United States Department of Agriculture

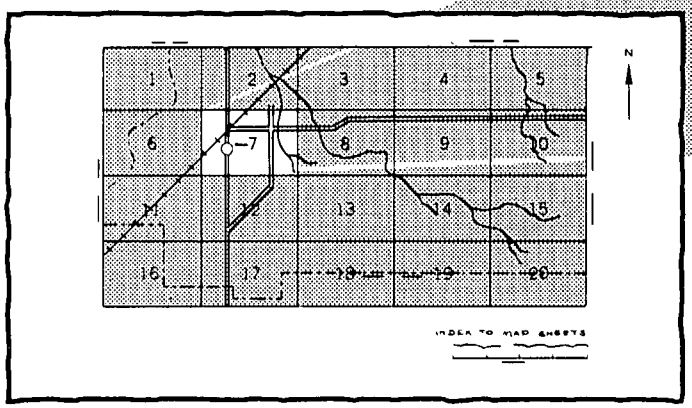
Soil Conservation Service

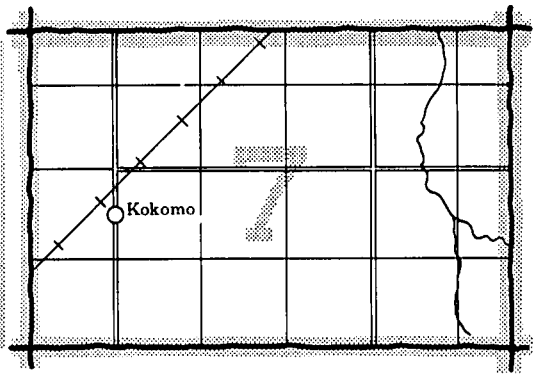
In cooperation with Iowa Agriculture and Home Economics Experiment Station; Cooperative Extension Service, Iowa State University; and Department of Soil Conservation, State of Iowa

Soil Survey of Osceola County, Iowa

HOW TO USE

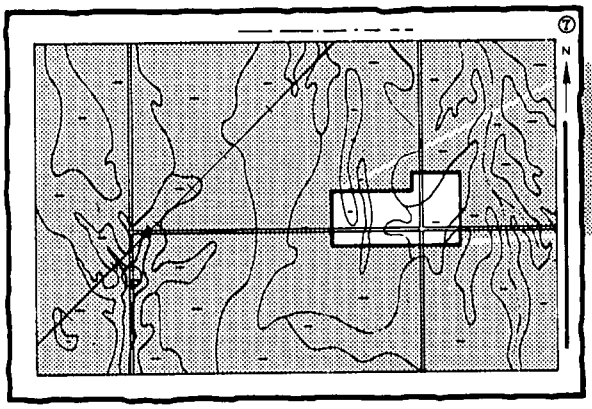
1. Locate your area of interest on the "Index to Map Sheets."

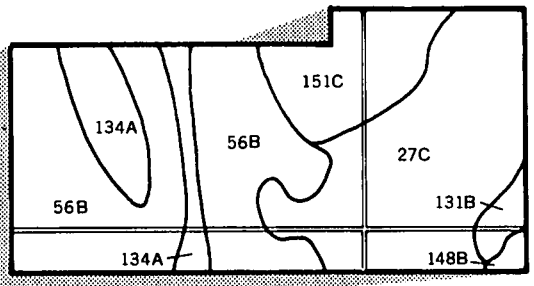




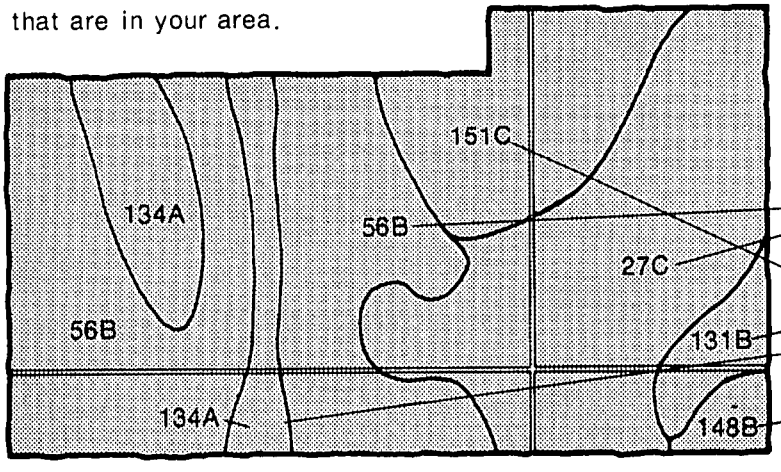
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area.

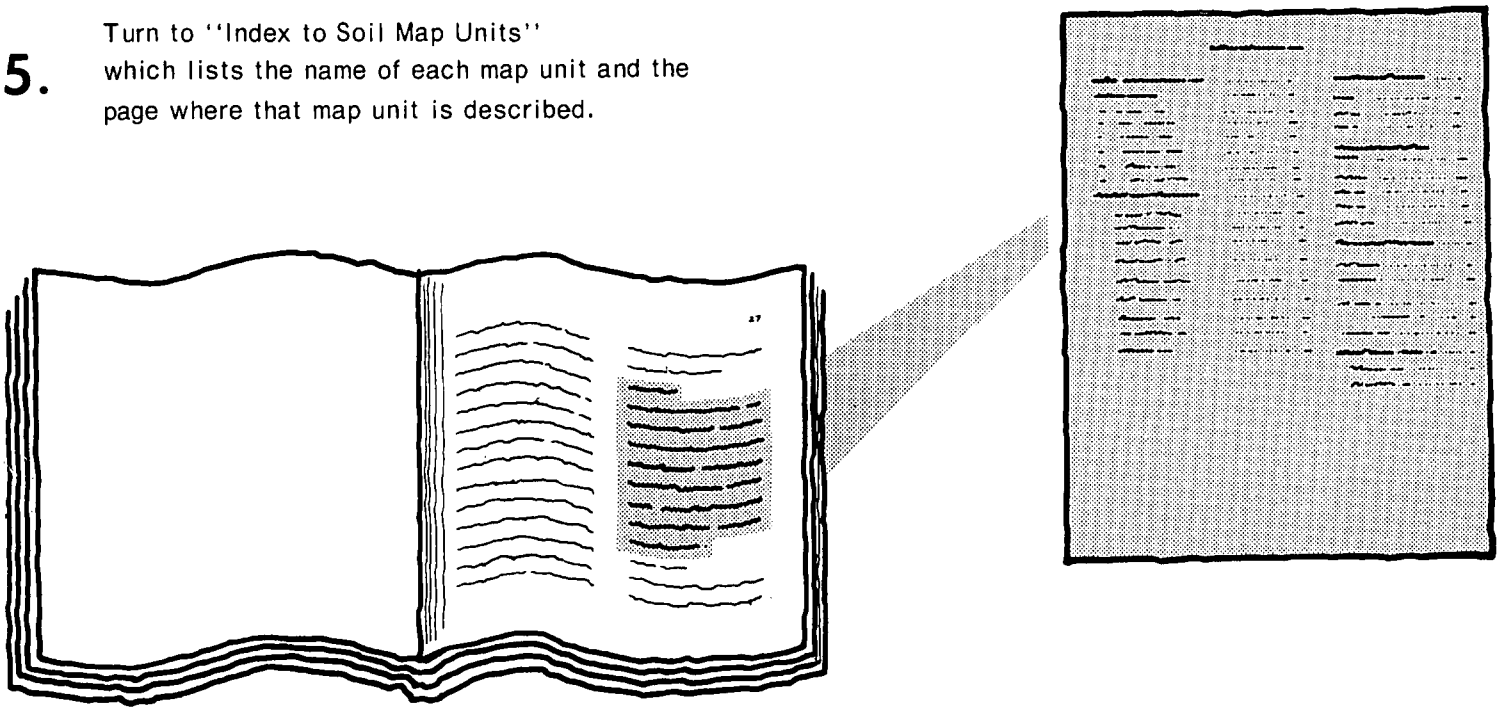


Symbols

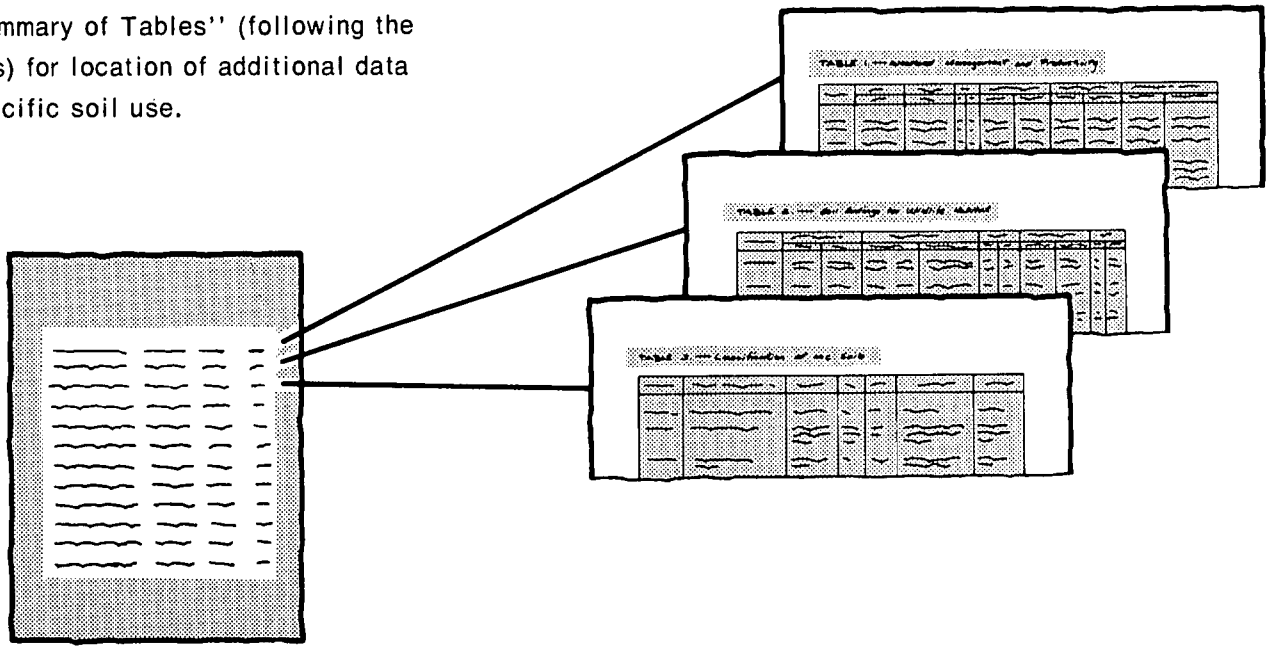
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was performed during the period 1980 to 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Osceola County Soil Conservation District. Funds appropriated by Osceola County were used to defray part of the cost of the survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Clarion and Storden soils on the Ocheyedan Mound. Clarion and Nicollet soils are in the foreground.

Contents

Soil Series

Issued October 1988

Index to Map Units

Summary of Tables

Preface

This soil survey contains information that can be used in land-planning programs in Osceola County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Soil Survey of Osceola County, Iowa

By Robert J. Vobora and Joseph Kristoff, Jr., Soil Conservation Service

Fieldwork by Robert J. Vobora, Joseph Kristoff, Jr.,
and Michael Hosbein, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Iowa Agriculture and Home Economics Experiment Station;
the Cooperative Extension Service, Iowa State University;
and the Department of Soil Conservation, State of Iowa

OSCEOLA COUNTY is in the northwestern part of Iowa (fig. 1). It has an area of 254,720 acres, or 398 square miles. Sibley, the county seat, is in the west-central part of the county, about 250 miles northwest of Des Moines.

