clay loam, 6 to 12 percent slopes	50	70	20	32	45	65	2. 5	3. 5	110	160	90	120
Everly clay loam, 6 to 12 percent slopes, eroded	50	70	20	32	45	65	2. 5	3. 5	110	160	90	120
Everly-Storden complex, 6 to 12 percent slopes, eroded	45	70	20	32	45	65	2. 5	3. 5	110	160	90	120
Everly-Storden complex, 12 to 18 percent slopes, eroded					35	50	2. 0	3. 0	90	135	75	90
Everly-Storden complex, 18 to 24 percent slopes											30	70
Everly-Storden-Estherville complex, 2 to 6 percent slopes	45	70	18	24	40	60	2. 0	3. 0	90	135	75	105
Everly-Storden-Estherville complex, 6 to 12 percent slopes, eroded	35	60	16	22	35	55	2. 0	3. 0	90	135	75	105
Everly-Storden-Estherville complex, 12 to 18 percent slopes, eroded					25	45	1. 5	2. 5	65	110	50	90
Fairhaven silt loam, 0 to 2 percent slopes	45	65	16	24	45	65	2. 5	3. 0	110	135	90	105
Fairhaven silt loam, 2 to 6 percent slopes	45	60	14	22	40	60	2. 5	3. 0	110	135	90	105
Fairhaven silt loam, 2 to 6 percent slopes, eroded	40	60	14	22	40	60	2. 5	3. 0	110	135	90	105
Fairhaven silt loam, deep, 0 to 2 percent slopes	50	80	24	36	55	75	3. 0	4. 5	135	200	105	160
Fairhaven silt loam, deep, 2 to 6 percent slopes	50	75	22	32	50	75	3. 0	4. 5	135	200	105	160
Fairhaven silt loam, sandy subsoil, 0 to 2 percent slopes	45	65	16	24	45	65	2. 5	3. 0	110	135	90	105
Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes	45	60	14	22	40	60	2. 5	3. 0	110	135	90	105
Fairhaven silt loam, sandy subsoil, 2 to 6 percent slopes, eroded	40	60	14	22	40	60	2. 5	3. 0	110	135	90	105
Galva silty clay loam, 1 to 3 percent slopes	50	80	22	32	55	75	3. 0	4. 5	135	200	105	160
Glencoe silty clay loam	55	85	24	36	55	80	3. 0	4. 5	135	200	105	160
Kanaranzi loam, 0 to 2 percent slopes	45	65	16	24	40	60	2. 0	3. 0	90	135	60	105
Kanaranzi loam, 2 to 6 percent slopes	40	60	16	22	40	60	2. 0	3. 0	90	135	60	105
Kingston silty clay loam	70	90	26	38	60	80	3. 0	4. 5	135	200	105	160
Kingston silty clay loam, loamy subsoil variant, 0 to 2 percent slopes	70	90	26	38	60	80	3. 0	4. 5	135	200	105	160
Kingston silty clay loam, loamy subsoil variant, 2 to 6 percent slopes	70	90	26	36	60	80	3. 0	4. 5	135	200	105	160
Lake beaches	15	25	8	12	20	40	1. 5	3. 0	65	135	55	105
Letri silty clay loam	60	90	26	38	60	80	3. 0	4. 5	135	200	105	160
Lura silty clay	50	80	22	32	50	75	3. 0	4. 5	135	200	105	160
Marcus-Spicer silty clay loams	60	90	26	38	60	80	3. 0	4. 5	135	200	105	160
Marsh												
Millington silty clay loam	70	90	26	38	60	80	3. 0	3. 5	135	160	105	120
Millington silty clay loam, frequently flooded											105	120
Millington silty clay loam, depressional											90	120
Nicollet clay loam	70	90	26	38	60	80	3. 0	4. 5	135	200	105	160
Primghar silty clay loam	70	90	26	38	60	80	3. 0	4. 5	135	200	105	165
Ransom silty clay loam	70	90	26	38	60	80	3. 0	4. 5	135	200	105	165
Rushmore silty clay loam	70	90	24	36	60	75	3. 0	4. 5	135	200	105	165
Sac silty clay loam, 1 to 3 percent slopes	70	85	24	36	60	80	3. 0	4. 5	135	200	105	165
Sac silty clay loam, 3 to 5 percent slopes, eroded	65	80	22	34	55	75	3. 0	4. 5	135	200	105	165
Spicer silty clay loam	70	90	24	35	60	75	3. 0	4. 5	135	200	105	165
Spillville loam	60	75	20	28	50	75	3. 0	4. 5	135	200	105	165
Talcot silty clay loam	40	65	12	22	40	65	2. 0	3. 0	90	135	60	105
Terril loam, 2 to 6 percent slopes	65	85	24	32	60	80	3. 0	4. 5	135	200	105	165
Wadena loam, 0 to 2 percent slopes	50	70	18	26	50	75	2. 5	3. 5	110	160	90	120
Wadena loam, 2 to 6 percent slopes	45	65	16	24	50	70	2. 5	3. 5	110	160	90	120
Waldorf silty clay	65	90	26	38	55	80	3. 0	4. 5	135	200	105	165
Webster clay loam	65	90	26	38	55	80	3. 0	4. 5	135	200	105	165
Webster silty clay loam	65	90	26	38	55	80	3. 0	4. 5	135	200	105	165
Wilmonton silty clay loam	65	90	26	38	55	80	3. 0	4. 5	135	200	105	165

[1] Estimates are for alfalfa-bromegrass mixtures. Yields of mixtures of timothy and either red clover or alsike clover are 10 to 25 percent less.

[2] Animal-unit-days (A.U.D.) is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of days the pasture can be grazed during a single grazing season without injury ot the sod. An acre of pasture that provides 30 days of grazing for 2 cows has a carrying capacity of 60 animal-unit-days.

of Soils, University of Minnesota. Observation of crops were made and farmers were interviewed during the course of the survey. The predictions were judged in relation to soil properties that are known to affect the growth of crops. The predictions were compared with those made for similar soils in other counties and were checked against average yields that are reported in data from the agricultural census.

The yields given in table 2 are those obtainable where present farming practices and varieties of crops are used. As the technology of farming advances, increased yields per acre might be obtained. It is also possible that plant diseases and pests might cause average yields to be less than those predicted here.

Because the climate, especially rainfall, varies from year to year, the predicted yields are averages to be expected over a period of about 10 years. Some differences in yields are to be expected in different areas of the same soil, because some variations in a soil are allowable when soils are classified.

Yields are not predicted for crops on soils that are not suited to those crops. Although it is possible to grow crops on soils that are steep, shallow to gravel, poorly drained, or subject to flooding, the yields obtained are not likely to be worth the effort.

Field and Farmstead Windbreaks [3]

The chief use of trees and shrubs in Nobles County is for farmstead windbreaks. Some field windbreaks also are planted. Windbreaks help block out strong or cold winds, reduce wind damage, reduce dust, provide protection for livestock in feedlots, reduce feed costs for livestock, reduce heating costs, control snow drifts, and protect orchards and gardens. Wildlife is benefited, esthetic qualities are improved, and outdoor living is made more enjoyable by windbreaks. This section lists the trees and shrubs that can be grown for field and farmstead windbreaks. The soils have been placed in windbreak suitability groups, and table 3 gives performance ratings of the woody plants on soils of all but one of the groups.

Woodland in Nobles County occupies less than 1 percent of the acreage and is mainly along streams and lake banks. Some of the common trees are green ash, American elm, oaks, cottonwood, soft maple, and boxelder.

A windbreak suitability group is made up of soils that are suited to similar trees and shrubs. Other factors considered in grouping the soils are species to plant or to favor, seedling mortality, plant competition, erosion hazard, and equipment limitations.

The trees and shrubs suitable for farmstead windbreaks are listed in table 3. Because aspect, or direction in which a slope faces, affects the performance of trees and shrubs on soils in suitability group 5, ratings are given for north- and east-facing slopes and for south- and west-facing slopes. Group 7 is not included in the table, because the soils of this group normally are too wet to be rated.

Performance of each species on soils in the first six groups is rated as *preferred*, *acceptable*, or *not recommended*. The species rated as acceptable can be expected to grow, but they are not so desirable as the preferred species. Species rated as not recommended are not suitable for planting on the soils in the group.

These performance ratings are based on soil and plant characteristics that affect growth and survival of trees and shrubs listed in table 3. Texture, depth, wetness, soil reaction, stoniness, steepness, and direction of slope are important soil characteristics. The discussions of the windbreak suitability groups that follow tell how these soil characteristics affect the performance of the trees and shrubs. Suggestions about the preparation of sites for planting also are given.

Windbreak suitability groups

Some of the hazards and limitations rated in the discussions of windbreak suitability groups require explanation.

Seedling mortality refers to the expected loss of naturally occurring or planted seedlings as a result of unfavorable soil characteristics. Mortality is *slight* if the expected loss is less than 25 percent. It is *moderate* if the expected loss is between 25 to 50 percent. Mortality is *severe* if the expected loss is more than 50 percent.

Plant competition refers to encroachment of competing vegetation on a desired species. Competition is *slight* if competing vegetation does not cause mortality or restrict growth of seedlings. It is *moderate* if the invading plants delay but do not prevent the establishment of a normal, fully stocked stand of a desired species. Competition is *severe* if grass, brush, or undesirable trees prevent adequate regeneration, and intensive site preparation and maintenance are needed.

The equipment limitations are *slight* if there are no restrictions on the type of equipment or on the time of year that the equipment can be used. The limitation is *moderate* if the use of equipment is restricted by slope or wetness of soil for no more than 3 months, or if the use of equipment damages tree roots to some extent. The limitation is *severe* if the use of normal equipment is restricted or limited more than 3 months per year.

The erosion hazard is the degree of potential loss of soil by wind or water. Plant cover, slope, and soil properties are important factors. The hazard is *slight* if erosion is not significant. It is *moderate* if normal measures are needed to prevent unnecessary loss of soil. It is *severe* if special care and methods are needed to minimize loss and deterioration of the soil.

Each windbreak group is discussed in the pages that follow. The names of soil series represented are mentioned in the description of each windbreak group, but this does not mean that all soils of a given series appear in the unit. The names of all soils in any given windbreak group can be found by referring to the "Guide to Mapping Units" at the back of this survey. Additional information about windbreaks can be obtained from local technicians of the Soil Conservation Service and of the Extension Service.

WINDBREAK SUITABILITY GROUP 1

The group consists of deep, somewhat poorly drained to somewhat excessively drained, medium-textured and moderately fine textured soils. In this group are soils of the Clarion, Collinwood, Everly, Fairhaven, Galva, Kingston, Nicollet, Primghar, Ransom, Sac, Spillville, Storden,

[3] JOHN HULTGREN, woodland conservationist, Soil Conservation Service, helped prepare this section.

TABLE 3.—*Performance ratings for various species of shrubs and trees on soils of the windbreak suitability groups*

[Performance ratings are: 1, preferred; 2, acceptable; and 3, not recommended. Group 7 is not shown, because the soils in that group are too wet to be rated]

Species of shrubs and trees	Windbreak suitability groups						
	1	2	3	4	5		6
					North and east slopes	South and west slopes	
Ash, green	1	1	1	2	1	2	1
Caragana	2	3	3	2	2	1	1
Crab apple	1	3	3	2	2	3	1
Elm, Siberian	2	2	1	2	1	1	2
Hackberry	1	2	2	3	2	3	1
Honeylocust	1	2	2	1	1	2	1
Honeysuckle	1	2	2	2	1	1	1
Lilac, common or villosa	1	3	3	1	1	2	1
Maple, Ginnala	1	2	3	3	1	3	2
Maple, soft	1	1	1	3	3	3	2
Pine, ponderosa	1	3	3	1	1	1	1
Pine, white	1	3	3	2	1	2	1
Plum, American	1	2	2	1	1	1	1
Poplar, hybrid	1	1	1	3	2	3	2
Redcedar, eastern	2	3	3	1	2	1	1
Russian-olive	2	2	1	1	2	1	1
Spruce	1	3	3	2	1	2	1
White-cedar, northern	1	1	2	3	3	3	2
Willow	2	1	1	3	2	3	2

Terril, and Wilmonton series and Kingston, loamy subsoil variant. Except for the Spillville and Fairhaven soils, these soils are on uplands. The Spillville soil is on the high parts of the bottom lands, and the Fairhaven soils are on terraces and outwash plains. Slopes range from 0 to 12 percent.

Except for the Storden and Collinwood soils, the soils in this group have few characteristics that are detrimental to growth and survival of the trees and shrubs listed in table 3. The Storden soils are high in lime, and the Collinwood soil has a texture that is too fine for good growth of trees and shrubs. The hazard of soil blowing is slight on most of the cultivated soils, and the hazard of water erosion is slight on the sloping soils. The soils of this group are deep, and their texture and drainage allow deep penetration of moisture and deep, uniform distribution of roots.

All the soils in this group have a high available water capacity, and they hold enough moisture to permit trees to survive during short droughts. The reaction in the surface layer and subsoil of all except the Storden soils ranges from slightly acid to mildly alkaline. This is the range most suitable for the trees and shrubs listed in table 3. Seedling mortality is slight, plant competition is severe, and equipment limitations are slight.

WINDBREAK SUITABILITY GROUP 2

This group consists of deep and moderately deep, moderately fine textured and fine textured, poorly drained and very poorly drained soils in the Biscay, Comfrey, Glencoe, Letri, Lura, Marcus, Rushmore, Waldorf, and Webster series and Alluvial land. These nearly level soils are in depressions and on upland flats.

Wetness of the soils in this group limits the kinds of trees and shrubs that can be grown successfully. Willow and poplar grow well, but spruce does not. Texture of the soils generally is favorable for trees and shrubs, but the Lura and Waldorf soils have too fine a texture for a good growth of these plants. Other soil characteristics are favorable, especially depth, reaction, and available water capacity. Trees or shrubs rarely die because of drought. Plant competition is severe. Equipment limitations are moderate to severe. Erosion hazard is slight. If soils in this group are adequately drained, they are suited to about the same species as the soils in group 1. Many areas of these soils have been artificially drained.