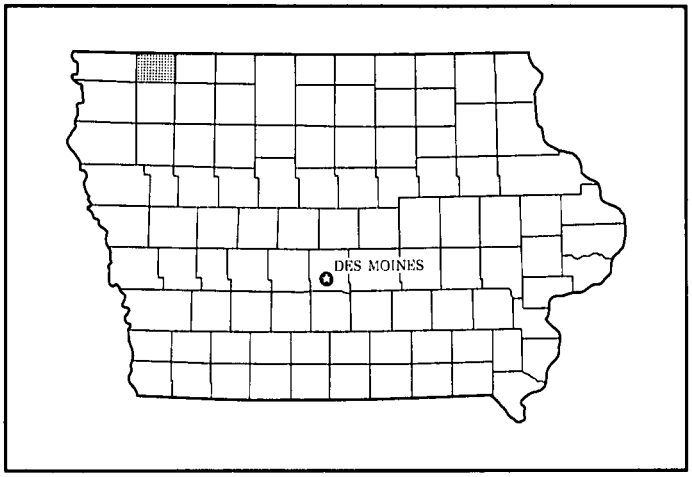


Figure 1.—Location of Osceola County in Iowa.

The county is chiefly agricultural. The principal crops are corn and soybeans. Some of the corn is fed to livestock. Beef cattle and hogs are the most common livestock, although some farms have dairy cattle or sheep.

The landscape varies throughout the county. The northeastern third is characterized by a poorly defined surface drainage pattern and by many depressions and sloughs. The rest of the county has a well defined surface drainage pattern. All of the soils are deep, and most are nearly level to gently sloping.

This survey updates the soil survey of Osceola County published in 1940 (*10*). It provides additional information and larger maps, which show the soils in greater detail.

General Nature of the County

This section describes the history and development, agriculture, natural resources, transportation facilities and industry, physiography and drainage, and climate in the county.

History and Development

Osceola County was named after a Seminole chief, the acknowledged head of a band of Indians who inhabited the Everglades of Florida. The boundaries of the county were established by the Third General Assembly in January 1851.

Captain E. Huff, a veteran of the Civil War, became the first permanent settler in the county in the fall of 1870. Until this time, the only people to set foot in the county were travelers, explorers, surveyors, trappers, or

hunting Indian bands. Several other settlers arrived in 1871. In January 1872, Osceola County was organized as a separate county. Sibley was the first town in the county. Other towns were St. Gilman (now Ashton), Harris, Ocheyedan, Cloverdale, Allendorf, and Melvin (*11*).

Thirty-seven years after Captain Huff built his shanty on the bank of Otter Creek, the state auditor's report indicated that 72,392 acres in the county produced 2,993,755 bushels of corn. The report shows similarly encouraging figures for oats, wheat, barley, rye, and potatoes (*7*). In 1982, about 106,800 acres produced 13,059,000 bushels of corn. The population of the county was 8,371 in 1980.

Agriculture

In 1982, the county had 820 farms, which made up about 245,000 acres. About 215,000 acres was used for row crops; 10,000 acres for close-grown crops, mainly oats; and 7,000 acres for hay, mainly alfalfa. The rest of the farmland was pastured or was idle land. Corn for grain was grown on about 106,800 acres. It yielded 122 bushels per acre. Corn for silage was grown on about 5,900 acres. It yielded an average of 17 tons per acre. Soybeans were harvested for grain on about 102,000 acres, which yielded an average of 37.9 bushels per acre. Oats was harvested for grain on about 6,000 acres, which yielded an average of 80 bushels per acre.

The farms in the county generally are used for a mixture of livestock enterprises and grain crops. Hogs, beef, and sheep are the most common livestock. In 1982, about 165,000 hogs, 33,100 beef cattle, and 25,000 sheep and lambs were marketed. Dairy cattle numbered about 2,700 and laying hens about 76,000 (*18*).

Natural Resources

Agricultural land is the most abundant natural resource in Osceola County. Large deposits of sand and gravel are in some areas adjacent to the Ocheyedan River, the Little Rock River, and Otter Creek. Some of this sand and gravel is excavated and used as road-surfacing material or as concrete aggregate. The bottom land along the Ocheyedan River has a good supply of water for an existing rural water system.

Transportation Facilities and Industry

U.S. Highway 59 and State Highways 9 and 60 are the main transportation routes in the county. These routes are connected to all parts of the county by all-weather roads or by roads surfaced with gravel. Nearly all of the secondary roads are on section lines.

One railway and one bus company currently serve the county. A presently idle railway that connects Sibley, Ocheyedan, and Harris is scheduled to resume service. The county has one small, hard-surfaced airport, which has no scheduled flights.

The county has several industries, including a bag company, a concrete company, and a printing company, all of which are located in or near Sibley. Several grain elevators are in the county.

Physiography and Drainage

The Ocheyedan River and its main tributary, the Little Ocheyedan River, drain the eastern part of Osceola County, mainly to the south and east. These two streams and their branches drain about 45 percent of the county. Otter Creek and the Little Rock River drain the western part, mainly to the south and west. These two streams and their branches drain about 37 percent of the county (*9*). The entire county is part of the Missouri River drainage area.

The highest elevation in the county, 1,670 feet above sea level, is near Sibley. It is the highest point in Iowa. The lowest elevation in the county is about 1,390 feet above sea level. It is in the southeast corner, in an area where the Ocheyedan River leaves the county.

Most of the county is on dissected uplands. The landscape is mainly level to undulating. Typical features in the southern and western parts of the county are broad flats on upland drainage divides, undulating ridges and side slopes, and nearly level drainageways. Typical features in the northeastern part of the county are nearly level swales, gently sloping knobs and ridges, and level depressions.

The areas along the Ocheyedan River, the Little Ocheyedan River, and the Little Rock River are nearly level to steep. Typical features are nearly level bottom land and stream terraces and steep valley sides.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Osceola County is cold in winter. Summer is characterized by quite hot temperatures and occasional cool spells. During the winter, precipitation frequently occurs as snow. During the warmer months, it falls chiefly as showers, which often are heavy. The total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Sibley in the period 1951 to 1981. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 18 degrees F, and the average daily minimum temperature is 8 degrees. The lowest temperature on record, which occurred at Sibley on February 28, 1962, is -36 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 83 degrees.

The highest recorded temperature, which occurred at Sibley on June 20, 1974, is 102 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 28 inches. Of this, 21 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 17 inches. The heaviest 1-day rainfall during the period of record was 3.90 inches on June 22, 1957. Thunderstorms occur on about 44 days each year. Tornadoes and severe thunderstorms strike occasionally. These storms are local in extent and of short duration and result in sparse damage in narrow belts. Hailstorms sometimes occur in scattered small areas during the warmer part of the year.

The average seasonal snowfall is about 35 inches. The greatest snow depth at any one time during the period of record was 40 inches. On the average, 12 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a

fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Sac-Primghar Association

Nearly level to moderately sloping, well drained and somewhat poorly drained, silty soils that formed in loess or in loess and the underlying glacial till; on uplands

This association consists of soils in broad, plane and convex areas on ridges; on long, convex side slopes; and in small drainageways. Slopes range from 0 to 9 percent.

This association makes up about 23 percent of the county. It is about 45 percent Sac soils, 30 percent Primghar soils, and 25 percent soils of minor extent (fig. 2).

Sac soils are well drained and are gently sloping on convex ridgetops and moderately sloping on side slopes. Primghar soils are somewhat poorly drained and are in broad, nearly level areas and in very gently sloping areas in small drainageways.

Typically, the surface layer of the Sac soils is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer also is very dark grayish brown silty clay loam. It is about 5 inches thick. The subsoil is brown, friable silty clay loam about 22 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Primghar soils is black silty clay loam about 11 inches thick. The subsurface layer is silty clay loam about 10 inches thick. The upper part is black, and the lower part is very dark gray mixed with dark grayish brown and black. The subsoil is dark grayish brown and olive brown, mottled, friable silty clay loam about 21 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Minor in this association are the Galva, Marcus, and Spicer soils. Galva soils are well drained and are on ridgetops and side slopes. They formed in more than 40 inches of loess. Marcus and Spicer soils are poorly drained and are in low areas and drainageways.

Nearly all of this association is used for cultivated crops. The main enterprise is growing cash-grain crops. A small acreage on some farms is used for pasture and hay.

Corn, soybeans, oats, and hay grow well on the major soils. Available water capacity is high. Organic matter content is moderate or high. The main management concerns are controlling water erosion on the gently sloping and moderately sloping soils and draining the small drainageways. A conservation tillage system that leaves crop residue on the surface and contour farming help to prevent excessive soil loss. In areas of the Sac soils, terraces also help to control erosion. The hazard of soil blowing is increased if the soils are tilled in the fall. Foregoing fall tillage and establishing field windbreaks reduce this hazard and conserve moisture.

2. Primghar-Marcus-Ransom Association

Nearly level and very gently sloping, somewhat poorly drained and poorly drained, silty soils that formed in loess or in loess and the underlying glacial till; on uplands

This association consists of soils on broad, plane and concave drainage divides and in drainageways. Slopes range from 0 to 3 percent.

This association makes up about 8 percent of the county. It is about 45 percent Primghar soils, 30 percent Marcus soils, 10 percent Ransom soils, and 15 percent soils of minor extent.

Primghar and Ransom soils are somewhat poorly drained and are nearly level and very gently sloping. They are on broad drainage divides. Marcus soils are

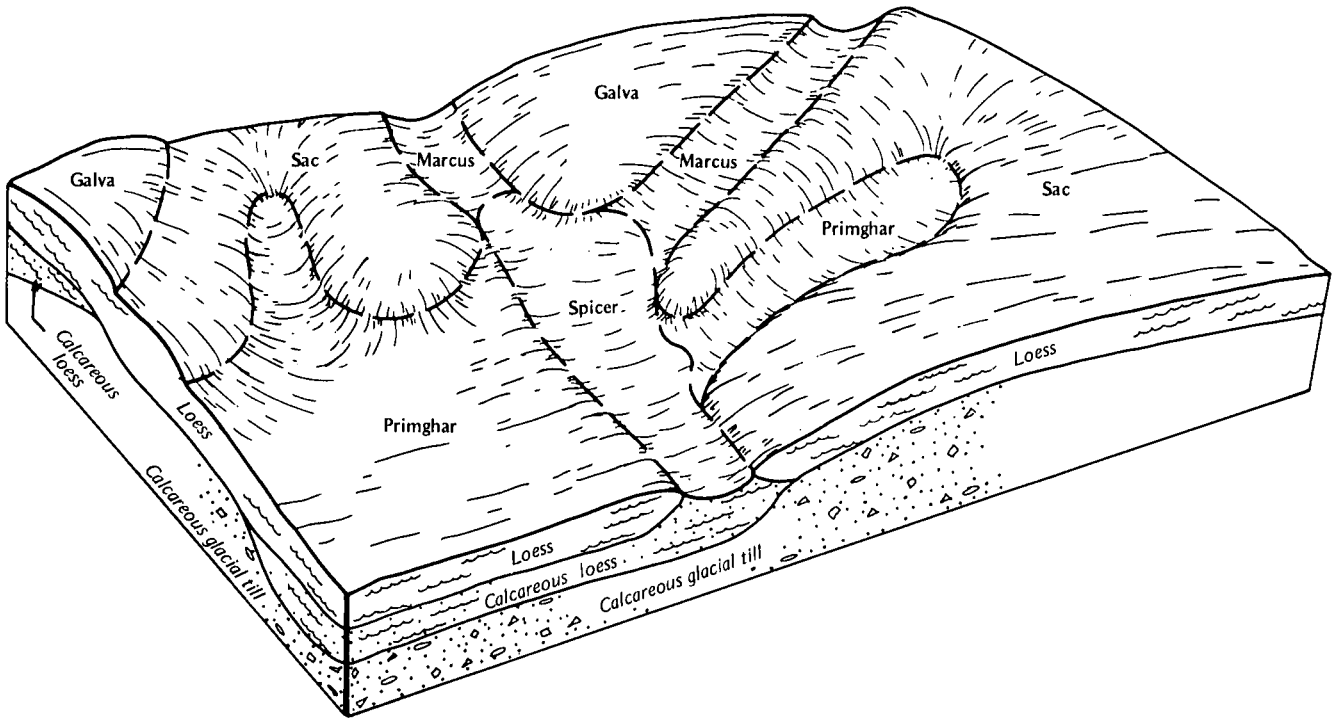


Figure 2.—Typical pattern of soils and parent material in the Sac-Primghar association.

poorly drained and nearly level. They are in concave areas on drainage divides and in drainageways.