WINDBREAK SUITABILITY GROUP 3

This group consists of medium-textured and moderately fine textured, poorly drained or very poorly drained, limy soils in the Blue Earth, Canisteo, Millington, Spicer, and Talcot series. These nearly level soils are on flats and in depressions on uplands and bottom lands. Except for the Talcot soils, which are moderately deep over sand and gravel, these soils are deep.

Wetness and a high content of lime limit the kinds of trees and shrubs that are suited to these soils. The excessive lime interferes with the intake of nutrients in many woody plants. Chlorosis, generally caused by a deficiency of available iron, affects many trees and shrubs on these soils. The affected plants are yellowish and stunted, and they are likely to die unless the condition is corrected. Seedling mortality is severe. Plant competition and equipment limitations are severe. The hazard of erosion is slight.

Surface drainage is needed if trees are planted on these soils. Open ditches or tile drains lower the water table. Lowering the water table increases the depth of the rooting zone.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep to shallow, moderately coarse textured and medium-textured soils that have slopes ranging from 0 to 18 percent. These soils are on uplands and on stream terraces and terrace escarpments. They are in the Dickman, Estherville, and Kanaranzi series. These soils are sandy loam and loam over deep sand or sand and gravel.

Soils in this group have a low available water capacity. Seedling mortality normally is moderate, but trees and shrubs in windbreaks are likely to have a high mortality if drought occurs while they are young. Some trees and shrubs tend to have a shorter life than the same species growing on deep, medium-textured soils. Plant competition is slight to moderate. Equipment limitation is slight.

The hazard of soil blowing is slight to moderate. Field windbreaks are effective in controlling soil blowing, but care is needed while the trees or shrubs are young to keep them from being damaged by windblown particles or soil. A cover of grass or the residue from a crop of corn or sorghum helps to protect the soil against blowing. If windbreaks are planted on the contour, moisture is conserved and this helps the trees make uniform, rapid growth.

WINDBREAK SUITABILITY GROUP 5

This group consists of deep, medium-textured and moderately fine textured, well-drained and somewhat excessively drained soils. These moderately steep and steep soils are on uplands. They are in the Clarion, Everly, and Storden series. Separate performance ratings have been made for windbreaks on north- and east-facing slopes and on south- and west-facing slopes.

Seedling mortality is slight to severe, depending on the aspect and position on slope. Conditions are less favorable on hot, dry slopes facing south and west. More species of trees and shrubs can be grown on the cooler, more moist slopes facing north and east. The north- and east-facing slopes along most streams in the county are naturally wooded, and south- and west-facing slopes are naturally grassed. Plant competition and hazard of erosion are moderate to severe.

Equipment limitations are moderate. The soils are too steep and erodible to permit plowing and fallowing of planted sites. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees or shrubs.

WINDBREAK SUITABILITY GROUP 6

This group consists of moderately deep, medium-textured, well-drained soils in the Fairhaven and Wadena series. These nearly level and gently sloping soils are on uplands and stream terraces. They are underlain by sand or gravel at a depth of 2 to 3 feet.

These soils have moderate available water capacity. The surface layer and subsoil are silt loam or loam. The soil reaction is slightly acid to mildly alkaline. Trees and shrubs on these soils are affected by drought sooner than those on the deep soils in group 1, but not so soon as those on the shallow soils of group 4.

Seedling mortality is slight to moderate. Plant competition is moderate. Weeds and grass need to be controlled while the trees and shrubs are young because competition for moisture is likely to be critical. The erosion hazard is slight to moderate. Equipment limitations are slight.

WINDBREAK SUITABILITY GROUP 7

This group consists of Alluvial land, frequently flooded; Lake beaches; Marsh; and soils in the Comfrey and Millington series. These land types and soils are wet and subject to frequent flooding. Each area needs to be investigated to determine its suitability for windbreaks.

Suitability of Soils For Wildlife Habitat

The soils of Nobles County vary in their suitability to provide habitat for various wildlife species. Different kinds of soil have different potentials for producing various components of wildlife habitat, and there is a distinct interrelationship between different kinds of plants on various soils and the animals associated with these plants. Table 4 gives the wildlife habitat potential for the soil associations of Nobles County. The associations are shown on the general soil map at the back of this survey.

The soils in the Webster-Clarion-Nicollet association are well suited to producing habitat components that the ring-necked pheasant requires. Clarion soils produce high-quality grasses and legumes that the pheasant uses for nesting and escape cover. They also produce high-quality food plants and woody winter cover needed by pheasant. Undrained Webster soils produce areas of high-quality cattails and of sedges and water-tolerant grasses, all of which provide nesting and escape cover. Where drained, Webster soils are suited to high-quality row crops, such as corn and soybeans, which provide food for pheasant.

The pheasant population is high in Nobles County, and the largest population is in the Everly-Sac-Rushmore association. The land-use pattern appears to be changing toward more intensive row cropping of corn and soybeans. This changing land use will affect the future population of pheasant.

Some deer are found throughout the county, but most of them are concentrated in the bottom lands of the Comfrey-Millington-Spillville association.

Seedings on ditchbanks and field borders provide cover for many kinds of wildlife. Farm shelterbelts provide habitat for squirrels and mourning doves, as well as winter cover for pheasants.

A fairly high population of Hungarian partridge is throughout the county. Suitability for other game birds and animals is rated in table 4.

TABLE 4.—*Potential for production of wildlife habitat by soil association*

Soil association [1]	Suitability for production of habitat for [2]—				
	Ring-necked pheasant and Hungarian partridge	Duck, mink, and muskrat	Squirrels and rabbits	White-tailed deer	Songbirds
1. Webster-Clarion-Nicollet	Well suited	Suited [3]	Well suited	Suited	Well suited.
2. Everly-Sac-Rushmore	Well suited	Unsuited	Well suited	Suited	Well suited.
3. Webster-Nicollet	Well suited	Suited [3]	Well suited	Suited	Well suited.
4. Fairhaven-Kanaranzi-Wadena	Well suited	Suited	Well suited	Suited	Well suited.
5. Comfrey-Millington-Spillville	Suited	Well suited	Suited	Suited	Suited.
6. Everly-Storden	Well suited	Unsuited	Well suited	Suited	Well suited.
7. Dickman-Fairhaven	Suited	Unsuited	Suited	Suited	Suited.

[1] See general soil map.
[2] Habitat is managed as required.
[3] Undrained, poorly drained, or very poorly drained soils have a potential for wetland development.

Engineering Uses of the Soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5 and 6, which show, respectively, several estimated soil properties significant in engineering and interpretations of the soils for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 5 and 6, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 5 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists that are not known to all engineers. The Glossary defines many of these terms commonly used in soil science.

Information pertaining to parent materials and geology is given under "Parent Material" in the section "Formation and Classification of the Soils," and under "Physiography, Relief, and Drainage" in the section "General Nature of the County."

Some of the information useful in engineering can be obtained from the soil map. It may be necessary, however, to refer to other parts of this survey. By using the information on the soil map, the description of soil profiles, and the tables in this subsection, the soils engineer can plan a detailed survey of the soil at a construction site.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*7*) used by the SCS engineers, Department of Defense, and others, and the AASHO system adopted by the American Association of State Highway Officials (*1*). Additional information is given in the PCA Primer (*3*).

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SF, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML–CL.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated classification, without group index numbers, is given in table 5 for all soils mapped in the survey area.

Estimated soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Depth to bedrock is not given in the table, because the soils in the county are so deep over bedrock that the rock does not affect the use of the soils.

[4] CLARENCE P. SIMONSON, agricultural engineer, Soil Conservation Service, helped prepare this section.

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 referring to other series that

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
Alluvial land: Ad, Af. Too variable to estimate.	*Feet*	*Inches*			
Biscay: Bc	0–2	0–20	Silty clay loam	OL or CL	A–7
		20–34	Loam	ML	A–4
		34–60	Coarse sand and gravel	SP–SM or GP–GM	A–1
Blue Earth: Br	0–2	0–42	Silt loam	OL or CL	A–7
		42–60	Clay loam	ML or CL	A–6 or A–7
Canisteo: Ca	0–2	0–17	Clay loam	OL or CL	A–7
		17–32	Clay loam	CL or CH	A–6 or A–7
		32–60	Clay loam	CL	A–6
*Clarion: ClB, ClB2, ClC, ClC2, CnC2, CnD2, CnE, CoB2, CoC2, CoD2. For properties of Storden soils in mapping units CnC2, CnD2, CnE, CoB2, CoC2, and CoD2, refer to the Storden series. For properties of Estherville soils in mapping units CoB2, CoC2, and CoD2, refer to the Estherville series.	5+	0–19	Loam	OL or ML	A–6
		19–32	Loam	ML or CL	A–6
		32–60	Loam	ML or CL	A–6
Collinwood: CrB	3–5	0–17	Silty clay	OH or CH	A–7
		17–34	Silty clay	MH or CH	A–7
		34–60	Silty clay loam	ML or CL	A–6 or A–7
Comfrey: Cs, Ct, Cu	0–2	0–36	Silty clay loam	OH or CH	A–7
		36–44	Silty clay loam	CH or CL	A–7
		44–60	Loam	ML or CL	A–6
Dickman: DcB, DcC2	5+	0–31	Sandy loam	SM	A–2 or A–4
		31–60	Fine and medium sand	SP–SM	A–3
Estherville:					
EaB, EaC2	5+	0–10	Coarse sandy loam	SM	A–2 or A–4
		10–20	Coarse sandy loam	SM	A–2
		20–60	Coarse sand	SP–SM	A–1
EbB	5+	0–10	Loam	ML	A–6
		10–20	Sandy loam	SM	A–2
		20–60	Coarse sand	SP–SM	A–1
*Everly: EcB, EcB2, EcC, EcC2, EsC2, EsD2, EsE, EvB, EvC2, EvD2. For properties of Storden soils in mapping units EsC2, EsD2, EsE, EvB, EvC2, and EvD2, refer to the Storden series. For properties of Estherville soils in mapping units EvB, EvC2, and EvD2, refer to the Estherville series.	5+	0–16	Clay loam	OL or ML	A–4 or A–6
		16–33	Clay loam	ML or CL	A–6
		33–60	Clay loam to loam	ML or CL	A–6
Fairhaven:					
FaA, FaB, FaB2	5+	0–12	Silt loam	OL or ML	A–4
		12–22	Silty clay loam	ML or CL	A–6 or A–7
		22–26	Loam	ML	A–4
		26–60	Sand and gravel	SW–SM	A–1
FbA, FbB	5+	0–16	Silt loam	OL or ML	A–4
		16–44	Silty clay loam	ML or CL	A–4 or A–6
		44–60	Sand and gravel	SW–SM	A–1
FeA, FeB, FeB2	5+	0–12	Silt loam	OL or ML	A–4
		12–22	Silty clay loam	ML or CL	A–6 or A–7
		22–26	Loam	ML	A–4
		26–60	Fine sand	SM	A–3

significant in engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for appear in the first column of this table]

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 17–0. 19	6. 6–7. 8	Moderate.
45–60	30–40	25–30	5–10	6. 30–20. 0	0. 02–0. 04	6. 6–7. 8	Low.
95–100	95–100	95–100	90–100	0. 63–2. 0	0. 18–0. 23	7. 4–8. 4	Moderate.
98–100	95–98	85–98	70–90	0. 63–2. 0	0. 16–0. 18	7. 4–8. 4	Moderate.
98–100	95–100	85–98	70–90	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
95–100	95–100	85–95	65–80	0. 63–2. 0	0. 15–0. 19	7. 4–8. 4	Moderate.
95–100	90–100	80–95	65–80	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.
95–100	95–100	80–95	55–70	0. 63–2. 0	0. 20–0. 22	6. 1–6. 5	Moderate.
95–100	95–100	80–95	55–70	0. 63–2. 0	0. 17–0. 19	6. 1–7. 8	Moderate.
95–100	85–95	75–90	55–70	0. 63–2. 0	0. 17–0. 19	7. 4–7. 8	Moderate.
100	100	95–100	90–95	0. 2–0. 63	0. 14–0. 17	6. 1–6. 6	High.
100	100	95–100	90–100	0. 2–0. 63	0. 13–0. 16	6. 1–6. 6	High.
100	95–100	95–100	95–100	0. 2–0. 63	0. 11–0. 15	6. 6–7. 8	High.
100	95–100	85–98	75–90	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	95–100	85–98	75–90	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
100	95–100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
95–100	90–100	55–75	20–40	2. 0–6. 3	0. 13–0. 15	6. 1–7. 3	Low.
95–100	90–100	70–75	5–12	6. 3–20. 0	0. 05–0. 07	7. 4–7. 8	Low.
95–100	90–95	70–75	20–40	2. 0–6. 3	0. 12–0. 14	6. 1–6. 6	Low.
95–100	90–100	70–75	20–30	2. 0–6. 3	0. 11–0. 13	6. 1–7. 3	Low.
90	70–80	40–50	5–10	6. 3–20. 0	0. 02–0. 04	7. 4–7. 8	Low.
100	95–100	80–90	50–75	2. 0–6. 3	0. 17–0. 19	6. 1–6. 6	Low.
100	95–100	70–75	20–35	2. 0–6. 3	0. 12–0. 14	6. 1–7. 3	Low.
90	70–80	40–50	5–10	6. 3–20. 0	0. 02–0. 04	7. 4–7. 8	Low.
100	100	90–100	70–80	0. 63–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 15–0. 19	6. 1–7. 8	Moderate.
100	100	85–95	65–75	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 22–0. 24	6. 1–7. 3	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 16–0. 19	6. 1–7. 3	Moderate.
100	100	80–90	60–75	0. 63–2. 0	0. 17–0. 19	6. 1–7. 8	Moderate.
50–70	35–45	25–35	5–12	6. 3–20. 0	0. 02–0. 04	7. 4–7. 8	Low.
100	100	95–100	85–95	0. 63–2. 0	0. 22–0. 24	6. 1–7. 3	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 20–0. 22	6. 6–7. 8	Moderate.
50–70	35–45	25–35	5–12	6. 3–20. 0	0. 02–0. 04	7. 4–7. 8	Low.
100	100	95–100	85–95	0. 63–2. 0	0. 22–0. 24	6. 1–7. 3	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 16–0. 19	6. 1–7. 3	Moderate.
100	100	80–90	60–75	0. 63–2. 0	0. 17–0. 19	6. 1–7. 3	Moderate.
100	100	65–80	5–10	6. 3–20. 0	0. 05–0. 07	7. 4–7. 8	Low.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Galva: GaB	5+	0–15	Silty clay loam	OL or ML	A–7 or A–4
		15–36	Silty clay loam	CL or ML	A–7 or A–6
		36–44	Silt loam	ML	A–4
		44–60	Clay loam	ML or CL	A–6
Glencoe: Gc	0–2	0–28	Silty clay loam	OH or OL	A–7
		28–38	Silty clay loam	CH	A–7
		38–60	Clay loam	CL	A–6
Gravel pits: Gp. Too variable to estimate.					
Kanaranzi: KaA, KaB	5+	0–19	Loam	ML	A–4
		19–22	Sandy loam	SM	A–2 or A–4
		22–60	Sand and gravel	SW–SM	A–1
Kingston: Kc	3–5	0–19	Silty clay loam	OL–CL	A–4 or A–7
		19–37	Silty clay loam	CL	A–6 or A–7
		37–60	Silty clay loam	CL	A–6 or A–7
Kingston, loamy subsoil variant: KlA, KlB	3–5	0–15	Silty clay loam	OL or CL	A–4 or A–7
		15–30	Silty clay loam	CL	A–6 or A–7
		30–60	Clay loam	CL	A–6 or A–7
Lake beaches: La. Too variable to estimate.					
Letri: Le	0–2	0–8	Silty clay loam	OL or ML	A–4 or A–7
		8–32	Clay loam	CL or ML	A–6
		32–60	Clay loam	CL or ML	A–6
Lura: Lu	0–2	0–31	Silty clay	OH or CH	A–7
		31–38	Silty clay	CH	A–7
		38–60	Silty clay	CH	A–7
*Marcus: Ma. For properties of Spicer soils, refer to the Spicer series.	0–2	0–19	Silty clay loam	OL or CL	A–7
		19–36	Silty clay loam	CL	A–7
		36–43	Silty clay loam	CL	A–7
		43–60	Clay loam	CL	A–6
Marsh: Mb. Too variable to estimate.					
Millington: Mn, Mo, Mp	0–2	0–30	Silty clay loam	OH or CL	A–7
		30–40	Loam	CL	A–4
		40–60	Loam	CL	A–4
Nicollet: Nc	3–5	0–20	Clay loam	CL	A–7
		20–28	Clay loam	ML or CL	A–6 or A–7
		28–60	Clay loam	ML or CL	A–6 or A–7
Primghar: Pr	3–5	0–16	Silty clay loam	OH or CL	A–7
		16–30	Silty clay loam	CL	A–6
		30–44	Silty clay loam	CL	A–6
		44–60	Clay loam	ML	A–6

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 1–7. 3	Moderate.
100	100	100	90–100	0. 63–2. 0	0. 16–0. 19	6. 1–7. 3	Moderate.
100	100	95–100	85–95	2. 0 –6. 3	0. 20–0. 22	6. 6–7. 8	Moderate.
100	95–100	90–100	70–80	0. 63–2. 0	0. 14–0. 16	6. 6–7. 8	Moderate.
100	95–100	85–98	75–90	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	85–100	85–98	75–90	0. 63–2. 0	0. 18–0. 22	6. 6–7. 8	Moderate.
98–100	95–100	80–98	70–85	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
95–100	95–100	80–95	50–70	2. 0–6. 3	0. 20–0. 22	6. 1–7. 3	Low.
95–100	95–100	60–80	20–40	2. 0–6. 3	0. 12–0. 14	7. 4–7. 8	Low.
50–70	35–45	25–35	0–12	6. 3–20. 0	0. 02–0. 04	7. 4–7. 8	Low.
100	98–100	95–100	90–98	0. 63–2. 0	0. 18–0. 22	6. 1–7. 3	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 16–0. 19	7. 4–7. 8	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 18–0. 22	6. 1–7. 3	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
98–100	95–100	80–98	70–85	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
95–100	95–100	95–100	80–95	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
95–100	90–100	85–95	75–85	0. 63–2. 0	0. 14–0. 16	6. 6–7. 8	Moderate.
95–100	90–100	85–95	70–75	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
100	98–100	95–100	90–98	0. 06–0. 2	0. 14–0. 17	6. 6–7. 3	High.
100	98–100	95–100	90–98	0. 06–0. 2	0. 13–0. 16	6. 6–7. 8	High.
100	98–100	95–100	90–98	0. 06–0. 2	0. 11–0. 15	6. 6–7. 8	High.
100	100	95–100	90–100	0. 63–2. 0	0. 18–0. 22	6. 1–7. 8	Moderate.
100	100	95–100	95–100	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
100	100	95–100	95–100	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
98–100	95–100	80–98	70–85	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
100	100	95–100	90–95	0. 63–2. 0	0. 18–0. 22	7. 4–8. 4	Moderate.
100	100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
100	100	80–90	60–75	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
98–100	95–100	85–98	65–85	0. 63–2. 0	0. 17–0. 19	6. 1–7. 3	Moderate.
95–100	95–100	80–95	60–80	0. 63–2. 0	0. 15–0. 19	6. 1–7. 8	Moderate.
95–100	95–100	80–95	60–80	0. 63–2. 0	0. 15–0. 19	7. 4–8. 4	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 18–0. 22	6. 6–7. 8	Moderate.
100	98–100	95–100	90–98	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
98–100	95–100	80–90	70–85	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.

TABLE 5.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Ransom: Ra	3–5	0–16	Silty clay loam	OL or ML	A–7
		16–33	Silty clay loam	ML or CL	A–6 or A–7
		33–60	Clay loam	CL	A–6
Rushmore: Ru	0–2	0–18	Silty clay loam	OL or OH	A–7
		18–28	Silty clay loam	MH or CL	A–7
		28–60	Clay loam	CL	A–6
Sac: SaA, SaB2	5–10	0–12	Silty clay loam	OL or OH	A–7
		12–30	Silty clay loam	MH or CL	A–7
		30–60	Clay loam	CL	A–6
Spicer: Sp	0–2	0–20	Silty clay loam	OL or OH	A–7
		20–48	Silty clay loam	MH or CL	A–7
		48–60	Clay loam	CL	A–6
Spillville: Sv	0–5	0–28	Loam	OL or ML	A–4
		28–38	Sandy loam	SM	A–2 or A–4
		38–60	Loam	ML	A–4
Storden	10+	0–7	Loam	ML	A–4
Mapped only in complexes with Clarion, Estherville, and Everly soils.		7–60	Loam	ML	A–4
Talcot: Ta	0–2	0–27	Silty clay loam	OL or CL	A–7
		27–33	Loam	ML	A–4
		33–60	Sand and gravel	SP–SM	A–1
Terril: TeB	3–5	0–27	Loam	OL or ML	A–4
		27–36	Clay loam	CL	A–6
		36–60	Clay loam	CL	A–6
Wadena: WaA, WaB	0–2	0–12	Loam	OL or ML	A–4
		12–28	Loam	ML	A–4
		28–60	Sand and gravel	SP–SM	A–1
Waldorf: Wb	0–2	0–23	Silty clay	OH or CH	A–7
		23–60	Silty clay	CH	A–7
Webster: We, Wf	0–2	0–20	Clay loam	OH or CL	A–7
		20–30	Clay loam	CL	A–6
		30–60	Clay loam	CL	A–6
Wilmonton: Wm	3–5	0–14	Silty clay loam	OL or ML	A–7
		14–31	Clay loam	CL	A–6
		31–60	Clay loam	CL	A–6

significant in engineering—Continued

Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH value*	
100	95–100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	95–100	95–100	85–95	0. 63–2. 0	0. 16–0. 19	6. 6–7. 8	Moderate.
95–100	90–100	85–95	65–75	0. 63–2. 0	0. 14–0. 16	7. 6–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	100	95–100	85–95	0. 2–0. 63	0. 16–0. 19	6. 6–7. 8	Moderate.
95–100	90–100	90–100	65–75	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 1–7. 3	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 16–0. 19	6. 1–7. 3	Moderate.
95–100	90–100	90–100	65–75	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	7. 4–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 16–0. 19	7. 4–8. 4	Moderate.
95–100	90–100	90–100	65–75	0. 63–2. 0	0. 14–0. 16	7. 4–7. 8	Moderate.
100	100	85–95	60–75	0. 63–2. 0	0. 20–0. 22	6. 6–7. 8	Moderate.
100	100	60–70	30–40	2. 0–6. 3	0. 12–0. 14	6. 6–7. 8	Low.
100	100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	6. 6–8. 4	Moderate.
95–100	95–100	85–95	60–75	0. 63–2. 0	0. 20–0. 22	7. 4–7. 8	Moderate.
95–100	95–100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	7. 4–8. 4	Moderate.
95–100	95–100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	7. 4–8. 4	Moderate.
65–90	60–80	20–45	5–10	6. 3–20. 0	0. 02–0. 04	7. 4–8. 4	Low.
100	100	85–95	60–75	0. 63–2. 0	0. 20–0. 22	6. 1–7. 3	Moderate.
95–100	90–100	90–100	70–80	0. 63–2. 0	0. 15–0. 19	6. 6–8. 4	Moderate.
95–100	90–100	90–100	70–80	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.
100	100	85–95	60–75	0. 63–2. 0	0. 20–0. 22	6. 1–7. 3	Moderate.
100	100	85–95	60–75	0. 63–2. 0	0. 17–0. 19	6. 1–7. 3	Moderate.
65–90	60–80	20–45	5–10	6. 3–20. 0	0. 02–0. 04	6. 6–7. 8	Low.
100	100	95–100	90–95	0. 2–0. 63	0. 14–0. 17	6. 1–7. 3	High.
100	100	95–100	90–95	0. 2–0. 63	0. 13–0. 16	6. 6–8. 4	High.
100	100	90–100	70–80	0. 63–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 15–0. 19	6. 6–7. 8	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 14–0. 16	6. 6–8. 4	Moderate.
100	100	95–100	85–95	0. 63–2. 0	0. 18–0. 22	6. 6–7. 3	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 15–0. 19	6. 6–7. 8	Moderate.
100	100	90–100	70–80	0. 63–2. 0	0. 14–0. 16	7. 4–8. 4	Moderate.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Alluvial land: Ad, Af	Poor: wet	Poor	Poor: wet	Flooding; variable materials.	Variable materials.	Flooding; variable materials.
Biscay: Bc	Poor: poorly drained.	Fair below a depth of 3 feet.	Fair below a depth of 3 feet: high water table.	Seasonal high water table; lower horizons porous.	Low permeability in upper 3 feet when compacted; high permeability below a depth of 3 feet when compacted.	Seasonal high water table.
Blue Earth: Br	Poor: highly calcareous; poorly drained.	Not suitable	Poor: poor compaction; moderate shrink-swell potential.	Not applicable	Poor stability; high permeability when compacted.	Seasonal high water table.
Canisteo: Ca	Poor: poorly drained.	Not suitable	Poor: moderate shrink-swell potential; high susceptibility to frost action.	Seasonal high water table; more than 5 percent organic matter.	Seasonal high water table; fair to good stability.	Seasonal high water table.
Clarion: C1B, C1B2	Good	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action.	Moderate permeability; gently undulating slopes.	Fair stability; fair resistance to piping; low permeability when compacted, moderate shrink-swell potential.	Drainage not needed; well drained.
C1C, C1C2	Good	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action.	Slopes of 6 to 12 percent.	Fair stability; fair resistance to piping; low permeability when compacted; moderate shrink-swell potential.	Drainage not needed; well drained.
CnC2	Fair: surface layer is thin in some places.	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action.	Slopes of 6 to 12 percent.	Fair stability; fair resistance to piping; low permeability when compacted; moderate shrink-swell potential.	Drainage not needed; well drained.
CnD2	Fair: surface layer is thin in some places.	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action.	Slopes of 12 to 18 percent.	Fair stability; fair resistance to piping; low permeability when compacted; moderate shrink-swell potential.	Drainage not needed; well drained.