Typically, the surface layer of the Primghar soils is black silty clay loam about 10 inches thick. The subsurface layer is silty clay loam about 11 inches thick. The upper part is black, and the lower part is very dark gray mixed with dark grayish brown and black. The subsoil is dark grayish brown and olive brown, mottled, friable silty clay loam about 21 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Typically, the surface layer of the Marcus soils is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 6 inches thick. The subsoil is about 18 inches thick. It is mottled and friable. The upper part is dark grayish brown and olive gray silty clay, and the lower part is olive silty clay loam. The substratum to a depth of about 60 inches is calcareous silty clay loam. The upper part is mottled light olive brown and olive gray, and the lower part is olive gray and mottled.

Typically, the surface layer of the Ransom soils is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 11 inches thick. The upper part is very dark gray, and the lower part is very dark gray and very dark grayish brown. The subsoil is friable silty clay loam about 13 inches thick. The upper part is dark grayish brown and olive brown, and the lower part is olive brown. The upper part of the substratum is mottled olive brown and grayish brown, calcareous loam. The lower part to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam.

Minor in this association are the Galva, Sac, and Spicer soils. Galva and Sac soils are well drained and are on ridges. Spicer soils are poorly drained and are in drainageways. They are calcareous at the surface.

Nearly all of this association is used for cultivated crops. The main enterprise is growing cash-grain crops.

Corn, soybeans, oats, and hay grow well on the major soils. Available water capacity and organic matter content are high. The main management concerns are controlling soil blowing on all the major soils and draining the poorly drained soils. Applying a conservation tillage system that leaves crop residue on the surface and establishing field windbreaks reduce the hazard of soil blowing.

3. Everly-Wilmonton-Letri Association

Nearly level to moderately sloping, well drained, somewhat poorly drained, and poorly drained, loamy and silty soils that formed in erosional sediments and in the underlying glacial till; on uplands

This association consists of soils on broad, plane and convex ridges; on long, convex side slopes; and in

concave drainageways. Slopes range from 0 to 9 percent.

This association makes up about 24 percent of the county. It is about 40 percent Everly soils, 35 percent Wilmonton soils, 20 percent Letri soils, and 5 percent soils of minor extent (fig. 3).

Everly soils are well drained and are gently sloping on convex ridgetops and moderately sloping on side slopes. Wilmonton soils are somewhat poorly drained and are in broad, very gently sloping areas. Letri soils are poorly drained and nearly level. They are in concave areas on drainage divides and in drainageways.

Typically, the surface layer of the Everly soils is black clay loam about 8 inches thick. The subsurface layer is mixed very dark gray and dark brown clay loam about 6 inches thick. The subsoil is clay loam about 21 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of the Wilmonton soils is black silty clay loam about 8 inches thick. The subsurface layer is about 5 inches of silty clay loam mixed with some very dark grayish brown material. The subsoil is mottled, friable silty clay loam about 15 inches thick. The upper part is mixed very dark grayish brown and very dark gray, and the lower part is olive brown. The upper part of the substratum is grayish brown, mottled, calcareous silt loam. The next part is mottled light gray and yellowish brown, calcareous clay loam. The lower part to a depth of about 60 inches is mottled yellowish brown, light gray, strong brown, and light olive brown, calcareous loam.

Typically, the surface layer of the Letri soils is black silty clay loam about 10 inches thick. The subsurface layer is silty clay loam about 13 inches thick. The upper part is black, and the lower part is mixed very dark gray, black, and grayish brown. The subsoil is about 19 inches thick. It is friable. The upper part is mixed dark gray, very dark gray, and olive brown silty clay loam; the next part is olive gray and light olive brown, mottled silty clay loam; and the lower part is mottled olive gray, light olive brown, and yellowish brown, calcareous loam. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous clay loam.

Minor in this association are the well drained Storden soils on side slopes in the uplands. These soils formed entirely in calcareous glacial till.

Nearly all of this association is used for cultivated crops. The main enterprise is growing cash-grain crops.

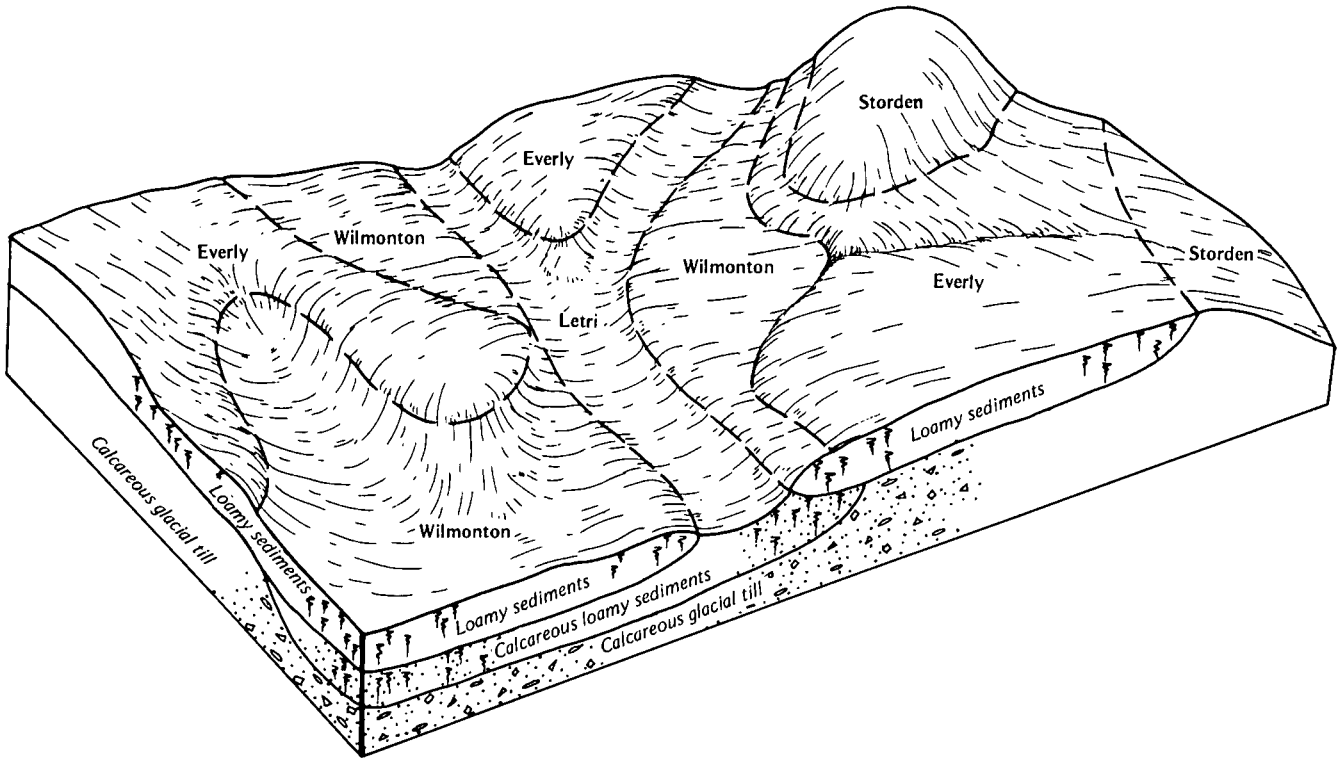


Figure 3.—Typical pattern of soils and parent material in the Everly-Wilmonton-Letri association.

Corn, soybeans, oats, and hay grow well on the major soils. Available water capacity is high. Organic matter content is moderate or high. The main management concerns are controlling water erosion on the gently sloping and moderately sloping soils, draining the poorly drained soils, and controlling soil blowing on all the major soils. A conservation tillage system that leaves crop residue on the surface and contour farming help to prevent excessive soil loss. In areas of the Everly soils, terraces also help to control erosion. The hazard of soil blowing is increased if the soils are tilled in the fall. Foregoing fall tillage and establishing field windbreaks reduce this hazard and conserve moisture.

4. Havelock-Galva Association

Nearly level to gently sloping, poorly drained and well drained, loamy and silty soils that formed in alluvium or in loess over sand and gravel; on bottom land and stream benches

This association consists of nearly level soils on bottom land and nearly level to gently sloping soils on stream benches. Slopes range from 0 to 5 percent.

This association makes up about 4 percent of the county. It is about 45 percent Havelock soils, 35 percent Galva soils, and 20 percent soils of minor extent.

Havelock soils are poorly drained and nearly level. They are on bottom land. Galva soils are well drained and are nearly level to gently sloping. They are on stream benches.

Typically, the surface layer of the Havelock soils is black, calcareous clay loam about 8 inches thick. The subsurface layer is calcareous clay loam about 38 inches thick. The upper part is black, and the lower part is very dark gray. The next layer is dark gray, friable loam about 8 inches thick. The substratum to a depth of about 60 inches is gray, calcareous loam.

Typically, the surface layer of the Galva soils is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 10 inches thick. The subsoil is about 24 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is silt loam. The upper 13 inches of the substratum is brown silt loam. The lower part to a depth of about 60 inches is stratified sand and gravel.

Minor in this association are the Allendorf, Cylinder, and Wadena soils on stream terraces and outwash plains. These soils have sand and gravel within 40 inches of the surface.

Most of this association is used for cultivated crops. The main enterprise is growing cash-grain crops. Some areas of the nearly level Havelock soils are used as permanent pasture.

Corn, soybeans, oats, and hay grow well on the major soils. The content of organic matter is moderate or high. The main management concern is controlling erosion on the gently sloping soils. Also, a drainage system and protection from flooding may be needed on the poorly drained soils.

5. Clarion-Nicollet-Storden Association

Very gently sloping to very steep, well drained and somewhat poorly drained, loamy soils that formed in glacial till; on uplands

This association consists of very gently sloping soils on swells; gently sloping to strongly sloping soils on rises or knolls; and moderately sloping to very steep soils on side slopes. Slopes range from 1 to 40 percent.

This association makes up about 13 percent of the county. It is about 35 percent Clarion soils, 25 percent Nicollet soils, 10 percent Storden soils, and 30 percent soils of minor extent.

Clarion soils are well drained and are gently sloping to moderately sloping. They are on rises and knolls. Nicollet soils are somewhat poorly drained and very gently sloping. They are on swells. Storden soils are well drained and are strongly sloping to very steep. They are on side slopes.