See footnotes at end of table.

engineering properties

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Not needed	Not needed	Severe: flooding	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Not needed	Moderately deep over sand and gravel; moderate available water capacity.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; moderate shrink-swell potential.	Severe: seasonal high water table; seasonal flooding.	Severe: rapid permeability below a depth of 3 feet; seasonal high water table.	Severe: seasonal high water table; rapid permeability below a depth of 3 feet.
Not needed	Deep soil; high available water capacity.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; low shear strength; moderate shrink-swell potential.	Severe: seasonal high water table; occasional ponding.	Severe: high organic-matter content; seasonal high water table.	Severe: seasonal high water table; occasional ponding.
Not needed	Deep soil; high available water capacity; moderate permeability.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; moderate permeability.	Severe: high organic-matter content in upper 18 inches; seasonal high water table.	Severe: seasonal high water table; moderately fine texture.
All features favorable.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action.	Moderate: moderate shrink-swell potential; medium bearing capacity; medium shear strength.	Slight	Moderate: moderate permeability; slopes of 2 to 6 percent.	Slight.
All features favorable.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action.	Moderate: moderate shrink-swell potential; medium bearing capacity; medium shear strength.	Moderate: moderate permeability; slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight.
All features favorable.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action.	Moderate: moderate shrink-swell potential; medium bearing capacity; medium shear strength.	Moderate: moderate permeability; slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight.
Slopes of 12 to 18 percent.	Slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Clarion—Continued CnE	Fair: surface layer is thin in some places.	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action.	Slopes of 18 to 24 percent.	Fair stability; fair resistance to piping; low permeability when compacted; moderate shrink-swell potential.	Drainage not needed; well drained.
CoB2	Fair: surface is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to moderate shrink-swell potential.	Variable soil material; rapid permeability in some areas.	Variable soil material; low to high permeability when compacted.	Drainage not needed; well drained and somewhat excessively drained.
CoC2	Fair: surface is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to moderate shrink-swell potential.	Slopes of 6 to 12 percent; low to high permeability when compacted.	Variable soil material; low to high permeability when compacted.	Drainage not needed; well drained and somewhat excessively drained.
CoD2	Fair: surface is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to moderate shrink-swell potential.	Slopes of 12 to 18 percent; low to high permeability when compacted.	Variable soil material; low to high permeability when compacted.	Drainage not needed; well drained and somewhat excessively drained.
Collinwood: CrB	Poor: fine texture; poor workability.	Not suitable	Poor: high susceptibility to frost action; high shrink-swell potential.	Low permeability when compacted; slow seepage rate.	Poor stability and compaction characteristics; high shrink-swell potential.	Not needed
Comfrey: Cs	Poor: poorly drained.	Not suitable	Poor: fair to low shear strength; low bearing capacity; moderate shrink-swell potential.	Moderate seepage rate; seasonal high water table; occasional flooding; suitable for pits.	Occasional flooding; seasonal high water table; low permeability when compacted; fair resistance to piping; high organic-matter content in upper 3 feet.	Poorly drained; moderate permeability; suitable outlet channel must be developed.
Ct, Cu	Poor: poorly drained.	Not suitable	Poor: fair to low shear strength; low bearing capacity; moderate shrink-swell potential.	Moderate seepage rate; frequent flooding; poor workability; suitable for pits.	Frequent flooding; high organic-matter content in upper 3 feet; seasonal high water table; poor workability.	Frequent flooding; adequate outlets not available in most places.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Slopes of 18 to 24 percent.	Slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.
Soils shallow to sand and gravel in places.	Deep and shallow soils; high and low available water capacity.	Slight	Slight	Slight: sandy substratum can permit contamination of ground water.	Severe: some areas with rapid permeability below a depth of 2 feet.	Slight: areas with rapid permeability can permit contamination of ground water.
Soils shallow to sand and gravel in places.	Deep and shallow soils; high and low available water capacity.	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight: areas with rapid permeability can permit contamination of ground water.
Slopes of 12 to 18 percent.	Slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.
Fine-textured soil.	Deep soil; moderate to high available water capacity; slow intake rate.	Moderate: high shrink-swell potential; susceptible to frost action.	Moderate: high shrink-swell potential; seasonal high water table at a depth of 3 to 5 feet.	Severe: low percolation rate; moderately slow permeability.	Moderate: high organic-matter content; moderately slow permeability.	Severe: seasonal high water table at a depth of 3 to 5 feet; fine texture.
Tiling needed before waterway construction; poor workability when wet.	High available water capacity; moderately slow intake rate.	Severe: seasonal high water table; high susceptibility to frost action; occasional flooding; moderate shrink-swell potential.	Severe: occasional flooding; seasonal high water table; moderate shrink-swell potential; low to fair shear strength.	Severe: seasonal high water table; occasional flooding.	Severe: seasonal high water table; high organic-matter content in upper 3 feet.	Severe: seasonal high water table; occasional flooding; moderately fine texture; poor trafficability.
Not needed	Not applicable	Severe: frequent flooding; seasonal high water table.	Severe: frequent flooding; seasonal high water table.	Severe: frequent flooding; seasonal high water table.	Severe: frequent flooding; seasonal high water table.	Severe: frequent flooding; seasonal high water table.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Dickman: DcB	Fair to a depth of 12 to 16 inches: low available water capacity.	Good for sand below a depth of 2 feet.	Good: all features favorable.	Rapid permeability below a depth of 2 feet.	High permeability below a depth of 2 feet when compacted; low resistance to piping.	Not needed; well drained.
DcC2	Fair to a depth of 12 to 16 inches: low available water capacity.	Good for sand below a depth of 2 feet.	Good: all features favorable	Rapid permeability below a depth of 2 feet; slopes of 6 to 12 percent.	High permeability below a depth of 2 feet when compacted; low resistance to piping.	Not needed; well drained.
Estherville: EaB, EaC2, EbB.	Fair to a depth of 12 inches: low available water capacity.	Good for sand and gravel below a depth of 2 feet.	Good: all features favorable.	Not suitable: rapid permeability; rapid seepage below a depth of 2 feet.	High permeability when compacted; low resistance to piping.	Not needed; well drained.
Everly: EcB, EcB2	Good to a depth of 12 to 18 inches.	Not suitable	Fair: moderate shrink-swell potential; good workability; good compaction characteristics.	Moderate permeability; slow seepage rate; slopes of 2 to 6 percent.	Fair stability; low permeability when compacted; good resistance to piping; moderate erodibility.	Not needed; well drained.
EcC, EcC2	Good to a depth of 6 to 10 inches.	Not suitable	Fair: moderate shrink-swell potential; good workability; good compaction characteristics.	Moderate permeability; slow seepage rate; slopes of 6 to 12 percent.	Fair stability; low permeability when compacted; good resistance to piping; moderate erodibility.	Not needed; well drained.
EsC2	Good to a depth of 4 to 10 inches.	Not suitable	Fair: moderate shrink-swell potential; good compaction characteristics; good workability.	Moderate permeability; slow seepage rate; slopes of 6 to 12 percent.	Fair stability; low permeability when compacted; good resistance to piping; moderate erodibility.	Not needed; well drained.
EsD2	Fair to a depth of 4 to 8 inches. Surface layer in Storden soil is low in organic-matter content.	Not suitable	Fair: moderate shrink-swell potential; good compaction characteristics; good workability.	Moderate permeability; slopes of 12 to 18 percent.	Fair to good stability; low to medium permeability when compacted; good resistance to piping; moderate shrink-swell potential.	Not needed; well drained.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Generally not needed; droughty and difficult to establish seeding.	Low available water capacity; rapid intake rate; frequent applications required.	Slight	Slight	Slight to severe: rapid permeability can permit contamination of ground water.	Severe: rapid permeability in sand below a depth of 2 feet.	Severe: rapid permeability can permit contamination of ground water.
Generally not needed; droughty and difficult to establish seeding.	Low available water capacity; rapid intake rate; frequent applications required.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent; rapid permeability can permit contamination of ground water.	Severe: rapid permeability in sand below a depth of 2 feet.	Severe: rapid permeability can permit contamination of ground water.
Generally not needed; droughty and difficult to establish seeding; sand and gravel at a depth of 2 feet.	Low available water capacity; rapid intake rate; frequent applications required.	Slight: moderate on slopes of 6 to 12 percent.	Slight	Slight to severe: rapid permeability can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 feet.	Severe: rapid permeability can permit contamination of ground water.
Most soil features are favorable; low fertility in substratum if exposed; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Moderate: good bearing capacity; moderate shrink-swell potential; moderate susceptibility to frost action; slopes of 2 to 6 percent.	Slight	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 6 percent.	Slight.
Most soil features are favorable; low fertility in substratum if exposed; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight.
Most soil features are favorable; low fertility if substratum is exposed.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight.
Slopes of 12 to 18 percent.	Slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Everly—Continued						
EsE	Fair to a depth of 4 to 8 inches. Surface layer in Storden soil is low in organic-matter content.	Not suitable	Fair: moderate shrink-swell potential; good compaction characteristics; good workability.	Severe: slopes of 18 to 24 percent.	Fair to good stability; low to medium permeability when compacted; good resistance to piping; moderate shrink-swell potential.	Not needed; well drained.
EvB	Fair: surface layer is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to medium permeability when compacted; fair shear strength; moderate to low shrink-swell potential.	Variable soil material; low to medium permeability when compacted.	Variable soil material; low to medium permeability when compacted.	Not needed; well drained and somewhat excessively drained.
EvC2	Fair: surface layer is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to medium permeability when compacted; fair shear strength; moderate to low shrink-swell potential.	Low to medium permeability when compacted; slopes of 6 to 12 percent.	Variable soil material; low to medium permeability when compacted.	Not needed; well drained and somewhat excessively drained.
EvD2	Fair: surface layer is thin in some places.	Not suitable to good: small pockets of sand and gravel.	Fair to good: variable soil material; low to medium permeability when compacted; fair shear strength; moderate to low shrink-swell potential.	Slopes of 12 to 18 percent.	Variable soil material; low to medium permeability when compacted.	Not needed; well drained and somewhat excessively drained.
Fairhaven:						
FaA	Good in upper 12 inches.	Fair for gravel below a depth of 2 feet. Good for sand below a depth of 2 feet.	Good: all features are favorable.	Rapid permeability below a depth of 2 feet.	High permeability below a depth of 2 feet when compacted; fair shear strength; low resistance to piping.	Not needed; well drained.
FaB, FaB2	Good in upper 12 inches.	Fair for gravel below a depth of 2 feet. Good for sand below a depth of 2 feet.	Good: all features are favorable.	Rapid permeability below a depth of 2 feet.	High permeability below a depth of 2 feet when compacted; fair shear strength; low resistance to piping.	Not needed; well drained.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Slopes of 18 to 24 percent.	Slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.
Soils thin over sand and gravel in places.	Deep soil and shallow soil; high and low available water capacity.	Slight	Slight	Slight: coarse substratum can permit contamination of ground water.	Severe: some areas with rapid permeability below a depth of 2 feet.	Slight: hazard of pollution in areas with rapid permeability.
Soils thin over sand and gravel in places.	Deep soil and shallow soil; high and low available water capacity.	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Severe: slopes of 6 to 12 percent.	Slight: hazard of pollution in areas with rapid permeability.
Slopes of 12 to 18 percent.	Slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.
Generally not needed; sand and gravel at a depth of 2 or 3 feet; difficult to establish seeding.	Moderately deep to sand and gravel; medium intake rate; suitable for irrigation.	Slight	Slight	Slight: coarse substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 feet.	Severe: rapid permeability below a depth of 2 feet; hazard of pollution.
Generally not needed; sand and gravel at a depth of 2 or 3 feet; difficult to establish seeding.	Moderately deep to sand and gravel; medium intake rate; suitable for irrigation.	Slight	Slight	Slight: coarse substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 feet.	Severe: rapid permeability below a depth of 2 feet; hazard of pollution.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Fairhaven—Con. FbA, FbB	Good in upper 12 inches.	Fair for gravel below a depth of 3 feet. Good for sand below a depth of 3 feet.	Good: all features are favorable.	Rapid permeability below a depth of 3 feet.	High permeability below a depth of 3 feet when compacted; fair shear strength; low resistance to piping.	Not needed; well drained.
FeA	Good in upper 12 inches.	Poor for gravel. Good for sand below a depth of 2 feet.	Good: all features are favorable.	Rapid permeability below a depth of 2 feet.	High permeability below a depth of 2 feet when compacted; fair shear strength; low resistance to piping.	Not needed; well drained.
FeB, FeB2	Good in upper 6 to 12 inches.	Good for sand below a depth of 2 feet.	Good: all features are favorable.	Rapid permeability below a depth of 2 feet.	High permeability when compacted.	Not needed; well drained.
Galva: GaB	Good in upper 10 to 20 inches.	Not suitable	Fair: moderate shrink-swell potential; moderate susceptibility to frost action; fair shear strength.	Moderate permeability; slow seepage rate; depth to water table is usually more than 10 feet.	Fair stability; low permeability when compacted.	Not needed; well drained.
Glencoe: Gc	Poor: very poorly drained.	Not suitable	Poor: seasonal high water table; poor shear strength; low bearing capacity; high susceptibility to frost action.	Seasonal high water table; occasional ponding; moderately slow permeability.	Low permeability when compacted; fair resistance to piping; occasional ponding; fair stability; poor workability.	Seasonal high water table; very poorly drained; moderately slow permeability.
Gravel pits: Gp. Too variable to estimate.						
Kanaranzi: KaA, KaB.	Fair: loam 6 to 12 inches thick.	Good for sand and gravel below a depth of 2 feet.	Good in substratum; high shear strength; low compressibility.	Porous substratum has rapid permeability.	Medium permeability in upper 20 inches when compacted.	Not needed; well drained.
Kingston: Kc	Fair: silty clay loam 12 to 18 inches thick.	Not suitable	Poor: moderate shrink-swell potential; moderate susceptibility to frost action; low bearing capacity; low shear strength; poor stability.	Low permeability when compacted; slow seepage rate.	Low resistance to piping; low shear strength; low to medium permeability when compacted.	Not needed; moderately well drained.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Generally not needed; sand and gravel at a depth of 3 feet; difficult to establish seeding.	Deep to sand and gravel; medium intake rate: suitable for irrigation.	Slight	Slight	Slight: coarse substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 3 feet.	Severe: rapid permeability below a depth of 3 feet; hazard of pollution.
Generally not needed; sand and gravel at a depth of 2 or 3 feet; difficult to establish seeding.	Moderately deep to sand and gravel; medium intake rate; suitable for irrigation.	Slight	Slight	Slight: sandy substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 feet.	Severe: rapid permeability below a depth of 2 feet; hazard of pollution.
Generally not needed; sand at a depth of 2 feet; difficult to establish seeding.	Moderately deep soil; moderate available water capacity; medium intake rate; well suited to irrigation.	Slight	Slight	Slight: sandy substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 feet.	Severe: rapid permeability below a depth of 2 feet; hazard of pollution.
Soil features favorable; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Slight	Moderate: fair bearing capacity and shear strength.	Slight	Moderate: moderate permeability; slopes of 1 to 3 percent.	Slight.
Not needed	Deep soil; high available water capacity; slow intake rate.	Severe: seasonal high water table; occasional ponding; moderately low permeability; moderate shrink-swell potential.	Severe: seasonal high water table; occasional ponding; very poorly drained.	Severe: seasonal high water table; occasional ponding; moderate permeability.	Severe: seasonal high water table; high organic-matter content in upper 2 or 3 feet.	Severe: very poorly drained; seasonal high water table.
Shallow to sand and gravel; difficult to establish seeding.	Low available water capacity; medium intake rate; well suited to irrigation; frequent applications required.	Slight	Slight	Slight: coarse substratum can permit contamination of ground water.	Severe: rapid permeability below a depth of 20 inches.	Severe: rapid permeability below a depth of 20 inches can permit contamination of ground water.
Not needed; slopes of 0 to 3 percent.	High available water capacity; deep soil; low water intake rate.	Moderate: moderate shrink-swell potential; high susceptibility to frost action.	Severe: low shear strength; low bearing capacity; moderate shrink-swell potential.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: high organic-matter content in upper 12 to 18 inches; seasonal high water table at a depth of 3 to 5 feet.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; moderate shrink-swell potential.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Kingston, loamy subsoil variant: KlA	Fair: silty clay loam 12 to 18 inches thick.	Not suitable	Poor: moderate shrink-swell potential; moderate susceptibility to frost action; low bearing capacity; low shear strength; poor stability.	Low permeability when compacted; slow seepage rate.	Low resistance to piping; low shear strength; low to medium permeability when compacted.	Not needed; moderately well drained.
KlB	Fair: silty clay loam 12 to 18 inches thick.	Not suitable	Poor: moderate shrink-swell potential; moderate susceptibility to frost action; low bearing capacity; low shear strength; poor stability.	Low permeability when compacted; slow seepage rate.	Low resistance to piping; low shear strength; low to medium permeability when compacted.	Not needed; moderately well drained.
Lake beaches: La	Poor: wet in some areas.	Variable materials	Variable materials	Variable materials	Variable materials	Adequate outlets not available.
Letri: Le	Poor: poorly drained.	Not suitable	Poor: seasonal high water table; low bearing capacity; poor shear strength; high organic-matter content.	Moderate permeability; slow seepage rate; high organic-matter content.	Poor shear strength; moderate shrink-swell potential; fair resistance to piping.	Moderate permeability; seasonal high water table.
Lura: Lu	Poor: very poorly drained; fine texture.	Not suitable	Poor: seasonal high water table; high susceptibility to frost action; high shrink-swell potential.	Seasonal high water table; occasional ponding; slow permeability.	Low permeability when compacted; high resistance to piping; high organic-matter content in upper 30 inches; poor workability.	Very poorly drained; seasonal high water table; slow permeability.
Marcus: Ma	Poor: poorly drained.	Not suitable	Fair to poor: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential; fair shear strength.	Moderate permeability; slow seepage rate; high organic-matter content in upper 18 inches.	Seasonal high water table; low permeability when compacted; fair resistance to piping; fair stability.	Seasonal high water table; moderate permeability; poorly drained.
Marsh: Mb	Poor: very wet.	Not suitable.	Poor: very wet.	Soils under water.	Soils under water.	Soils under water.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Not needed; slopes of 0 to 2 percent.	High available water capacity; deep soil; slow intake rate.	Moderate: moderate shrink-swell potential; high susceptibility to frost action.	Severe: low shear strength; low bearing capacity; moderate shrink-swell potential.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: high organic-matter content in upper 12 to 18 inches; seasonal high water table at a depth of 3 to 5 feet.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; moderate shrink-swell potential.
All soil features favorable.	High available water capacity; deep soil; slow intake rate.	Moderate: moderate shrink-swell potential; high susceptibility to frost action.	Severe: low shear strength; low bearing capacity; moderate shrink-swell potential.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: high organic-matter content in upper 12 to 18 inches.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; moderate shrink-swell potential.
Not needed	Not needed	Severe: wet in most areas.	Severe: seasonal high water table in most areas.	Severe: seasonal high water table in most areas.	Severe: seasonal high water table in most areas.	Severe: seasonal high water table in most areas.
Tiling helps installation of waterways.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; moderate susceptibility to frost action; moderate shrink-swell potential.	Severe: seasonal high water table; moderate susceptibility to frost action.	Severe: seasonal high water table.	Severe: moderate permeability; high organic-matter content in upper 18 inches; seasonal high water table.	Severe: wet soil; seasonal high water table.
Not needed	Deep soil; high available water capacity; slow intake rate.	Severe: seasonal high water table; occasional ponding; high shrink-swell potential; high susceptibility to frost action.	Severe: seasonal high water table; occasional ponding; poor shear strength; high shrink-swell potential.	Severe: seasonal high water table.	Severe: seasonal high water table; high organic-matter content in upper 2 or 3 feet.	Severe: seasonal high water table; occasional ponding; poor workability; poor trafficability.
Tiling helps installation of waterways.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; moderate shrink-swell potential; high susceptibility to frost action.	Severe: seasonal high water table; high susceptibility to frost action; fair shear strength.	Severe: seasonal high water table.	Severe: seasonal high water table; high organic-matter content in upper 2 feet.	Severe: seasonal high water table; moderately fine textured soil.
Not needed	Not needed	Severe: soils under water.	Severe: soils under water.	Severe: soils under water.	Severe: soils under water.	Severe: soils under water.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Millington: Mn	Poor: poorly drained.	Not suitable	Fair to poor: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential; surface layer 30 inches thick and high in organic-matter content.	Seasonal high water table; medium permeability when compacted; high organic-matter content in upper 30 inches.	High compressibility; medium permeability when compacted; low shear strength; high organic-matter content in upper 30 inches.	Seasonal high water table; occasional flooding.
Mo, Mp	Poor: poorly drained.	Not suitable	Fair to poor: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential; surface layer 30 inches thick and high in organic-matter content.	Seasonal high water table; medium permeability when compacted; high organic-matter content in upper 30 inches.	High compressibility; medium permeability when compacted; low shear strength; high organic-matter content in upper 30 inches.	Seasonal high water table; frequent flooding and ponding.
Nicollet: Nc	Good in upper 20 inches.	Not suitable	Fair to good: fair bearing capacity; fair shear strength; fluctuating water table; moderate susceptibility to frost action.	Moderate permeability; high organic-matter content in upper 20 inches.	Low permeability when compacted; fair shear strength; fair resistance to piping; fair stability.	Not needed; moderately well drained.
Primghar: Pr	Fair in upper 16 inches.	Not suitable	Fair: fair bearing capacity; fair shear strength; moderate susceptibility to frost action.	Moderate permeability; high organic-matter content in upper 16 inches.	Low to medium permeability when compacted; fair stability; fair resistance to piping.	Not needed
Ransom: Ra	Fair in upper 17 inches: moderately fine texture.	Not suitable	Fair: fair shear strength; moderate to high susceptibility to frost action; fair bearing capacity.	Moderate permeability; high organic-matter content in upper 17 inches.	Low to medium permeability when compacted; fair stability; fair resistance to piping.	Not needed; moderately well drained.
Rushmore: Ru	Poor: poorly drained; seasonal high water table.	Not suitable	Poor: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential.	Moderately slow permeability; slow seepage rate; high organic-matter content in upper 18 inches.	Medium to low permeability when compacted; fair stability; fair shear strength; seasonal high water table.	Seasonal high water table; moderately slow permeability.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Tiling helps installation of waterways.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; occasional flooding; high susceptibility to frost action.	Severe: seasonal high water table; occasional flooding; high susceptibility to frost action; moderate shrink-swell potential.	Severe: seasonal high water table; occasional flooding.	Severe: flooding hazard; high organic-matter content in upper 30 inches; seasonal high water table.	Severe: seasonal high water table; flooding hazard.
Not needed	Not needed	Severe: seasonal high water table; occasional flooding; high susceptibility to frost action.	Severe: seasonal high water table; occasional flooding; high susceptibility to frost action; moderate shrink-swell potential.	Severe: seasonal high water table; occassional flooding.	Severe: flooding hazard; high organic-matter content in upper 30 inches; seasonal high water table.	Severe: seasonal high water table; flooding hazard.
Generally not needed.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: moderate permeability; high organic-matter content in upper 20 inches.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; fair trafficability when wet.
Few limitations; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: moderate permeability; high organic-matter content in upper 16 inches.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; fair trafficability when wet.
Few limitations; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; fluctuating water table.	Moderate: moderate permeability; seasonal moderately high water table at a depth of 3 to 5 feet.	Moderate: moderate permeability; high organic-matter content in upper 17 inches.	Severe: seasonal high water table at a depth of 3 to 5 feet; fair workability; fair trafficability.
Tiling helps construction and establishment of waterway seeding.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table.	Severe: moderate permeability; high organic-matter content in upper 18 inches; seasonal high water table.	Severe: seasonal high water table; poorly drained.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Sac: SaA	Good in upper 12 inches.	Not suitable	Fair: moderate to high susceptibility to frost action; fair shear strength; good compaction characteristics.	Moderate permeability; slow seepage rate; seasonal water table is at a depth of more than 5 feet.	Fair stability; low permeability when compacted; fair shear strength; good workability.	Not needed; well drained.
SaB2	Good in upper 12 inches.	Not suitable	Fair: moderate to high susceptibility to frost action; fair shear strength; good compaction characteristics.	Slopes of 3 to 5 percent.	Fair stability; low permeability when compacted; fair shear strength; good workability.	Not needed; well drained.
Spicer: Sp	Poor: poorly drained; seasonal high water table.	Not suitable	Poor: low bearing capacity; poor shear strength; poor stability; high susceptibility to frost action.	Seasonal high water table; low permeability when compacted; high organic-matter content in upper 20 inches.	Seasonal high water table; poor stability; low resistance to piping; high organic-matter content in upper 20 inches.	Seasonal high water table; moderate permeability.
Spillville: Sv	Good in upper 38 inches.	Not suitable	Poor: high organic-matter content in upper 3 feet; fair shear strength; fair bearing capacity.	Moderate permeability; variable seepage rate; high organic-matter content in upper 3 feet.	High organic-matter content in upper 3 feet; medium permeability when compacted; occasional flooding; poor shear strength.	Not needed; moderately well drained soil.
Talcot: Ta	Poor: very poorly drained.	Fair: below a depth of 2 or 3 feet; seasonal high water table makes excavation difficult; occasional ponding.	Poor: seasonal high water table; occasional ponding.	Not applicable	Low permeability in upper 2 or 3 feet when compacted; rapid permeability below a depth of 2 or 3 feet.	Very poorly drained; moderate permeability in the upper 2 or 3 feet; seasonal high water table.
Terril: TeB	Good in upper 27 inches.	Not suitable	Fair: fair shear strength; fair bearing capacity; high organic-matter content in upper 27 inches.	Moderate permeability; high organic-matter content in upper 27 inches.	Low to medium permeability when compacted; fair stability; fair resistance to piping.	Not needed; moderately well drained.

See footnotes at end of table.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
All soil features are favorable.	Deep soil; high available water capacity; medium intake rate.	Slight: moderate susceptibility to frost action; good bearing capacity.	Slight: moderate shrink-swell potential; well drained.	Slight	Moderate: moderate permeability.	Slight.
All soil features are favorable.	Deep soil; high available water capacity; medium intake rate.	Slight: moderate susceptibility to frost action; good bearing capacity.	Slight: moderate shrink-swell potential; well drained.	Slight	Moderate: slopes of 3 to 5 percent.	Slight.
Tiling helps construction of waterways.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential.	Severe: seasonal high water table; high susceptibility to frost action; moderate shrink-swell potential.	Severe: seasonal high water table; poorly drained.	Severe: high organic-matter content in upper 20 inches; seasonal high water table.	Severe: seasonal high water table; poorly drained.
Terraces not needed; soil features favorable for waterways; occasional flooding.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; high susceptibility to frost action; occasional flooding; high organic-matter content in upper 3 feet.	Severe: seasonal high water table; high susceptibility to frost action; occasional flooding; high organic-matter content in upper 3 feet.	Severe: seasonal high water table; occasional flooding.	Severe: seasonal high water table; high organic-matter content in upper 3 feet; occasional flooding.	Severe: seasonal high water table; occasional flooding.
Tiling helps construction of waterways.	Not needed; occasional ponding.	Severe: seasonal high water table; high susceptibility to frost action; very poorly drained.	Severe: seasonal high water table; high susceptibility to frost action; very poorly drained.	Severe: seasonal high water table; very poorly drained.	Severe: substratum too porous to hold water.	Severe: seasonal high water table; very poorly drained.
All soil features favorable.	Deep soil; high available water capacity; medium intake rate.	Moderate: high susceptibility to frost action; possible seasonal high water table and sidehill seep.	Moderate: high susceptibility to frost action; possible seasonal high water table and sidehill seep.	Moderate: possible seasonal high water table; moderate permeability.	Moderate: high organic-matter content in upper 27 inches; possible seasonal high water table.	Severe: possible seasonal high water table for short periods; fair to good workability.

TABLE 6.—*Interpretations of*

Soil series and map symbols	Suitability as source of—			Soil features affecting—		
	Topsoil	Sand or gravel	Material for road fill	Pond reservoirs	Pond embankments	Agricultural drainage
Wadena: WaA	Good in upper 12 inches.	Good for sand and gravel below a depth of 2 or 3 feet.	Good: all soil features favorable below a depth of 2 or 3 feet.	Rapid permeability below a depth of 2 or 3 feet.	High permeability below a depth of 2 or 3 feet when compacted; low resistance to piping.	Not needed; well drained.
WaB	Good in upper 12 inches.	Good for sand and gravel below a depth of 2 or 3 feet.	Good: all soil features favorable below a depth of 2 or 3 feet.	Rapid permeability below a depth of 2 or 3 feet.	High permeability below a depth of 2 or 3 feet when compacted; low resistance to piping.	Not needed; well drained.
Waldorf: Wb	Poor: poorly drained; moderately fine texture.	Not suitable	Poor: seasonal high water table; high shrink-swell potential; high susceptibility to frost action; high organic-matter content in upper 23 inches.	Moderately slow permeability; slow seepage rate; seasonal high water table.	Seasonal high water table; fair stability; fair resistance to piping; poor workability.	Moderately slow permeability; seasonal high water table.
Webster: We, Wf	Poor: poorly drained.	Not suitable	Poor: seasonal high water table; high susceptibility to frost action; fair shear strength; high organic-matter content in upper 20 inches.	Moderate permeability; slow seepage rate; high organic-matter content in upper 20 inches.	Medium to low permeability when compacted; fair shear strength; high organic-matter content in upper 20 inches.	Seasonal high water table; moderate permeability.
Wilmonton: Wm	Fair to a depth of 17 inches; moderately fine texture.	Not suitable	Fair: moderate to high susceptibility to frost action; fair shear strength; fair bearing capacity.	Moderate permeability; slow seepage rate; high organic-matter content in upper 17 inches.	Low permeability when compacted; fair shear strength; fair resistance to piping; fair stability; high organic-matter content in upper 17 inches.	Not needed; moderately well drained.