Typically, the surface layer of the Clarion soils is black clay loam about 10 inches thick. The subsurface layer is very dark grayish brown, brown, and black clay loam about 5 inches thick. The subsoil is dark yellowish brown, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled.

Typically, the surface layer of the Nicollet soils is black clay loam about 7 inches thick. The subsurface layer is very dark gray clay loam about 7 inches thick. The subsoil is friable clay loam about 12 inches thick. The upper part is dark grayish brown and very dark grayish brown, and the lower part is dark grayish brown and yellowish brown and is mottled. The substratum to a depth of about 60 inches is mottled gray, yellowish brown, dark grayish brown, and strong brown, calcareous clay loam.

Typically, the surface layer of the Storden soils is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam.

Minor in this association are the Canisteo, Havelock, Knoke, Okoboji, and Webster soils. Canisteo and Webster soils are poorly drained and are in low areas. Canisteo, Knoke, and Havelock soils have free carbonates throughout. Knoke and Okoboji soils are very poorly drained and are in low upland depressions. Havelock soils are on bottom land. They have a thick, dark surface soil.

Most of the very gently sloping to strongly sloping areas on uplands are used for cultivated crops. The

moderately steep to very steep areas are used as permanent pasture or wildlife habitat. The bottom land is used for cultivated crops or pasture. The main enterprise in the association is growing cash-grain crops.

Corn, soybeans, oats, and hay grow well or moderately well on the very gently sloping to strongly sloping soils. Available water capacity is high. Organic matter content is moderately low to high. The main management concern is controlling water erosion on the very gently sloping to strongly sloping soils.

6. Wadena-Coland-Cylinder Association

Nearly level to gently sloping, well drained, poorly drained, and somewhat poorly drained, loamy soils that formed in outwash and alluvium; on stream terraces and bottom land

This association consists of soils in plane and convex areas on stream terraces and in plane and concave areas on bottom land. Slopes range from 0 to 5 percent.

This association makes up about 6 percent of the county. It is about 30 percent Wadena soils, 20 percent Coland soils, 15 percent Cylinder soils, and 35 percent soils of minor extent (fig. 4).

Wadena soils are well drained and are nearly level to gently sloping. They are on stream terraces. Coland soils are poorly drained and nearly level. They are on bottom land. Cylinder soils are somewhat poorly drained and nearly level. They are in plane and slightly convex areas on stream terraces.

Typically, the surface layer of the Wadena soils is black loam about 10 inches thick. The subsurface layer is mixed very dark gray, dark brown, and brown loam about 3 inches thick. The subsoil is friable loam about 15 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy sand, and the lower part is sand and gravel.

Typically, the surface layer of the Coland soils is black clay loam about 9 inches thick. The subsurface layer is clay loam about 34 inches thick. The upper part is black, the next part is very dark gray, and the lower part is very

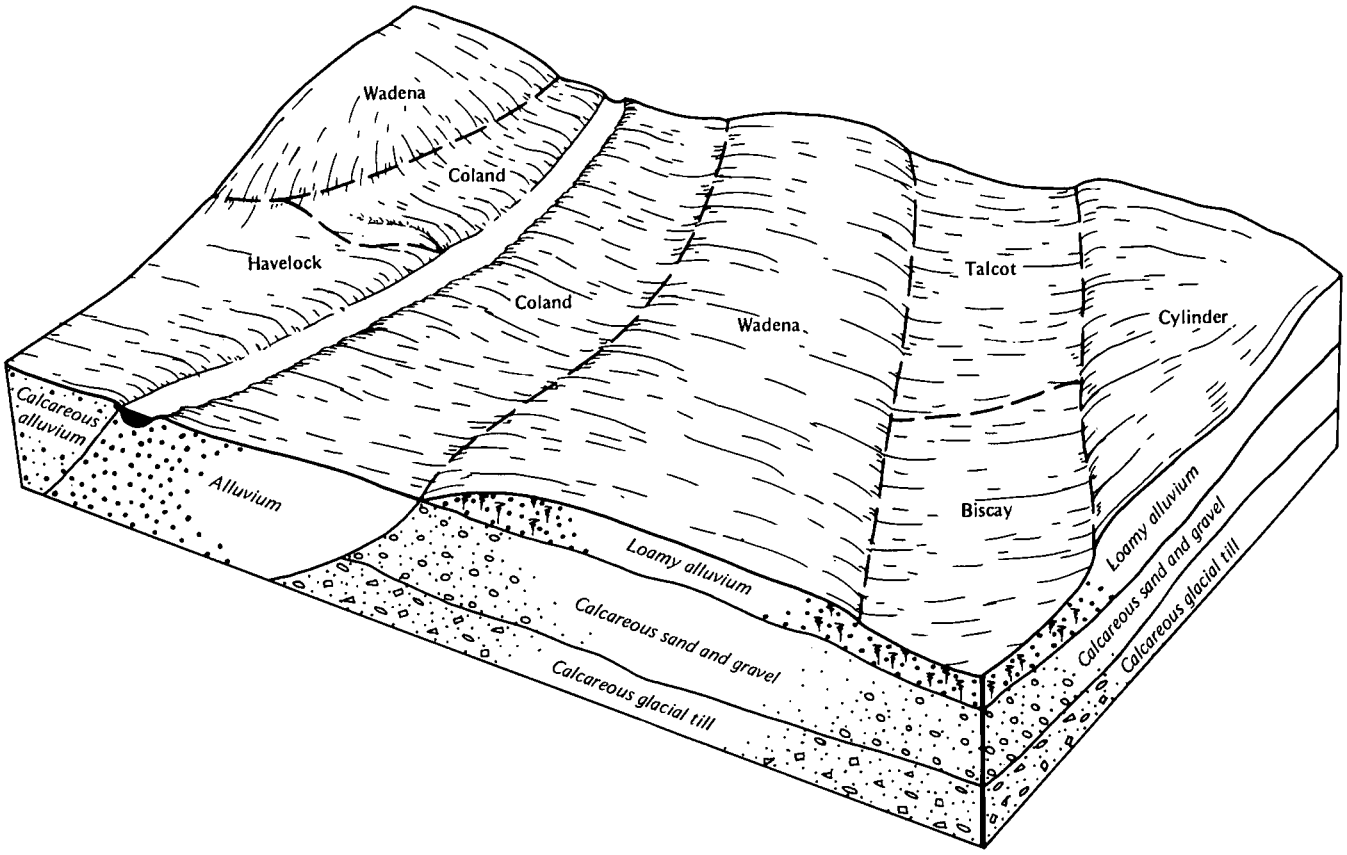


Figure 4.—Typical pattern of soils and parent material in the Wadena-Coland-Cylinder association.

dark grayish brown. The subsoil is dark gray, friable clay loam about 13 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled loam.

Typically, the surface layer of the Cylinder soils is black clay loam about 9 inches thick. The subsurface layer also is clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown mixed with some dark grayish brown. The subsoil is about 20 inches thick. It is friable. The upper part is dark grayish brown and olive brown clay loam; the next part is olive brown, mottled clay loam; and the lower part is olive brown, mottled sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and gravel.

Minor in this association are the Biscay, Havelock, and Talcot soils. Biscay and Talcot soils are poorly drained and formed in glacial outwash in plane and slightly concave areas on stream terraces. Havelock soils are poorly drained and formed in calcareous alluvium on bottom land.

Most of this association is used for cultivated crops. The main enterprise is growing cash-grain crops. Some areas on bottom land are used as pasture.

Corn, soybeans, oats, and hay grow moderately well on the major soils. Available water capacity is low to high. Organic matter content is moderate or high. The main management concerns are drought and water erosion on the Wadena soils and drainage and flooding on the Coland soils. A conservation tillage system that leaves crop residue on the surface helps to control water erosion and conserves moisture.

7. Nicollet-Clarion-Webster Association

Nearly level to moderately sloping, somewhat poorly drained, well drained, and poorly drained, loamy and silty soils that formed in glacial till; on uplands

This association consists of nearly level soils in low areas and drainageways; very gently sloping soils on swells; and gently sloping and moderately sloping soils on rises or knolls. Slopes range from 0 to 9 percent.

This association makes up about 22 percent of the county. It is about 30 percent Nicollet soils, 25 percent

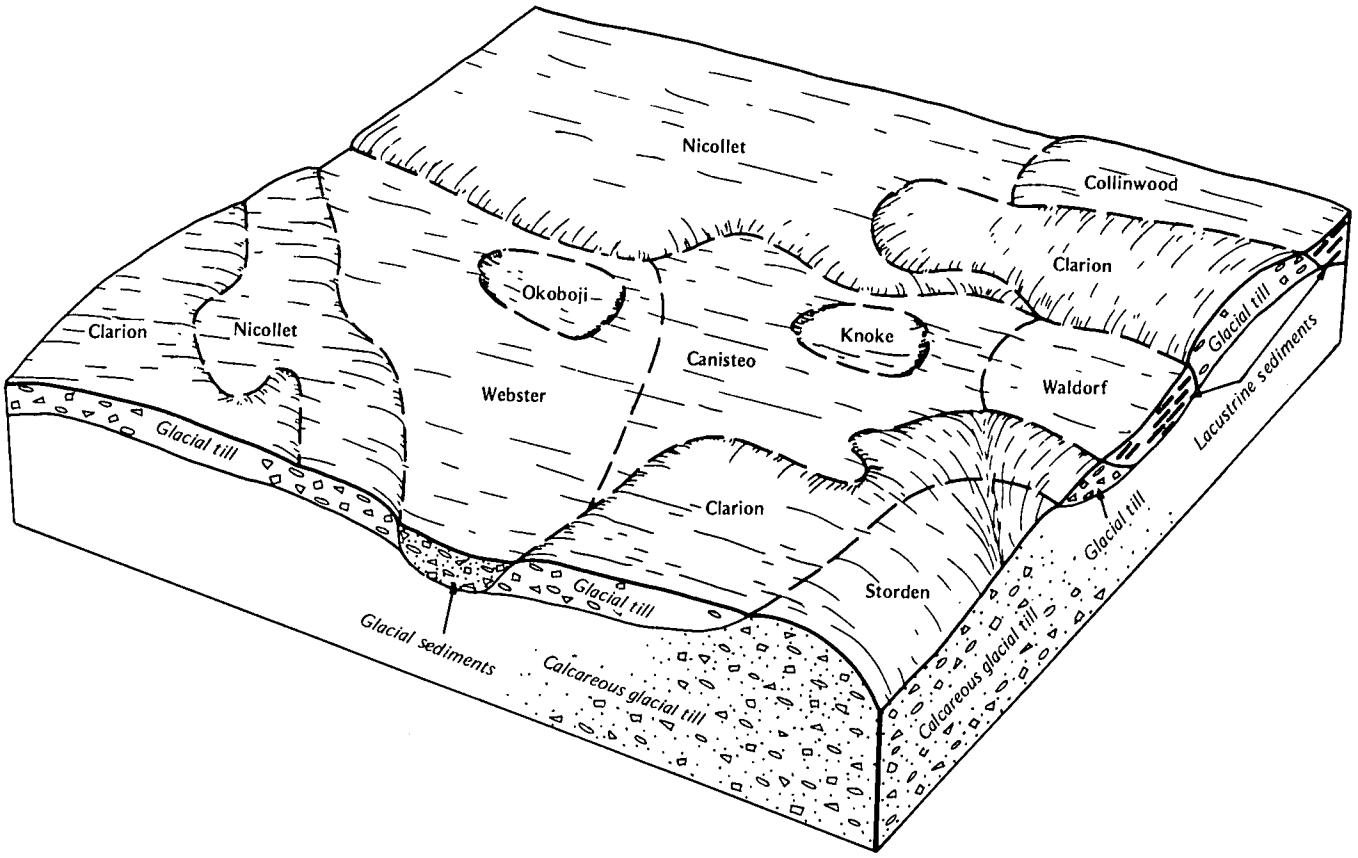


Figure 5.—Typical pattern of soils and parent material in the Nicollet-Clarion-Webster association.