[1] The surface layer, high in organic-matter content and usually removed, is not considered in the ratings.
[2] Engineers and others should not apply specific values to the estimates given for bearing capacity.

engineering properties—Continued

Soil features affecting—Continued		Degree and kinds of limitations for—				
Terraces and waterways	Irrigation	Local roads and streets [1]	Foundations for low buildings [2]	Septic tank absorption fields	Sewage lagoons	Sanitary land fill [3]
Generally not needed; difficult to establish seeding.	Moderately deep soil; moderate available water capacity; medium intake rate.	Slight	Slight	Slight: rapid permeability below a depth of 2 or 3 feet can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 or 3 feet.	Severe: rapid permeability below a depth of 2 or 3 feet can permit contamination of ground water.
Generally not needed; difficult to establish seeding.	Moderately deep soil; moderate available water capacity; medium intake rate.	Slight	Slight	Slight: rapid permeability below a depth of 2 or 3 feet can permit contamination of ground water.	Severe: rapid permeability below a depth of 2 or 3 feet.	Severe: rapid permeability below a depth of 2 or 3 feet can permit contamination of ground water.
Generally not needed.	Deep soil; moderate to high available water capacity; medium intake rate.	Severe: seasonal high water table; high susceptibility to frost action; high shrink-swell potential.	Severe: seasonal high water table; high susceptibility to frost action; high shrink-swell potential.	Severe: seasonal high water table; moderately slow permeability.	Severe: high organic-matter content in upper 23 inches; seasonal high water table.	Severe: seasonal high water table; poorly drained.
Tiling helps construction of waterways.	Deep soil; high available water capacity; medium intake rate.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; high susceptibility to frost action.	Severe: seasonal high water table; poorly drained.	Severe: moderate permeability; high organic-matter content in upper 20 inches; seasonal high water table.	Severe: seasonal high water table.
Few limitations; good slope pattern.	Deep soil; high available water capacity; medium intake rate.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; high organic-matter content in upper 17 inches.	Moderate: moderate shrink-swell potential; moderate susceptibility to frost action; high organic-matter content in upper 17 inches.	Moderate: moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Moderate: moderate permeability; high organic-matter content in upper 17 inches.	Severe: seasonal high water table at a depth of 3 to 5 feet.

[3] Onsite deep studies of the underlying strata, water table, and hazards of aquifer pollution and drainage into ground water need to be made for landfills deeper than 5 or 6 feet.

Explanations of the columns in table 5 follow.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is given in table 5 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. Loam, for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. Sand, silt, and clay are defined in the Glossary of this soil survey.

Permeability, as used in table 5, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on soil characteristics that influence porosity of the soil. Plowpans, surface crusts, and other properties resulting from use of the soils are not considered.

Available water capacity is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value, and relative terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials.

Interpretations of engineering properties

The estimated interpretations in table 6 are based on the engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Nobles County. In table 6, ratings are used to summarize suitability of the soils for topsoil, sand and gravel, and material for roadfill. In addition, soil features affecting pond embankments and reservoirs, agricultural drainage, terraces and waterways, and irrigation are given. Detrimental or undesirable features are emphasized, but very important desirable features also may be listed. Table 6 also rates the soils for limitation to use for local roads and streets, foundations for low buildings, septic tank absorption fields, sewage lagoons, and sanitary land fill. The information applies only to soil depths indicated in table 5, but it is reasonably reliable to depths of about 5 or 6 feet.

The suitability of a soil as a source of topsoil depends mainly on the thickness and quality of the surface layer, but a steep soil is less suitable than one that is level or gently sloping. Each particular deposit of sand or gravel needs to be examined to determine if the material is suitable for the use intended. Suitable sources of sand or gravel are available in the Estherville, Fairhaven, Kanaranzi, and Wadena soils. The Dickman and some of the Fairhaven soils are underlain by medium to fine sand. The poorly drained Biscay and the very poorly drained Talcot soils are underlain by sand and gravel.

In rating the suitability of soils for road fill, only the material below the surface layer has been considered. Some soils, for example, the Blue Earth, have a thick, highly organic surface layer. They are generally not suitable for road fill, because of the depth to the underlying mineral soil. Collinwood, Lura, and Waldorf soils have a high shrink-swell potential because of their high content of clay. If a subgrade consists mainly of such material, the pavement is likely to crack or warp when changes occur in the moisture content.

The poorly drained silty clay loams and clay loams, such as Canisteo, Comfrey, Glencoe, Letri, Marcus, Spicer, Millington, Rushmore, and Webster soils, are highly susceptible to the action of frost. Frost heaves and the subsequent frost boils affect the pavement and gravel roads throughout the county. Heaving by frost can be expected if 10 percent or more of the soil material passes a No. 200 sieve. The excessively drained and the well-drained soils are least susceptible if adequate drainage of the road is provided. Examples of the soils least susceptible to frost action are the Clarion, Estherville, Everly, Fairhaven, Galva, Kanaranzi, and Storden soils. The water table in all of these soils is deep. Frost heaves also are likely to occur where materials in the subgrade are not uniform and have different rates of expansion. Some deposits of glacial till contain lenses or pockets of fine sand or silt that cause differential frost heave. Where the subgrade for the highway is laid over glacial till, it should contain a thick enough layer of material that is not susceptible to frost heave so the pavement will not be damaged when freezing occurs.

The bearing capacity of most of the soils is good for highway locations. Exceptions are soils on bottom lands and soils in old lake beds and depressions. Such soils are in the Blue Earth, Comfrey, Glencoe, Lura and Millington series. Engineers and others, however, should not apply specific values to the estimates given for bearing capacity of soils.

Some good sites for farm ponds are in the deep drainageways that have side slopes of steep Storden soils. These drainageways provide good reservoir areas because Storden soils have a slow seepage rate. The underlying glacial till of the Storden soils is suitable for embankments. It has fair compaction characteristics and low permeability when compacted. Borings should be made in the reservoir area before a pond site is selected to determine the presence or extent of sandy lenses or gravelly pockets. The soil features listed under road fill apply also in the construction of embankments. Dikes or levees can be constructed on the Comfrey, Millington, and Spillville soils. Most of the material in the bottom lands is suitable for use in dikes or levees if it is well compacted.

Artificial drainage of the wet soils is needed for optimum production of crops. Surface drainage and tile drainage are needed on the very poorly drained Blue Earth and Glencoe soils.

Tile drainage is beneficial on the poorly drained Canisteo, Letri, Marcus, Rushmore, Spicer, Waldorf, and Webster soils. Many areas were drained in years past, and more tiling is now in progress. If suitable outlets can

be obtained, Comfrey and Millington soils are improved by tile drainage.

If row crops are grown extensively, terraces are the most practical method for water management and erosion control on slopes of less than 12 percent. Systems of parallel terraces can be laid out in sloping areas of Everly, Galva, and Sac soils. The Clarion soils have slopes that are irregular. On these irregular slopes, cuts and fills are likely to be needed for good alignment of terraces. Compaction of soil in the terrace channel is likely to be a problem if terraces are constructed in spring. The problem of compaction is less severe if terraces are constructed in fall because freezing and thawing help restore good structure before the next growing season. Diversion terraces are built mainly on slopes of more than 12 percent.

Grassed waterways are needed to conduct water in drainageways without causing excessive erosion. Sod is difficult to establish in waterways on highly erodible soils, especially on sandy and gravelly soils. On Dickman, Estherville, Fairhaven, Kanaranzi, and Wadena soils, replacement of topsoil may be necessary in a new waterway to encourage growth of grass. Tile drainage is needed to establish good grass sod in waterways in many areas of wet soils, such as the Canisteo, Letri, Marcus, Rushmore, Waldorf, and Webster soils.

Little irrigation has been done in Nobles County. The lack of water supplies has been a major factor. The nearly level Dickman, Fairhaven, Galva, Kanaranzi, and Sac soils that occupy broad areas in the southwestern part of the county have characteristics that make them well suited to sprinkler irrigation.

Also in table 6, limitations to construction and maintenance are rated for local streets and roads, foundations for low buildings, septic tank absorption fields, sewage lagoons, and sanitary land fill.

Local roads and streets have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material, a base consisting of gravel, crushed rock, or soil material stablized with lime or cement, and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from the soil at hand, and most cuts and fills are less than 6 feet deep. The Dickman, Estherville, and Wadena soils are examples of soils that have only slight limitations.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness, flooding, and a seasonal high water table affect stability of the material. Slope, depth to hard rock, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Foundations for low buildings are rated for buildings of not more than three stories that are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are a seasonal high water table, susceptibility to flooding, density, plasticity, texture, susceptibility to frost action, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks. The Dickman, Estherville, and Wadena soils are examples of soils that have only slight limitations.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 5 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow to effluent. Large rocks or boulders increase construction costs. The well-drained Clarion, Galva, Kingston, and Sac soils are generally well suited to absorption fields for septic tanks. The Dickman, Estherville, Fairhaven, Kanaranzi, and Wadena soils also are well suited if there is no danger of contaminating nearby water supplies.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet for a period long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Among those that affect the pond floor are permeability, content of organic matter, and slope. If the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified classification system and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material. All soils in Nobles County have some degree of limitations if they are used for sewage lagoons. The Collinwood soils and soils that formed in clay loam till, such as the Everly soils, provide the most favorable sites.

Sanitary land fill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil material throughout the disposal period. Land fill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for land fill are those that affect ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 6 apply only to a depth of about 5 feet, and therefore limitation ratings of slight or moderate may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected. There are large areas of Clarion, Everly, Galva, and Sac soils that have properties most suitable for sanitary land fills.

Soils and Recreation

The lakes, streams, and hills and the scenery in Nobles County provide ample opportunity for recreational development. City dwellers in increasing numbers are turning to outdoor activities for recreation. Owners of farms, woodlands, and lakeshores have an opportunity for new and potentially profitable enterprises, such as the development of facilities for camping, picnicking, fishing, hunting, golfing, and other forms of outdoor recreation. This section is designed to help determine the suitability of the various soils for recreational purposes. All soils have been treated as being in their natural condition. Practices such as intensive drainage, effective diking, and others can greatly alter the natural limitations. Such manmade alterations need to be considered during onsite evaluations.

In table 7 each soil in the county is rated for selected recreational purposes, and limitations for these uses are given. The ratings are based on soil features and do not include other features, such as land value, location, esthetic value, and features that may be important in selecting an area for the purpose stated. A rating of *slight* means that the soil has few or no limitations for the specified use or that the limitations can be easily overcome; a rating of *moderate* indicates the soil has limitations to use, but they can be overcome if management is good and design is careful; *severe* indicates that the soil has limitations that are difficult to overcome and that development is questionable.

Play areas for intensive use.—Table 7 shows that the soils have a wide range in limitations as play areas for intensive use. The ratings apply to areas to be developed for baseball, football, badminton, and similar organized games. These areas are subject to intensive foot traffic. The most desirable areas are nearly level, have good drainage, soil texture, and consistence that give a firm surface, and are free from flooding.

Picnic areas for intensive use.—Accommodations for picnicking should be uncrowded and should have suitable areas for parking cars. The ratings are based on soil features only. They do not include other factors that may affect the desirability of the site, such as trees, lakes in the area, fishing, swimming, or hiking. Soils selected for picnic areas for intensive use generally have good drainage, are nearly level to gently sloping, provide good footing, and are safe from flooding.

Paths and trails.—The soils also are rated according to limitations to their use for trails, local and cross-county hiking, bridle paths and nonintensive uses that allow for random movement of people. Areas that have slight limitations for paths and trails have good drainage, are not subject to flooding, are nearly level to rolling, and have a surface layer that provides good footing. Soils that have severe limitations have poor drainage, are subject to flooding, are steep, and do not provide good footing.

Buildings in recreational areas.—Detailed onsite investigations generally are required for the selection of a specific building site. Table 7 gives preliminary information on suitability of the soils for this use. The ratings apply to seasonal and year-round use of cottages, washrooms, bathhouses, picnic shelters, and service buildings. The ratings do not include the suitability of the soil for septic tanks and filter fields. Extreme care should be exercised to prevent lake and stream pollution. In areas where the soils are sandy or gravelly, adjacent to the lakes, the hazard of pollution is very great. In Nobles County most of the lakes in the eastern half of the county are surrounded by sand or gravel. On the lakes that are surrounded by loam glacial till, the hazard of pollution is not as great, because the effluent cannot move as rapidly through the soil. Soils that are most suitable for building sites in recreational areas have good drainage, are nearly level to gently sloping, and are not subject to flooding.

Camp areas for intensive use.—These areas are used for tents, trailers, and activities related to camping. Such areas are used frequently during the camping season. They should require little site preparation other than shaping and leveling to be made suitable for unsurfaced parking for cars, tent sites, and camp trailers. The soils should be suitable for heavy traffic by people and for limited traffic by motor vehicles. The most suitable sites have good drainage, are not subject to flooding, are nearly level to gently sloping, are not subject to blowing, and provide good footing in all kinds of weather.

TABLE 7.—*Degree and kind of limitation for specified recreational uses*

Soil series, land types, and map symbols	Play area for intensive use	Picnic areas for intensive use	Paths and trails	Buildings in recreational areas	Camp areas for intensive use
Alluvial land: Ad	Severe: seasonal high water table; occasional flooding.	Moderate: occasional flooding; seasonal high water table.	Moderate: occasional flooding.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.
Af	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.
Biscay: Bc	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Blue Earth: Br	Severe: very poorly drained.	Severe: very poorly drained.	Severe: very poorly drained.	Severe: very poorly drained.	Severe: very poorly drained.