Clarion soils, 15 percent Webster soils, and 30 percent soils of minor extent (fig. 5).

Nicollet soils are somewhat poorly drained and very gently sloping. They are on swells. Clarion soils are well drained and are gently sloping to moderately sloping. They are on rises and knolls. Webster soils are poorly drained and nearly level. They are in low areas and drainageways.

Typically, the surface layer of the Nicollet soils is black clay loam about 7 inches thick. The subsurface layer is very dark gray clay loam about 7 inches thick. The subsoil is friable clay loam about 12 inches thick. The upper part is dark grayish brown and very dark grayish brown, and the lower part is dark grayish brown and yellowish brown and is mottled. The substratum to a depth of about 60 inches is mottled gray, yellowish brown, dark grayish brown, and strong brown, calcareous clay loam.

Typically, the surface layer of the Clarion soils is black clay loam about 10 inches thick. The subsurface layer is mixed very dark grayish brown, brown, and black clay loam about 5 inches thick. The subsoil is dark yellowish brown, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled.

Typically, the surface layer of the Webster soils is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 12 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is olive gray, mottled, friable clay loam about 17 inches thick. It is calcareous in the lower part. The upper part of the substratum is light olive gray, mottled, friable, calcareous clay loam. The lower part to a depth of about 60 inches is light olive gray, mottled, calcareous loam.

Minor in this association are the Canisteo, Collinwood, Knoke, Okoboji, Storden, and Waldorf soils. The poorly drained Canisteo soils are in slightly concave areas. They have free carbonates throughout. The somewhat poorly drained Collinwood and poorly drained Waldorf soils formed in clayey lacustrine deposits. Collinwood soils are in slightly convex to slightly concave areas, and Waldorf soils are in plane and concave areas. The very poorly drained Knoke and Okoboji soils are in low depressions. The well drained Storden soils are on knolls and convex side slopes along streams and upland drainageways. They have free carbonates throughout.

Nearly all of this association is used for cultivated crops. The main enterprise is growing cash-grain crops.

Corn, soybeans, oats, and hay grow well on the major soils. Available water capacity is high. Organic matter content is moderate or high. The main management concerns are controlling water erosion on the gently sloping and moderately sloping soils and controlling soil blowing on all the major soils. Also, a drainage system may be needed on the poorly drained soils. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. If the slopes are sufficiently long and uniform, terracing also helps to control water erosion.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Sac silty clay loam, 2 to 5 percent slopes, is a phase of the Sac series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

4—Knoke silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Areas are dominantly 2 to 10 acres in size but range to 30 acres. They are elliptical.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer also is black, calcareous silty clay loam. It is about 20 inches thick. The subsoil is about 14 inches thick. The upper part is very dark gray, mottled, calcareous, firm silty clay, and the lower part is dark gray, mottled, calcareous, friable silty clay loam. The substratum to a depth of about 60 inches is dark gray and gray, mottled, calcareous silty clay loam. In some places the soil is less than 24 inches deep to olive gray, calcareous silty clay loam. In other places the surface soil and the upper part of the subsoil are noncalcareous.

Permeability is moderately slow, and runoff is ponded. A seasonal high water table is near or above the surface. Available water capacity is high. The content of organic matter is about 8 to 10 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains or tile intakes remove ponded water. Tile drains remove excess subsurface water. Even if the soil is drained, special care generally is needed to maintain good tilth in the surface layer. The availability of plant nutrients is adversely affected by the excess amount of

lime in the soil. Soil structure tends to be weak and breaks down if the soil is cultivated when it is too wet. Puddling results from the breakdown of soil structure. The number of suitable soybean varieties and pesticides is limited by the excess lime.

The wetness and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is helpful. The species that can grow in a wet, calcareous soil should be selected for planting. Applications of phosphorus, potassium, and minor nutrients are needed in most areas.

The land capability classification is IIIw.

6—Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding (fig. 6). Areas typically are 2 to 10 acres in size but range to 50 acres. They are elliptical.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 26 inches thick. The subsoil is mixed dark gray and very dark gray, mottled,

Figure 6.—Ponding in an area of Okoboji silty clay loam, 0 to 1 percent slopes.

friable silty clay loam about 5 inches thick. The upper part of the substratum is grayish brown, mottled, calcareous silty clay loam. The lower part to a depth of about 60 inches is olive gray, mottled, calcareous clay loam. In places the soil is less than 24 inches deep to olive gray silty clay loam. In some areas the surface layer is loam. In other areas the surface soil is calcareous.

Included with this soil in mapping are some small areas of the poorly drained, calcareous Harps soils on the rims of the depressions. These soils make up less than 2 percent of the unit.

Permeability is moderately slow in the Okoboji soil, and runoff is ponded. A seasonal high water table is near or above the surface. Available water capacity is high. The content of organic matter is about 9 to 12 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains or tile intakes remove ponded water. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Cultivating when the soil is too wet causes surface compaction and cloddiness.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is helpful. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes and alluvial fans in the uplands. Slopes generally are short. Areas are irregularly shaped or are long and narrow. Most range from 2 to 15 acres in size, but a few are somewhat larger.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is black and very dark brown loam about 18 inches thick. The subsoil to a depth of about 60 inches is friable loam. The upper part is very dark grayish brown, and the lower part is brown. In some places the lower part of the subsoil and the substratum are stratified loamy sand and sand. In other places the dark surface soil is less than 24 inches thick. In places the slope is more than 5 percent.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. Some are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In places contour farming is difficult because slopes are short and irregular. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or by surface mulch.

The land capability classification is IIe.

28B—Dickman sandy loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex side slopes and ridgetops in the uplands. Most areas range from about 3 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 35 inches thick. It is dark yellowish brown and friable. The upper part is sandy loam, and the lower part is loamy sand. The upper part of the substratum is yellowish brown sand. The lower part to a depth of about 60 inches is brown, mottled, calcareous loamy sand. In places the substratum is silt loam below a depth of 40 inches. In some areas the surface layer is thinner and has pockets and streaks of dark yellowish brown subsoil material. In other areas the surface soil is loam.

Permeability is moderately rapid, and runoff is medium. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture. Erosion is a hazard, especially on the longer slopes. Also, corn and soybeans can be damaged by drought, especially in years when the distribution of rainfall is poor. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and soil blowing and conserves moisture. Contour farming also helps to control erosion. If terraces are constructed on this soil, the cuts could expose the more droughty loamy sand or sand. Plant growth would be poor in the cut areas because of a greatly reduced available water capacity.

Good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain

tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIIe.

28B2—Dickman sandy loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex side slopes and ridgetops in the uplands. Most areas range from about 3 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown sandy loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is about 33 inches thick. It is dark yellowish brown and friable. The upper part is sandy loam, and the lower part is loamy sand. The upper part of the substratum is yellowish brown sand. The lower part to a depth of about 60 inches is brown, mottled, calcareous loamy sand. In places the substratum is silt loam below a depth of 40 inches. In some areas the surface layer is thicker and darker. In other areas it is loam.

Permeability is moderately rapid, and runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture. Erosion is a hazard, especially on the longer slopes. Also, corn and soybeans can be damaged by drought, especially in years when the distribution of rainfall is poor. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and soil blowing and conserves moisture. Contour farming also helps to control erosion. If terraces are constructed on this soil, the cuts could expose the more droughty loamy sand or sand. Plant growth would be poor in the cut areas because of a greatly reduced available water capacity.

Good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIIe.

31—Afton silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in drainageways on uplands. It is occasionally flooded. Areas are long and narrow. Most range from 5 to 25 acres in size, but some are as large as 40 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer also is black silty clay loam. It is about 18 inches thick. The subsoil is dark gray and olive gray, mottled, friable silty clay loam about 12 inches thick. The substratum to a depth of about 60 inches is olive gray and olive, mottled, calcareous silty clay loam. In places the dark surface soil is less than 24 inches thick.

Permeability is moderately slow, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained and protected from flooding, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If tile drainage is not adequate, cultivated crops can be damaged by excess water. Because of runoff from the adjacent soils that are higher on the landscape, crops are damaged by overflow and siltation unless the adjacent soils are terraced and farmed on the contour. Grassed waterways help to prevent rill erosion in the drainageways. A system of conservation tillage that leaves crop residue on the surface helps to control erosion. Timely fieldwork helps to maintain good tilth.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system may be necessary. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

32—Spicer silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in drainageways and low, concave areas on uplands. Most areas range from 5 to 40 acres in size and are longer than they are wide.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is calcareous silty clay loam about 12 inches thick. The upper part is black, and the lower part is very dark gray and is mixed with some grayish brown material. The subsoil is friable, calcareous silty clay loam about 21 inches thick. The upper part is mottled dark gray, olive, grayish brown, and very dark gray; the next part is mottled olive gray and olive; and the lower part is

mottled light olive brown, olive gray, and strong brown. The upper part of the substratum is light brownish gray, mottled, calcareous loamy sand. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In places the dark subsurface layer extends below a depth of 24 inches. In some areas the clay loam in the substratum is within a depth of 40 inches. In other areas the surface soil is noncalcareous.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface ditches and subsurface tile are effective in removing excess water. Because of runoff from the adjacent soils higher on the landscape, crops are damaged by overflow and siltation in some areas. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. If the slopes are sufficiently long and wide, terracing the higher adjacent soils and farming them on the contour also help to prevent this damage. Soil blowing is a hazard in areas where the surface is not protected by plants or crop residue. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface.

If drainage tile is installed and tillage is deferred when this soil is wet, good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

48—Knoke mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in large upland depressions, many of which formerly were shallow lakes. It is subject to ponding. Areas range from 5 to more than 50 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous mucky silt loam about 8 inches thick. The subsurface layer is about 20 inches thick. It is black and calcareous. The upper part is mucky silt loam, and the lower part is silty clay loam. The subsoil is about 14 inches thick. The upper part is very dark gray, mottled, firm, calcareous silty clay, and the lower part is dark gray, mottled, friable, calcareous silty clay loam. The substratum to a depth of about 60 inches is gray and dark gray, mottled, calcareous silty clay loam. In places the surface soil is noncalcareous.

Permeability is moderately slow, and runoff is ponded. A seasonal high water table is near or above the surface. Available water capacity is high. The content of organic matter is about 10 to 15 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. An adequate subsurface and surface drainage system is needed. The availability of plant nutrients is limited by the excess amount of lime in the soil, as is commonly evidenced by stunted soybeans that have yellow leaves. The excess lime limits the number of suitable soybean varieties and pesticides. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is wet hastens the breakdown of soil structure.

The wetness and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is helpful. The species that can grow in a wet, calcareous soil should be selected for planting. Applications of phosphorus, potassium, and minor nutrients are needed in most areas.

The land capability classification is IIIw.

55—Nicollet clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on knolls and swells in the uplands. Most areas range from 2 to 15 acres in size and are oblong, but some are 50 acres or more and are irregularly shaped.

Typically, the surface layer is black clay loam about 7 inches thick. The subsurface layer is very dark gray clay loam about 7 inches thick. The subsoil is friable clay loam about 12 inches thick. The upper part is dark grayish brown and very dark grayish brown, and the lower part is dark grayish brown and yellowish brown and is mottled. The substratum to a depth of about 60 inches is mottled gray, yellowish brown, dark grayish brown, and strong brown, calcareous clay loam. In some places the surface soil is silty clay loam. In other places it is calcareous.

Included with this soil in mapping are small areas of the poorly drained Webster soils on the low parts of the landscape and some areas of the well drained Clarion soils on the higher parts. Also included are small areas of the very poorly drained Rolfe soils in slight depressions. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Nicollet soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Good tilth generally can be easily maintained. Cultivating or grazing when the soil is too wet, however, causes surface compaction. Soil blowing is a hazard if large areas of the soil are plowed in the fall. Returning crop residue to the soil or regularly adding other organic material helps to prevent excessive soil blowing and surface crusting and increases the rate of water infiltration.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal high water table is a moderate limitation. It generally can be overcome, however, by planting species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

62C2—Storden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained, calcareous soil is on knolls and convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are irregularly shaped or are long and narrow. Most range from 2 to 15 acres in size, but some are somewhat larger.

Typically, the surface layer is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is less than 5 or more than 9 percent. In some areas the surface layer is thicker and darker.

Included with this soil in mapping are some small areas of sandy or gravelly, droughty soils on knobs. These soils make up less than 5 percent of the unit. Also included are small areas of Clarion soils. These soils do not have free carbonates in the solum. They are in the less sloping areas. They make up about 5 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

The excess amount of lime in this soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or by surface mulch. The species that can tolerate the excess lime should be selected for planting.

The land capability classification is IIIe.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are long and narrow. Most range from 2 to 10 acres in size, but a few, mainly along the major streams, are 25 acres or more.

Typically, the surface layer is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is less than 9 or more than 14 percent. In some areas the surface layer is thicker and darker.

Included with this soil in mapping are some small areas of sandy or gravelly soils on knobs. These soils make up less than 5 percent of the unit. Also included are small areas of Clarion soils. These soils do not have free carbonates in the solum. They are in the less sloping areas. They make up about 3 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. Some are pastured. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain. Erosion is a severe hazard. Much of the precipitation from intense rainfall runs off unless a plant cover protects the surface. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short and irregular. Good tilth generally can be easily maintained.

Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

The excess amount of lime in this soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

This soil is moderately suited to grasses and legumes for hay and pasture. A cover of grasses and legumes helps to control erosion and runoff. The species that can tolerate the excess lime should be selected for planting. Proper stocking rates and rotation grazing help keep the pasture in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or by surface mulch. The species that can tolerate the excess lime should be selected for planting.

The land capability classification is IIIe.

62E2—Storden loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are long and narrow. Most are 2 to 10 acres in size, but a few, mainly along the major streams, are 25 acres or more.

Typically, the surface layer is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown, calcareous substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is less than 14 or more than 18 percent. In some areas the surface layer is thicker and darker.

Included with this soil in mapping are some areas of the noncalcareous Clarion soils on the less sloping parts of the landscape. Also included are some small areas of sandy or gravelly soils on knobs. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are pastured. This soil is poorly suited to corn and soybeans and is moderately suited to small grain. Erosion is a severe hazard if cultivated crops are grown. A protective plant cover is needed because rainfall runs off the surface rapidly. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In many areas contour farming and terracing are difficult because slopes are too steep and too short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

The excess amount of lime in this soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

This soil is moderately suited to grasses and legumes for hay and pasture. Erosion is a severe hazard if the pasture is overgrazed. Good stands of grasses can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

The land capability classification is IVe.

62G—Storden loam, 18 to 40 percent slopes. This steep and very steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are long and narrow. Most range from 3 to 10 acres in size, but a few along the major streams are 25 acres or more.

Typically, the surface layer is black, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam. In some places the slope is less than 18 percent. In other places the surface layer is thinner and lighter colored.

Included with this soil in mapping are some small areas of soils that are not calcareous in the surface layer. Also included are spots of sandy or gravelly, droughty soils on knobs. Included soils make up less than 5 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is very rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are used for pasture. Some support bluegrass or native grasses. Because of the slope, this soil is unsuitable for cultivated crops. It is better suited to grasses and legumes for hay and pasture, but it is too erodible for unlimited grazing. In areas where farm machinery can be used, fertilizer can be applied and pastures renovated. The availability of plant nutrients is adversely affected by the excess amount of lime in the soil.

The land capability classification is VIIe.

77—Sac silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on the convex tops of ridges in the uplands. Most areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer also is very dark grayish brown silty clay loam. It is about 5 inches thick. The subsoil is brown, friable silty clay loam about 22 inches thick. It is mottled in the lower

part. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous clay loam. In places the depth to glacial till is more than 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Ransom soils. These soils are in the lower areas. They make up about 5 percent of the unit.

Permeability is moderate in the Sac soil, and runoff is slow. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Soil blowing is a hazard in cultivated areas. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

Very few hazards or limitations affect the use of this soil for the trees and shrubs grown as windbreaks or ornamental plantings.

The land capability classification is I.

77B—Sac silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on the convex tops and long sides of ridges in the uplands. Most areas range from 10 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer also is very dark grayish brown silty clay loam. It is about 5 inches thick. The subsoil is brown, friable silty clay loam about 21 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous clay loam. In places the surface layer is less than 7 inches thick and is lighter colored. In some areas the depth to the substratum is more than 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Ransom soils. These soils are in the lower, less sloping areas. They make up about 2 percent of the unit.

Permeability is moderate in the Sac soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, water erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

77B2—Sac silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on the convex tops and sides of ridges in the uplands. Areas are irregularly shaped. Most range from 2 to 10 acres in size, but a few are as large as 50 acres.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown, friable silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous clay loam. In some areas the depth to the substratum is more than 40 inches. In places the surface layer is thicker and darker.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further water erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

77C2—Sac silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Most areas range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. Plowing has mixed

some streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown, friable silty clay loam about 19 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous clay loam. In places the surface layer is thicker and darker. In some areas the content of sand in the surface layer and subsoil is higher.

Included with this soil in mapping are small areas of the well drained, calcareous Storden soils. These soils are in the more convex, more sloping areas. They make up less than 5 percent of the unit.

Permeability is moderate in the Sac soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further water erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIIe.

90—Okoboji mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions, many of which formerly were shallow lakes. It is subject to ponding. Areas are irregularly shaped. Most range from 5 to 20 acres in size, but some are 40 acres or more.

Typically, the surface layer is black mucky silt loam about 8 inches thick. The subsurface layer is black and dark gray silty clay loam about 20 inches thick. The subsoil is about 14 inches of dark gray and very dark gray, mottled, friable silty clay and silty clay loam. The substratum to a depth of about 60 inches is calcareous silty clay loam. The upper part is dark gray and mottled, and the lower part is mottled gray and dark yellowish brown. In places the surface soil is calcareous.

Included with this soil in mapping are small areas of the calcareous Harps soils on the rims of the depressions. These soils make up less than 2 percent of the unit.

Permeability is moderately slow in the Okoboji soil, and runoff is ponded. A seasonal high water table is near or above the surface. Available water capacity is high. The content of organic matter is about 12 to 18 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, small grain, and pasture grasses. Surface drains or tile intakes remove ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. If the soil is adequately drained, good tilth generally can be easily maintained.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system is needed. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIIw.

91—Primghar silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in broad, plane and convex areas on uplands. Areas are irregularly shaped. Most range from about 10 to 100 acres in size, but a few are as large as 1,000 acres.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is silty clay loam about 11 inches thick. The upper part is black, and the lower part is very dark gray mixed with dark grayish brown and black. The subsoil is dark grayish brown and olive brown, mottled, friable silty clay loam about 21 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam. In places the depth to clay loam glacial till is less than 40 inches.

Included with this soil in mapping are small areas of the well drained Galva and poorly drained Marcus soils. These soils make up about 10 percent of the unit. Galva soils are in the higher, more convex areas. Marcus soils are in the lower, more concave areas. Also included are small depressional areas on the lower parts of the landscape. These areas are subject to ponding. They make up about 1 percent of the unit.

Permeability is moderate in the Primghar soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated (fig. 7). This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal high water table is a moderate limitation. It generally can be

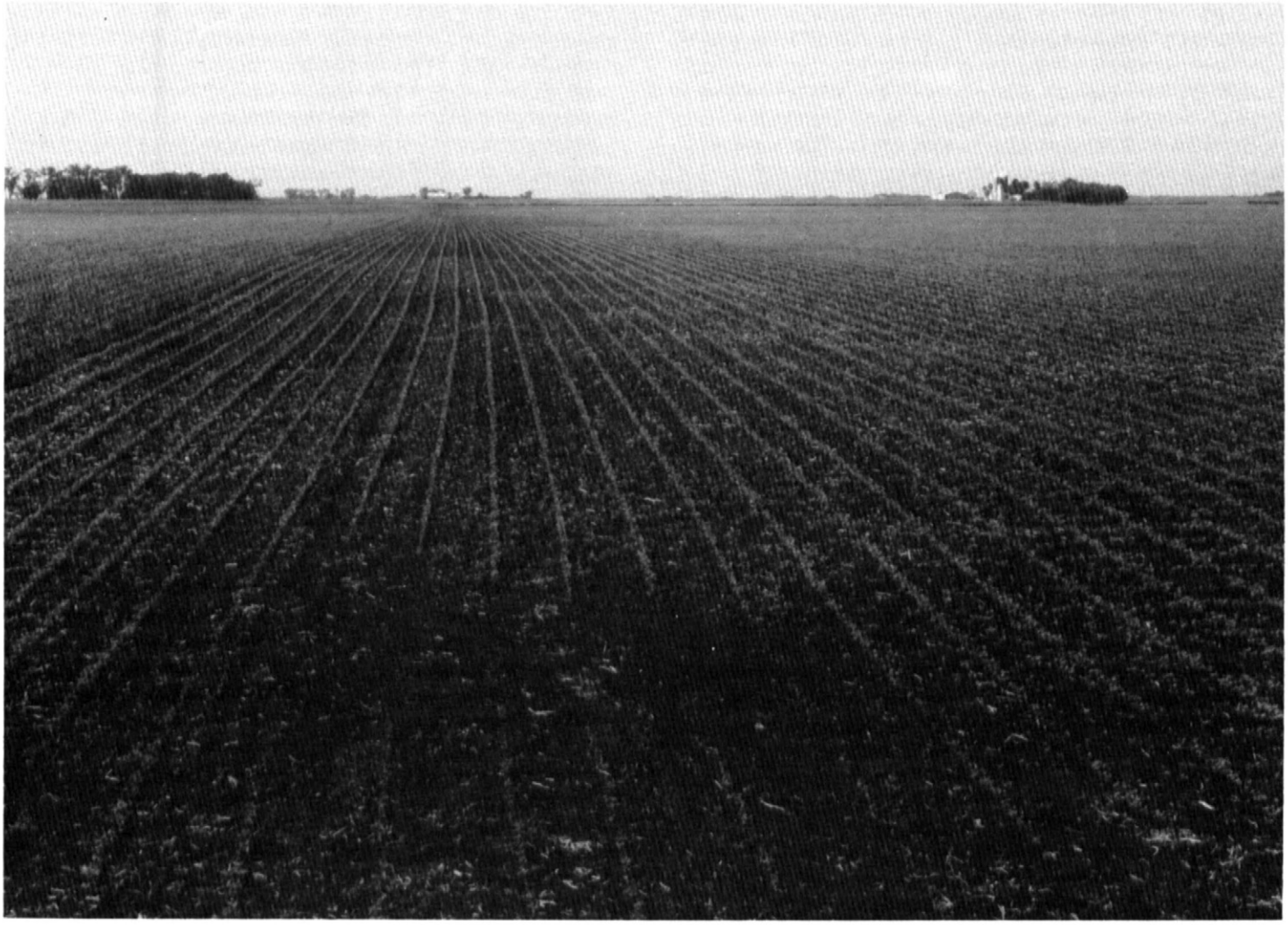


Figure 7.—A cultivated area of Primghar silty clay loam, 0 to 2 percent slopes. The included Marcus soils are in the lower concave areas.

overcome, however, by planting the species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

91B—Primghar silty clay loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is in upland drainageways. Most areas range from about 3 to 20 acres in size and are longer than they are wide.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is silty clay loam about 10 inches thick. The upper part is black, and the lower part is very dark gray mixed with dark grayish brown and black. The subsoil is dark grayish brown and olive brown, mottled, friable silty clay loam about 20 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam. In places the depth to clay loam glacial till is less than 40 inches.