TABLE 7.—*Degree and kind of limitation for specified recreational uses*—Continued

Soil series, land types, and map symbols	Play area for intensive use	Picnic areas for intensive use	Paths and trails	Buildings in recreational areas	Camp areas for intensive use
Canisteo: Ca	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Clarion:					
ClB, ClB2	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
ClC, ClC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
CnC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
CnD2	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Moderate: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.
CnE	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.
CoB2	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
CoC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
CoD2	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Moderate: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.
Collinwood: CrB	Severe: slippery and sticky when wet; slow permeability.	Severe: slippery and sticky when wet; slow permeability.	Severe: slippery and sticky when wet; slow permeability.	Severe: slippery and sticky when wet; slow permeability.	Severe: slippery and sticky when wet; slow permeability.
Comfrey:					
Cs	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.	Severe: occasional flooding; seasonal high water table.
Ct, Cu	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.	Severe: frequent flooding.
Dickman:					
DcB	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
DcC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
Estherville:					
EaB, EbB	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
EaC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
Everly:					
EcB, EcB2	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
EcC, EcC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
EsC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
EsD2	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Moderate: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.
EsE	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.	Severe: slopes of 18 to 24 percent.
EvB	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
EvC2	Severe: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.	Slight	Moderate: slopes of 6 to 12 percent.	Moderate: slopes of 6 to 12 percent.
EvD2	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Moderate: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.	Severe: slopes of 12 to 18 percent.

TABLE 7.—*Degree and kind of limitation for specified recreational uses*—Continued

Soil series, land types, and map symbols	Play area for intensive use	Picnic areas for intensive use	Paths and trails	Buildings in recreational areas	Camp areas for intensive use
Fairhaven: FaA, FbA, FeA.	Slight	Slight	Slight	Slight	Slight.
FaB, FaB2, FbB, FeB, FeB2.	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
Galva: GaB	Slight	Slight	Slight	Slight	Slight.
Glencoe: Gc	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.
Gravel pits: Gp. Limitations not estimated.					
Kanaranzi: KaA, KaB.	Slight	Slight	Slight	Slight	Slight.
Kingston: Kc, KlA, KlB.	Slight: moderate on slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
Lake beaches: La	Severe: seasonal high water table; frequent flooding.	Severe: seasonal high water table; frequent flooding.	Severe: seasonal high water table; frequent flooding.	Severe: seasonal high water table; frequent flooding.	Severe: seasonal high water table; frequent flooding.
Letri: Le	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Lura: Lu	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table.	Severe: very poorly drained: seasonal high water table.	Severe: very poorly drained; seasonal high water table.
Marcus: Ma	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Marsh: Mb	Severe: too wet	Severe: too wet	Severe: too wet	Severe: too wet	Severe: too wet.
Millington: Mn	Severe: poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding.	Severe: poorly drained; occasional flooding.
Mo, Mp	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.	Severe: poorly drained; frequent flooding.
Nicollet: Nc	Slight	Slight	Slight	Slight	Slight.
Primghar: Pr	Moderate: somewhat poorly drained.	Slight	Slight	Slight	Slight.
Ransom: Ra	Slight	Slight	Slight	Slight	Slight.
Rushmore: Ru	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Sac: SaA, SaB2	Slight: moderate on slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.

TABLE 7.—*Degree and kind of limitation for specified recreational uses*—Continued

Soil series, land types, and map symbols	Play area for intensive use	Picnic areas for intensive use	Paths and trails	Buildings in recreational areas	Camp areas for intensive use
Spicer: Sp	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Spillville: Sv	Moderate: occasional flooding.	Moderate: occasional flooding.	Moderate: occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.
Talcot: Ta	Severe: very poorly drained; ponding.	Severe: very poorly drained; ponding.	Severe: very poorly drained; ponding.	Severe: poorly drained; ponding.	Severe: very poorly drained; ponding.
Terril: TeB	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
Wadena:					
WaA	Slight	Slight	Slight	Slight	Slight.
WaB	Moderate: slopes of 2 to 6 percent.	Slight	Slight	Slight	Slight.
Waldorf: Wb	Severe: poorly drained; fine texture.	Severe: poorly drained; fine texture.	Severe: poorly drained; fine texture.	Severe: poorly drained; fine texture.	Severe: poorly drained; fine texture.
Webster: We, Wf	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; seasonal high water table.
Wilmonton: Wm	Slight	Slight	Slight	Slight	Slight.

Formation and Classification of the Soils

This section gives the outstanding morphologic characteristics of the soils of Nobles County and relates them to factors of soil formation. The section deals with the environment of the soils and the classification of soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plants and animals on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on parent material that has accumulated through the weathering of rocks and slowly change it into a natural body having genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that is formed and in a few places may determine it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. Generally, a long time is required for the development of district horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect on any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The soils of Nobles County have formed in several different parent materials. All of these materials, except the organic materials, are of glacial origin. The major kinds of parent material in the county are glacial till, loess, glacial outwash, alluvium, colluvium, and organic material. The glacial till in the county is from the Wisconsin glaciation (*2*). This glaciation is composed of several substages of the Wisconsin ice sheet, of which the Tazewell and Cary substages are represented in the county. About 65 percent of the soils in Nobles County formed in glacial till and in a thin loess mantle over glacial till; about 5 percent formed in lacustrine sediments; about 10 percent formed in deep (more than 40 inches) loess and fine sands; about 15 percent formed in glacial outwash on outwash plains; and about 5 percent formed in recent alluvium. The glacial till, loess, and lacustrine materials are discussed in this subsection in the order of their deposition.

Tazewell substage glacial till is the oldest parent material in Nobles County. It makes up the west and southwest one-third of the county to the west of the Bemis moraine. Most of the till is blanketed by loess. Where the loess is very thin, or the till is exposed on gentle slopes, Everly soils developed, and Storden soils are on the steeper slopes. The Tazewell glacial till is quite sim-

ilar to the Cary till, differing only in having more and larger lime concentrations and in being slightly less friable. The Tazewell landscape has long, smooth slopes in a well-developed dendritic drainage pattern. Closed depressions, a characteristic of the Cary glacial till landscape, normally are absent.

Loess was deposited after the Tazewell substage of the Wisconsin glaciation. The loess consisted of fine silty and clayey soil particles that were blown out of the flood plains and stream terraces of the Big Sioux River and Rock River valleys onto the glacial till plains. This silty material has a silt loam or silty clay loam texture. It is homogenous and lacks the stones, pebbles, and coarse sand that are common in glacial till. The loess mantle in the Everly-Sac-Rushmore soil association has an average thickness of 30 inches on Sac soils and 15 inches on Everly soils. On Galva soils the loess is more than 40 inches in thickness. In most places a thin sandy or pebbly layer separates the loess and the till. The deposits of loess tended to fill in and smooth the irregularities in the topography of the glacial ground moraine. The slopes are longer, smoother, and more uniform than in other parts of the county. The loess-covered outwash soils are in the Fairhaven series.

The Cary substage glacial till of the Wisconsin glaciation followed the deposition of loess. This substage covered most of the county, except for the southwestern one-third. The Bemis moraine and the Cary ground moraine consist of the Cary glacial till. These moraines range from sloping to moderately steep. In Nobles County the Bemis moraine occurs as twin ridges 1 to 3 miles apart. From the west ridge eastward, the soils formed chiefly in glacial till, though in places some loess influence occurs.

The main soils in this area are in the Clarion, Glencoe, Nicollet, Storden, and Webster series. The Cary ground moraine has undulating and complex relief. In this area are lacustrine soils, terrace and outwash soils, alluvial soils, and some depressional soils.

Lacustrine materials of the glacial lake plains are in large, nearly level areas throughout the eastern part of the county. In these areas Collinwood, Waldorf, and Lura soils are associated with the Nicollet, Webster, and Glencoe soils. The Collinwood, Waldorf, and Lura series are silty clay soils.

Glacial outwash soils have deposited on small intermittent stream terraces along most of the major streams and in small outwash areas in the glacial till uplands throughout Nobles County. These soils formed in parent material of loam, sandy loam, or silt loam 1 to 3 feet thick over sand and gravel. The Biscay, Comfrey, Millington, Spillville, and Talcot soils make up most of these bottom lands.

In drainageways, on alluvial fans, and at the base of steeper slopes, colluvium has accumulated. This sediment is similar to the alluvial material, except that it is not limy. In better drained areas, the Terril soils have developed. Glencoe, Marcus, Rushmore, and Webster soils are examples of soils that developed in the more poorly drained places.

Climate

The climate has had pronounced effects on soil formation. The freezing of the soil during winter slows all the soil-forming processes. The alternate thawing and freezing, especially in spring plays a part in development of soil structure. The rainfall of the area has affected the leaching of free lime, which has largely determined the thickness of the solum in the soils. Climate was responsible, to a large degree, for a plant cover of grass rather than forest in Nobles County. The grass vegetation has resulted in a dark-colored surface layer rather than the light-colored one associated with soils that formed under timber. Details on the climate in Nobles County are given in the section "General Nature of the County."

Plants and animals

The native vegetation in Nobles County consisted of tall and medium-height grasses, depending on the kind of soil and on drainage and site conditions. Some of the common species were big bluestem, little bluestem, Canada wildrye, prairie cordgrass, indiangrass, blue grama, side-oats grama, needle-and-thread, porcupine grass, and rice cutgrass. Aster, goldenrod, sunflower, blazing star, rose, lily, harebell, phlox, violets, fringed gentian, and many other flowers also grew on the native prairies. Cattails and sedges grew in the marshes. The grass vegetation is responsible for developing a surface layer that is naturally high in content of organic matter. On uneroded gentle slopes, most of the soils have a dark surface layer over 12 inches thick. On the steeper slopes, a thinner surface layer developed because of increased runoff, sparse vegetation, and natural erosion.

Some mixing of the surface layer, subsoil, and parent material by earthworms has occurred in nearly all of the soils. The Everly and Sac soils are examples of soils in which there has been a large amount of mixing by worms. Rodents and other burrowing animals also contribute to the mixing of different layers of the soil.

Man has had a great influence on the soils. Farming has affected most soil-forming processes. The action of some of the soil-forming factors has been increased. Accelerated erosion has occurred on the sloping soils, and some of the lower lying soils have gained soil material. The strong granular structure has been weakened or destroyed in the surface layer of many soils. In many places the originally dark-colored surface layer has become lighter colored because of the subsoil has been mixed with the surface layer and the content of organic matter has been reduced. The leaching process commonly has been slowed down because of an increase in runoff and a decrease in the infiltration of moisture.

Relief

Nobles County has relief ranging from nearly level to steep. Relief is the most important factor in the development of different soils in similar parent material. Soils with fairly mature soil profiles having distinct horizons have developed wherever drainage is good and slopes are gentle. Where slopes are steeper, however, there has been little soil development because of excessive runoff. The excessive runoff has reduced soil leaching and created droughty conditions, and these, in turn, reduce the growth of vegetation.

Topographic position assists in predicting the drainage and kind of soil at any given place in the landscape. For example, the characteristics of the soils in the Clarion drainage sequence can be predicted because each soil is

located on a particular part of the landscape. The somewhat excessively drained, steep Storden soils developed on side slopes; the well drained, undulating and gently sloping Clarion soils developed on hilltops; the moderately well drained, nearly level or very gently undulating Nicollet soils are in areas surounded by poorly drained or well drained soils; the poorly drained, nearly level Webster soils developed in drainageways on low flats; and the very poorly drained Glencoe soils are in closed depressions or very wet drainageways.

The glacial ground moraines are dominantly undulating or sloping, but the glacial end moraines are rolling. On ground moraines erosion and drainage are of about equal concern, but on end moraines erosion is a greater hazard and drainage is less of a limitation.

Time

The length of time required for soil development depends largely on the other factors of soil formation. Wherever relief and drainage are favorable in Nobles County, there has been sufficient time for soils to develop mature profiles. In steeper areas the soils have immature or thin profiles because the soil-forming processes have been less effective. Alluvial soils along the streams are also immature or weakly developed. Fresh deposits are laid down almost annually, and distinct, mature horizons have not had time to develop.

Geologically, all of the soils in the county are very young. The oldest soils are in the loess region and are probably about 15,000 years old. It is estimated that the soil-forming process has been active for 8,000 to 15,000 years in the rest of the county.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble information 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.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms, fields, and woodland; 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 currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*4*, *5*). In table 8, the soil series of Nobles County are placed in some categories of the current system.

The classification has six categories. Beginning with the most inclusive, the categories are order, suborder, great group, subgroup, family, and series. Brief descriptions of the six categories in the system are given in the paragraphs that follow.

Orders. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different climates. Each order is named with a word of three or four syllables ending in *sol*, for example (En-ti-*sol*).

Table 8 shows the two orders in Nobles County, the Mollisols and the Entisols. Mollisols normally develop under grass. They have a thick, dark-colored surface layer. Their name is derived from the Latin word *mollis*, meaning soft.

Entisols are mineral soils that have little, if any, horizon development.

Suborders. Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes having the greatest genetic similarity. Suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Udolls (*Ud* meaning humid climate, and *oll* from Mollisol).

Great Groups. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and other features. The horizons used as a basis for distinguishing between great groups are those in which (1) clay, iron, or humus has accumulated; (2) a pan has formed that interferes with growth of roots, movement of water, or both; or (3) a thick, dark-colored surface horizon has formed. Among the other features commonly used are the self-mulching properties of clay, soil temperature, and major difference in chemical composition, mainly calcium, magnesium, sodium, and potassium. 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 Hapludoll (*Hapl*, meaning simple; *ud*, meaning humid climate; and *oll* from Mollisol.).

Subgroups. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others called intergrades that have properties of the group and also have one or more properties of another group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Hapludoll (a typical Hapludoll).