Included with this soil in mapping are small areas of the poorly drained Marcus soils in the concave center of the drainageways. These soils make up about 10 percent of the unit.

Permeability is moderate in the Primghar soil, and runoff is medium. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Unless the surface is protected by crop residue, erosion is a hazard. It can be

controlled, however, by a system of conservation tillage that leaves crop residue on the surface. Because of runoff from the adjacent soils higher on the landscape, crops can be damaged by overflow and siltation. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. Terracing the higher adjacent soils and farming them on the contour also help to prevent this damage.

If tillage is deferred when this soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

Installing drainage tile in included areas of the poorly drained Marcus soils improves the timeliness of fieldwork. The tile line should be installed near the center of drainageways, where the soils tend to be wettest.

The seasonal high water table and the erosion hazard are moderate limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The wetness generally can be overcome by planting the species that can withstand occasional wetness or by installing a drainage system. The erosion hazard can be reduced by surface mulch.

The land capability classification is IIe.

92—Marcus silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in drainageways and on smooth divides in the uplands. Most areas in the upland drainageways occur as narrow bands about 3 to 30 acres in size. Most areas on the divides range from about 10 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 6 inches thick. The subsoil is about 18 inches thick. It is mottled and friable. The upper part is dark grayish brown and olive gray silty clay, and the lower part is olive silty clay loam. The substratum to a depth of about 60 inches is calcareous silty clay loam. The upper part is mottled light olive brown and olive gray, and the lower part is olive gray and mottled. In some places the substratum is loam or clay loam within a depth of 40 inches. In other places the dark surface layer is more than 24 inches thick. In some areas the surface soil is calcareous.

Included with this soil in mapping are some areas of the somewhat poorly drained Primghar soils in the higher landscape positions. These soils make up about 5 percent of the unit.

Permeability is moderately slow in the Marcus soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated crops can be damaged in areas where tile drainage is not adequate. Because of runoff from the adjacent soils higher on the landscape, crops in the drainageways also can be damaged by overflow and siltation. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. Terracing the higher adjacent soils and farming them on the contour also help to prevent this damage.

If drainage tile is installed and tillage is deferred when this soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system may be necessary. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

95—Harps clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in plane or slightly convex areas, typically on the rims of the larger upland depressions. Areas range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is black, calcareous clay loam about 8 inches thick. The subsurface layer is black and very dark gray, calcareous clay loam about 12 inches thick. It is mixed with olive material in the lower part. The subsoil is friable, calcareous clay loam about 23 inches thick. The upper part is olive gray and mottled and is mixed with some very dark gray material, and the lower part is olive gray and mottled. The substratum to a depth of about 60 inches is light olive gray, mottled, calcareous loam.

Included with this soil in mapping are small areas of the very poorly drained Knoke or Okoboji soils in small depressions. These soils make up about 5 percent of the unit.

Permeability is moderate in the Harps soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil and regularly adding other

organic material help to control soil blowing and prevent surface crusting and increase the rate of water infiltration. The excess amount of lime in the soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The seasonal high water table and the excess lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting. A tile drainage system may be necessary.

The land capability classification is IIw.

107—Webster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly concave areas in uplands. Most areas range from 5 to 60 acres in size and are long and narrow, but some are as large as 100 acres and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 12 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is olive gray, mottled, friable clay loam about 17 inches thick. The substratum is light olive gray, mottled, friable, and calcareous. The upper part is clay loam, and the lower part to a depth of about 60 inches is loam. In some places the black surface soil is more than 24 inches thick. In other places the surface soil is calcareous.

Included with this soil in mapping are some small areas of Nicollet, Okoboji, and Revere soils. The somewhat poorly drained Nicollet soils are in the slightly higher areas. The very poorly drained Okoboji soils are in depressions. The poorly drained Revere soils are in landscape positions similar to those of the Webster soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Webster soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system may be necessary. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

108—Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is mainly on slightly convex slopes on stream terraces, but in a few areas it is on uplands. Areas are irregularly shaped. Generally, those on stream terraces are 5 to more than 100 acres in size and those on uplands are 3 to 10 acres.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is mixed very dark gray, dark brown, and brown loam about 3 inches thick. The subsoil is friable loam about 15 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy sand, and the lower part is sand and gravel. In places the depth to loamy sand or to sand and gravel is less than 24 or more than 32 inches.

Included with this soil in mapping are some areas of the somewhat poorly drained Cylinder soils on the lower parts of the landscape. These soils make up less than 5 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Runoff is slow. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing. In areas where an abundant supply of water is available, irrigation can be very effective, especially during crucial growing periods.

The seasonal droughtiness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIs.

108B—Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is mainly on convex slopes on stream terraces, but in a few areas it is on uplands. Areas are

irregularly shaped. Generally, those on stream terraces are 2 to 10 acres in size and those on uplands are 2 to 3 acres.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is mixed very dark gray, dark brown, and brown loam about 2 inches thick. The subsoil is friable loam about 15 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy sand, and the lower part is sand and gravel. In some places the surface layer is thinner and has been mixed with brown subsoil material by plowing. In other places the depth to loamy sand or to sand and gravel is less than 24 or more than 32 inches.

Permeability is moderate in the upper part of the soil and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss and conserves moisture. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion. In areas where an abundant supply of water is available, irrigation can be very effective, especially during crucial growing periods.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIe.

108B2—Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is mainly on convex slopes on stream terraces, but in a few areas it is on uplands. Areas are irregularly shaped. Generally, those on stream terraces are 2 to 10 acres in size and those on uplands are 2 to 3 acres.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. It is mixed with some streaks and pockets of dark yellowish brown subsoil material. The subsoil is friable loam about 15 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy sand, and the lower part is sand and gravel. In some places the surface layer is thicker and darker. In other places the depth to loamy sand or to sand and gravel is less than 24 or more than 32 inches.

Permeability is moderate in the upper part of the soil and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss and conserves moisture. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion. In areas where an abundant supply of water is available, irrigation can be very effective, especially during crucial growing periods.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIe.

135—Coland clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. It is occasionally flooded. Areas range from 10 to 50 acres in size and are long and narrow.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is clay loam about 34 inches thick. It is black in the upper part, very dark gray in the next part, and very dark grayish brown in the lower part. The subsoil is dark gray, friable clay loam about 13 inches thick. It has mottles in the lower part. The substratum to a depth of about 60 inches is dark gray, mottled loam. In some places the surface soil is less than 36 inches thick. In other places it is calcareous. In some areas sand and gravel are within a depth of 48 inches.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 7 percent in the surface layer. The subsurface layer and

subsoil generally have a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. Some areas that are not protected from flooding or that do not have an adequate drainage tile outlet are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture if it is drained and if flooding is controlled. Special care generally is needed to maintain good tilth in the surface layer. Chisel plowing increases the infiltration rate by making the surface more pervious to water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. Water-tolerant grasses and legumes are the best suited pasture plants.

The seasonal high water table and the flooding are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can withstand the wetness and the flooding should be selected for planting.

The land capability classification is IIw.

138B—Clarion clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls in the uplands. Most areas range from 2 to 30 acres in size and are long and narrow, but a few are more than 50 acres and are irregularly shaped.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is mixed very dark grayish brown, brown, and black clay loam about 5 inches thick. The subsoil is dark yellowish brown, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thinner and has been mixed with dark yellowish brown subsoil material by plowing. In other places the surface soil and the upper part of the subsoil are silty clay loam.

Included with this soil in mapping are some areas of the somewhat poorly drained Nicollet soils on the lower parts of the landscape. Also included are some small areas of sandy or gravelly soils on knobs and some areas of the calcareous Storden soils on the higher parts of the landscape. Included soils make up less than 15 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in most areas (fig. 8). They are not feasible, however, in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

138B2—Clarion clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on knolls in the uplands. Areas range from 2 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable clay loam about 11 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In places the surface layer is thicker and darker.

Included with this soil in mapping are some areas of the somewhat poorly drained Nicollet soils on the lower parts of the landscape. Also included are some areas of the calcareous Storden soils on the higher parts of the landscape and some small areas of sandy or gravelly soils on knobs. Included soils make up less than 15 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in most areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

Figure 8.—Terraces on Clarion clay loam, 2 to 5 percent slopes.

If this soil is used for windbreaks or ornamental plantings, further erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

138C—Clarion clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on knolls in the uplands and on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are irregularly shaped or are long and narrow. Most range from 2 to 10 acres in size, but some of those near streams are somewhat larger.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is mixed very dark grayish brown, brown, and black clay loam about 5 inches thick. The subsoil is dark yellowish brown, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thinner and has been mixed with dark yellowish brown subsoil material by plowing. In other places the slope is more than 9 percent.

Included with this soil in mapping are some small areas of sandy or gravelly soils on knobs and areas of the calcareous Storden soils on the steepest part of the slopes. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some

areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a moderate hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

138C2—Clarion clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls in the uplands and on convex side slopes along upland drainageways. Slopes typically are short. Areas range from 5 to 35 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is dark yellowish brown, friable clay loam about 11 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thicker and darker. In other places the slope is more than 9 percent.

Included with this soil in mapping are some small areas of the calcareous Storden soils, which are mainly on the steepest part of the slopes. Also included are areas of sandy or gravelly soils on knobs. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Grassed waterways and a system of conservation tillage that leaves crop residue on the surface help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

138D2—Clarion clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes along streams and drainageways in the uplands. Slopes generally are short. Areas are long and narrow. Most range from 2 to 20 acres in size, but a few are larger.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. Plowing has mixed some of the dark yellowish brown subsoil material with the surface layer. The subsoil is dark yellowish brown, friable clay loam about 10 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thicker and darker. In other places the slope is more than 14 or less than 9 percent.

Included with this soil in mapping are small areas of the calcareous Storden soils and spots of sandy or gravelly soils. Included soils are in the steeper, more convex areas. They make up about 5 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

201B—Coland-Terril complex, 2 to 5 percent slopes. These gently sloping soils are near stream channels. They are occasionally flooded. The poorly drained Coland soil is in upland drainageways, and the moderately well drained Terril soil is on bottom land. Areas generally are 5 to 15 acres in size and are long and narrow. They are about 60 percent Coland soil and 40 percent Terril soil. The two soils occur as areas so narrow that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black clay loam about 9 inches thick. The subsurface layer is clay loam about 34 inches thick. It is black in the upper

part, very dark gray in the next part, and very dark grayish brown in the lower part. The subsoil is dark gray, mottled, friable clay loam about 13 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled loam. In some places the dark surface soil is less than 36 inches thick. In other places the surface soil is calcareous.