Families. Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The name of a family consists of a series of adjectives preceding the name of the subgroup. The adjectives are the class names for texture, mineralogy, and so on (see table 8). An example is the fine-loamy, mixed family of Typic Hapludolls.

TABLE. 8—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Biscay	Fine-loamy over sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Blue Earth	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Canisteo	Fine-loamy, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Clarion	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Collinwood	Fine, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Comfrey[1]	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Dickman[2]	Sandy, mixed, mesic	Typic Hapludolls	Mollisols.
Estherville[3]	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols.
Everly	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Fairhaven[4]	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Galva	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Glencoe	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Kanaranzi	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Kingston	Fine-silty, mixed, mesic	Aquic Hapludolls	Mollisols.
Kingston, loamy subsoil variant	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Letri	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Lura	Fine, montmorillonitic, mesic	Cumulic Haplaquolls	Mollisols.
Marcus	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Millington	Fine-loamy, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Nicollet	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Primghar	Fine-silty, mixed, mesic	Aquic Hapludolls	Mollisols.
Ransom	Fine-silty, mixed, mesic	Aquic Hapludolls	Mollisols.
Rushmore	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Sac	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Spicer	Fine-silty, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Spillville	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Storden[5]	Fine-loamy, mixed, mesic	Typic Udorthents	Entisols.
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic.	Typic Haplaquolls	Mollisols.
Terril	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Waldorf	Fine, montmorillonitic, mesic	Typic Haplaquolls	Mollisols.
Webster	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Wilmonton	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.

[1] The Comfrey silty clay loam, depressional, soils in this county are a taxadjunct of the Comfrey series because they are very poorly drained rather than poorly drained.

[2] The Dickman soils in this county are a taxadjunct of the Dickman series because they have free carbonates at a shallower depth than the defined range of the series.

[3] The Estherville coarse sandy loam soils in the county are a taxadjunct of Estherville series because they have a higher content of coarse and very coarse sand and a lower content of silt in their solum than the defined range of the series.

[4] The Fairhaven silt loam, deep, soils in this county are a taxadjunct of the Fairhaven series because they have the coarse-textured IIC horizon beginning at greater depths than the defined range of the series.

[5] The Storden soils that are associated with the Everly soils in this county are a taxadjunct of the Storden series because they have firm consistence in at least part of the C horizon, whereas other soils of the series have a friable consistence in that horizon.

SERIES. The series is a group of soils that formed in the same kind of parent material and have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile. These soils are given the name of a geographic location near the place where that series was first observed and mapped. An example is the Ransom series, which was first described in Ransom Township, Nobles County, Minnesota.

General Nature of the County

This section is intended for readers not familiar with Nobles County. It tells about the physiography, the relief and drainage of the county, and the climate. In addition, there are short discussions of the history, settlement, population, and transportation and markets. Also, the farming of the county is summarized, mainly by giving statistics from the U.S. Census of Agriculture.

Physiography, Relief, and Drainage

The highest part of Nobles County is in the northwestern townships, where elevations average 1,750 feet but in places are nearly 1,800 feet. From this area there is a gradual descent to the south and east. In the southeastern corner of the county, the elevation is about 1,500 feet and relief is slight. Around Worthington the elevation is just under 1,600 feet, but in the eastern part of the county the elevation ranges from 1,500 to 1,535 feet.

The Bemis moraine dissects the county in a diagonal line from a point east of the northwest corner to an area a few miles north of the southeast corner of the county. The land north and east of the Bemis moraine is drained mainly to the east, but the land south and west of the moraine is drained to the south and west. The relief of the Bemis moraine is steep in the northwestern area and sloping through most of its length to the southeast.

South and west of the Bemis moraine, the relief consists mainly of long, smooth, gentle slopes that are broken only by the banks of natural streams. This area is man-

tled by loess of varying thickness, which has filled in irregularities and has smoothed the surface. This filling process and erosion are responsible for much of the variation in the thickness of the loess.

The relief north and east of the Bemis moraine is largely ground moraine that has undulating till plains, complex slopes, and frequent potholes. To the north and east, the water flows to Jack Creek, Elk Creek, and Okabena Creek, all of which empty into Heron Lake. From the moraine west and south, the water flows into Champepedan Creek, Kanaranzi Creek, the Little Rock River, and the Ocheyedan River.

Related information about the physiography, relief, and drainage of Nobles County is given under the heading "Parent Material" in the section "Formation and Classification of the Soils."

The loess-covered part of the county is mainly underlain by glacial till. Below this is cretaceous shale that rests on Sioux quartzite. The glacial till area east and north of the Bemis moraine is composed of till over cretaceous shale over granite bedrock.

Climate [5]

The location of Nobles County, near the center of the great land area of the North American continent, is the chief factor that determines its climate. Summers are warm because the land is heated by the sun shining at a high altitude for long periods. Because southerly winds bring in warm moist air from the Gulf of Mexico, most of the precipitation is received in summer. In winter the land cools rapidly, for the days are short and the sun is at a low altitude. Prevailing northerly winds cause additional cooling, and since the air masses are relatively dry, winter is the season of least precipitation. The topography has no sharply marked differences, and the climate is quite uniform throughout the county. Table 9 lists temperature and precipitation data compiled from records kept at Worthington. Table 10 gives probabilities of the last freezing temperature in spring and the first in fall.

Approximately 77 percent, or almost 20.4 inches, of the annual precipitation falls during the period from April through September. Measurable precipitation of at least 0.01 inch can be expected on about 98 days a year, 5 of which will have 1 inch or more. Rainfall at the intensity of about 1½ inches per hour can be expected once in 2 years. Annual rainfall has ranged from a low of 14.49 inches in 1910 to a high of 40.50 inches in 1938. The most rainfall at Worthington in any month was 11.82 inches in June of 1969. About 42 thunderstorms occur each year, some of them accompanied by hail and damaging winds. Ten tornadoes were reported during the period from 1916 through 1969.

Drought occurs whenever the supply of water for crops, either in the form of rainfall or soil moisture, becomes inadequate. Each day there is inadequate moisture in the root zone is defined as a drought day. Severe drought has occurred in southwest Minnesota in 7 of the years between 1931 and 1970. The drought was the most severe in 1934; the other years of drought were 1931, 1933, 1955, 1956, 1959, and 1970.

The average temperature for December, January, and February is 16.2° F. One of the colder winters was that of 1916-17, when the average temperature for the 3 months was 6.0°. About one-half of the winters will have

[5] By EARLE L. KUEHNAST, climatologist for Minnesota, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation*

[Worthington, Nobles County, Minnesota, mostly for the period 1941–70]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total	One year in 10 will have [1]—		Days with snow cover of 1.0 inch or more [2]	Average depth of snow on days with snow cover [2]
						Less than—	More than—		
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	21.8	3.0	42.3	−17.9	0.53	0.10	1.19	26	6
February	26.6	7.6	46.0	−12.7	.81	.07	1.70	23	6
March	36.4	18.0	60.2	−2.2	1.42	.42	2.97	18	7
April	54.8	33.3	79.6	18.8	2.18	.73	4.42	2	4
May	68.0	45.0	87.4	29.4	3.44	.93	6.85	0	----------
June	77.0	55.9	91.2	42.2	5.00	2.21	7.07	0	----------
July	82.8	60.4	93.9	49.4	3.46	1.05	5.78	0	----------
August	80.8	58.6	93.0	46.7	3.28	1.14	5.71	0	----------
September	70.1	48.4	86.9	34.0	3.00	.91	6.15	0	----------
October	58.2	37.9	79.2	22.2	1.68	.49	3.22	[3]	----------
November	41.2	23.0	63.5	4.5	.99	.17	2.86	6	4
December	27.2	10.6	47.9	−10.0	.70	.09	1.57	19	4
Year	53.7	33.5	[4] 96	[5] −20	26.50	18.93	33.47	94	5

[1] Based on data for the period 1891–1970.
[2] Based on data for the period 1936–70.
[3] Less than one-half day.
[4] Average annual temperature.
[5] Average annual temperature.

TABLE 10.—*Probabilities of last freezing temperature in spring and first in fall* [1]

[Worthington, Nobles County, Minnesota]

Probability	Dates for given probabilities and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 11	April 16	May 2	May 14	May 21
2 years in 10 later than	April 6	April 12	April 26	May 9	May 16
5 years in 10 later than	March 28	April 3	April 14	April 29	May 7
Fall:					
1 year in 10 earlier than	October 25	October 17	October 5	September 28	September 21
2 years in 10 earlier than	October 30	October 22	October 12	October 4	September 26
5 years in 10 earlier than	November 10	November 1	October 25	October 15	October 5

[1] As published in the University of Minnesota Agricultural Experiment Station Tech. Bul. 243, March 1963, "Climate of Minnesota, Part I," by Baker and Strub.

1 or 2 days on which the temperature is 20° below zero or lower. The first measurable snowfall occurs early in November about 1 year in 3, and the last generally occurs in April. Annual snowfall averages 41.5 inches, and the extremes range from 5.7 inches in 1930-31 to 80.3 inches in 1961-62. Information on snow cover and average depths is given in table 9.

The average temperature for June, July, and August is 69.2°, and the daily maximum temperature ranges from the mid 70's to the low 80's. A temperature of 100° or higher occurs about once every 4 years, and a temperature of 90° or higher occurs about 13 times a year. The highest temperature recorded at Worthington was 110° on July 17, 1936, and the lowest was –37° on February 9, 1899.

The freeze-free period is long enough for the staple crops of the county to mature without much danger from frost. Table 10 shows, for example, that 5 years out of 10, or 50 percent of the time, a temperature of 32° or lower can be expected to occur later than May 7 in spring and earlier than October 5 in fall.

Long-term records of humidity, cloudiness, and wind velocity are not available for Nobles County but are available only from First Order National Weather Service Airport Stations. The following information is based on records kept at Sioux Falls, South Dakota. The average windspeed is near 11 miles per hour. The prevailing wind is northwesterly in winter and southerly in summer. Average relative humidity at noon is near 65 percent in summer and 69 percent in winter. In an average year there are 104 days that are clear, 105 days that are partly cloudy, and 156 days that are cloudy.

History, Settlement, and Population

Settlement in Nobles County began in 1860. Pioneer homes were built in scattered parts of the county in the 1860's and early 1870's. Worthington was founded in 1871. The first residents of the county were largely of Scandinavian and German descent. Later, many people of Dutch descent moved into the county. The population grew steadily until it reached about 23,750 in 1961, but by 1964 it had declined to about 23,000.

There are 14 villages in Nobles County. They are Adrian, Brewster, Rushmore, Round Lake, Wilmont, Lismore, Leota, Ellsworth, Bigelow, Reading, Dundee, St. Killian, Kinbrae, and Org.

Transportation and Markets

Nobles County is served by three railroads. These provide freight service to all parts of the county.

The county has a good system of secondary and township roads. U.S. Highway No. 16 and Interstate Highway 90 run from east to west through the county, and State Highway No. 60 crosses the county diagonally from southwest to northeast. U.S. Highway No. 59 runs from north to south in the eastern part of the county and State Highway No. 91 runs from north to south in the western part. These highways and most of the county roads are either paved or blacktopped. Worthington is served by a commercial airline and has private flying services at a modern airport. Two bus lines serve Nobles County.

Marketing facilities are satisfactory. Grain elevators are located in almost every town and village. A packing company in Worthington processes many hogs, and another plant processes a large number of chickens and turkeys. Livestock also is trucked to Sioux City and Sioux Falls. Milk generally is marketed as whole milk and is picked up daily by trucks.

Farming

The early settlers raised produce for home consumption and often had small amounts left for barter. Wheat, oats, barley, corn, potatoes, and wild hay cut from the prairie were the main crops.

Corn grown for cash sale and feeding is now the main crop. Corn acreage has decreased from about 158,000 acres in 1964 to about 133,000 acres in 1969, and oat acreage has increased from about 36,000 acres in 1964 to about 37,000 acres in 1969. Soybean acreage has decreased from about 83,000 acres in 1964 to about 79,000 acres in 1969. The acreage of wheat, barley, rye, and flaxseed is insignificant. Alfalfa, clover, and grasses have increased

in acreage. The acreage of improved pasture more than doubled from 1959 to 1964.

The number of hogs and pigs in Nobles County increased from about 108,000 in 1964 to about 132,000 in 1969. The number of cows and calves increased from about 74,000 in 1964 to about 75,000 in 1969. The number of milk cows and heifers decreased slightly. The number of chickens decreased from about 353,000 in 1964 to about 325,000 in 1969. The number of sheep and lambs declined from about 26,000 in 1964 to about 18,000 in 1969.

The number of turkeys raised increased from 108,000 in 1959 to 114,000 in 1964. The sales of whole milk increased sharply from 50,000,000 pounds in 1959 to 90,000,000 pounds in 1964. The amount of cream sold decreased from 434,000 pounds of butterfat in 1959 to 143,000 pounds in 1964.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Complex slope. A slope that is made up of more than one single slope, as in rolling terrain.

Concave slope. A slope that is rounded inward like the inside of a bowl.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

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

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

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

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

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

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

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

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

Cemented.—Hard and brittle; little affected by moistening.

Depth of soil. Effective depth to which plant roots can readily penetrate without being restricted by a cemented layer, gravel, sand, or bedrock. Deep is more than 36 inches; moderately deep is 20 to 36 inches; and shallow is less than 20 inches.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Lacustrine deposits (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Leaching. The removal of soluble materials from soils or other materials by percolating water.

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

Moraine, ground. An accumulation of earth, stones, and other debris deposited by a glacier when the ice melts and recedes.

Moraine, terminal. An accumulation of earth, stones, and other debris deposited in ridges. A terminal moraine marks the farthest advance of a glacier.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid or alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

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

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

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Variant, soil. A taxonomic soil unit closely related to another taxonomic unit, a series for example, but departing from it in at least one differentiating feature. A variant is of small extent, or a new series would be established. Kingston silty clay loam, loamy subsoil variant, 2 to 6 percent slopes, is a soil variant in Nobles County.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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