Typically, the Terril soil has a surface layer of black loam about 9 inches thick. The subsurface layer is black and very dark brown loam about 18 inches thick. The subsoil is friable loam about 33 inches thick. It is very dark grayish brown in the upper part and brown in the lower part. In some places the dark surface soil is less than 24 inches thick.

These soils are moderately permeable. Runoff is medium. The Coland soil has a seasonal high water table. Available water capacity is high in both soils. The content of organic matter is about 4 to 7 percent in the surface layer. The supply of available phosphorus in the subsurface layer and subsoil of the Coland soil is medium, and the supply of available potassium is very low. The supply of available phosphorus and potassium in the subsoil of the Terril soil is very low.

Most areas are cultivated. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The flooding is a problem, and wetness commonly is a problem in areas where excess water runs in from the adjoining hillsides. Diversion terraces can be built on the upper parts of the landscape, and tile drains have been installed in many areas of the Coland soil. Grassed waterways help to prevent gully erosion. Special care generally is needed to maintain good tilth in the surface layer of the Coland soil. Returning crop residue to the soils or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration in both soils.

The wetness and the occasional flooding are the main limitations if these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system may be necessary. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

202—Cylinder clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces and in outwash areas on uplands. Slopes generally are plane or convex but in places are slightly concave. Areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is clay loam about 7 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown mixed with some dark grayish brown. The subsoil is about 13 inches thick. It is friable. The upper part is dark grayish brown and olive brown clay loam; the next part is olive brown, mottled clay loam; and the lower part is olive brown, mottled sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and gravel. In some places the depth to sand and gravel is more than 32 inches. In other places the surface soil is calcareous.

Included with this soil in mapping are small areas of the well drained Wadena soils on rises and the poorly drained Biscay soils in swales. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the loamy upper part of the Cylinder soil and very rapid in the sandy lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It has a high water table during wet periods but becomes droughty after brief dry periods. Tile drains generally should not be installed because the soil is droughty during most of the growing season. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

Drought is a hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Generally, the species that can withstand the seasonal wetness as well as the droughtiness should be selected for planting. Surface mulch conserves moisture.

The land capability classification is IIs.

203—Cylinder clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces and in outwash areas on uplands. Slopes generally are plane or convex but in places are slightly concave. Areas range from 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown mixed with some dark grayish brown. The subsoil is about 20 inches thick. It is friable. The upper part is dark grayish brown and olive brown clay loam; the next part is olive brown, mottled clay loam; and the lower part is olive brown, mottled sandy loam. The substratum to a depth of about 60 inches is yellowish brown sand and gravel. In some places the depth to sand and gravel is less than 32 or more than 40 inches. In other places the surface soil is calcareous.

Included with this soil in mapping are small areas of the well drained Wadena soils on rises and the poorly

drained Biscay soils in swales. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the loamy upper part of the Cylinder soil and very rapid in the sandy lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It has a high water table during wet periods but becomes droughty after brief dry periods. Tile drains generally should not be installed because the soil is droughty during much of the growing season. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

Drought is a hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Generally, the species that can withstand the seasonal wetness as well as the droughtiness should be selected for planting. Surface mulch conserves moisture.

The land capability classification is IIs.

259—Biscay silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil is in low areas on stream terraces. Areas generally range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black clay loam about 13 inches thick. It is mixed with olive gray material in the lower part. The subsoil is about 14 inches thick. It is mottled. The upper part is olive gray clay loam mixed with very dark gray material; the next part is dark grayish brown clay loam; and the lower part is grayish brown gravelly sandy loam. The substratum to a depth of about 60 inches is olive gray gravelly coarse sand. In a few places the depth to the underlying sandy and gravelly material is less than 32 or more than 40 inches. In some areas the dark surface soil is more than 24 inches thick. In other areas the surface soil is calcareous.

Included with this soil in mapping are some small areas of the somewhat poorly drained Cylinder soils in the slightly higher landscape positions. These soils make up less than 5 percent of the unit.

Permeability is moderate in the loamy upper part of the Biscay soil and rapid in the sandy lower part. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter is about 5.5 to 6.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains can remove excess water, but installing the drains may be difficult because of slippage of the sand and gravel into the tile trench. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Almost any climatically adapted species can be grown if a drainage system is installed.

The land capability classification is IIw.

272—Kanaranzi Variant loam, 0 to 2 percent slopes. This nearly level, well drained soil is in glacial outwash areas and on stream terraces. Most areas range from about 3 to 35 acres in size and are long and narrow.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is brown, friable sandy clay loam about 12 inches thick. The upper part of the substratum is dark yellowish brown, calcareous gravelly coarse sandy loam. The next part is yellowish red, calcareous gravelly sandy loam. The lower part to a depth of about 60 inches is brown, calcareous gravelly loamy coarse sand. In some places the gravelly coarse sandy loam in the substratum is at or near the surface. In other places it is below a depth of 40 inches.

Permeability is moderate in the upper part of the soil and rapid in the substratum. Runoff is slow. Available water capacity is low. The content of organic matter is about 2 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture, but an even distribution of rainfall is needed. Soil blowing is also a hazard in areas where the surface is not protected by plants or crop residue. Also, droughtiness is a limitation. It results in more frequent damage to corn and soybeans than to small grain. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and soil blowing and conserves moisture. For most plants, root development is restricted by the sand and gravel at a depth of 15 to 24 inches.

Good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and

shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIIs.

272B—Kanaranzi Variant loam, 2 to 5 percent slopes. This gently sloping, well drained soil is in glacial outwash areas and on stream terraces. Most areas range from about 3 to 25 acres in size and are long and narrow.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is brown, friable sandy clay loam about 11 inches thick. The upper part of the substratum is dark yellowish brown, calcareous gravelly coarse sandy loam. The next part is yellowish red, calcareous gravelly sandy loam. The lower part to a depth of about 60 inches is brown, calcareous gravelly coarse loamy sand. In places the surface layer is thinner and lighter colored and has pockets and streaks of brown subsoil material. In some areas the gravelly coarse sandy loam in the substratum is at or near the surface. In other areas it is below a depth of 40 inches.

Permeability is moderate in the upper part of the soil and rapid in the substratum. Runoff is slow. Available water capacity is low. The content of organic matter is about 2 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture, but an even distribution of rainfall is needed. If cultivated crops are grown, erosion is a hazard. Soil blowing also is a hazard in areas where the surface is not protected by plants or crop residue. Droughtiness is a limitation. It results in more frequent damage to corn and soybeans than to small grain. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and soil blowing and conserves moisture. In areas where slopes are sufficiently long and wide, contour farming also helps to control erosion. Terraces generally are not constructed on this soil because the cuts would expose the unproductive coarse textured material in most areas. For most plants, root development is restricted by the sand and gravel at a depth of 15 to 24 inches.

Good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIIe.

272C2—Kanaranzi Variant loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is in glacial outwash areas and on stream terraces. Most areas range from about 3 to 15 acres in size and are long and narrow.

Typically, the surface layer is black loam about 8 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown, friable sandy clay loam about 10 inches thick. The upper part of the substratum is dark yellowish brown, calcareous gravelly coarse sandy loam. The next part is yellowish red, calcareous gravelly sandy loam. The lower part to a depth of about 60 inches is brown, calcareous gravelly loamy coarse sand. In some places the surface layer is thicker and darker. In other places the gravelly coarse sandy loam in the substratum is at or near the surface. In some areas the slope is more than 9 percent.

Permeability is moderate in the upper part of the soil and rapid in the substratum. Runoff is slow. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture, but an even distribution of rainfall is needed. If cultivated crops are grown, erosion is a hazard. Soil blowing also is a hazard in areas where the surface is not protected by plants or crop residue. Droughtiness is a limitation. It results in more frequent damage to corn and soybeans than to small grain. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and soil blowing and conserves moisture. In areas where slopes are sufficiently long and wide, contour farming also helps to control erosion. Terraces generally are not constructed on this soil because the cuts would expose the unproductive coarse textured material in most areas. For most plants, root development is restricted by the sand and gravel at a depth of 15 to 24 inches.

Good tilth generally can be easily maintained in the surface layer. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally

droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IVe.

274—Rolfe silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in small upland depressions. It is subject to ponding. Areas range from 2 to 8 acres in size and are nearly round or oblong.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer is dark gray, mottled silt loam about 13 inches thick. It is mixed with some very dark gray material in the upper part. The subsoil is about 30 inches thick. The upper part is very dark gray, mottled, firm silty clay, and the lower part is olive gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is olive gray, mottled clay loam. In places the soil has no subsurface layer.

Permeability is slow, and runoff is ponded. A seasonal high water table is near or above the surface. Available water capacity is high. The content of organic matter is about 3.5 to 5.0 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Because the subsoil is slowly permeable, tile ditches commonly are backfilled with porous material. Surface drains commonly help to remove ponded water. Good tilth generally can be easily maintained. Cultivating when the soil is wet causes cloddiness and a poor seedbed. Returning crop residue to the soil or regularly adding other organic material helps to prevent surface crusting and increases the rate of water infiltration.

The seasonal high water table is a limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the wetness should be selected for planting, especially if no drainage system is installed.

The land capability classification is IIIw.

282—Ransom silty clay loam, 0 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in broad, plane and convex areas on uplands. Areas are irregularly shaped. Most range from 5 to 50 acres in size, but a few are as large as 200 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 11 inches thick. The upper part is very dark gray, and the lower part is very dark gray and very dark grayish brown. The subsoil is dark grayish brown and olive brown, friable silty clay loam about 13 inches thick. The upper part of the substratum is mottled olive brown and grayish brown, calcareous loam. The lower part to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In a few places the depth to glacial till is more than 40 inches.

Included with this soil in mapping are some areas of the poorly drained Marcus soils in the lower landscape positions. Also included are some areas of the well drained Sac soils in the higher positions. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Ransom soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because of runoff from the adjacent soils higher on the landscape, crops are damaged by overflow and siltation in some concave areas. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. Terracing the higher adjacent soils and farming them on the contour also help to prevent this damage. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal high water table is a moderate limitation. It generally can be overcome, however, by planting the species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

308—Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is mainly on slightly convex slopes on stream terraces, but in a few areas it is on uplands. Areas are irregularly shaped. Those on stream terraces are 3 to 30 acres in size and those on uplands are 3 to 5 acres.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is mixed very dark gray, dark brown, and brown loam about 5 inches thick. The subsoil is friable loam about 20 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy sand, and the lower part is sand and gravel. In places the depth to loamy sand or to sand and gravel is less than 32 or more than 40 inches.

Included with this soil in mapping are some areas of the somewhat poorly drained Cylinder soils on the lower parts of the landscape. These soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Runoff is slow. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing. In areas where an abundant supply of water is available, irrigation is very effective, especially during crucial growing periods.

Drought is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Surface mulch conserves moisture.

The land capability classification is IIs.

308B—Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is mainly on convex stream terraces, but in a few areas it is on uplands. Areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is mixed very dark gray, dark brown, and brown loam about 4 inches thick. The subsoil is friable loam about 19 inches thick. The upper part is dark yellowish brown mixed with very dark grayish brown and very dark gray, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown. The upper part is gravelly loamy coarse sand, and the lower part is sand and gravel. In some places the depth to sand and gravel is more than 40 or less than 32 inches. In other places the surface layer is thinner and is mixed with dark yellowish brown subsoil material.

Permeability is moderate in the upper part of the soil and very rapid in the substratum. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A system of conservation tillage that leaves crop residue on the surface, a cropping sequence that includes grasses and legumes, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion. Good tilth generally can be easily maintained. In areas where an abundant supply of water is available, irrigation is very effective, especially during crucial growing periods.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. Also, the soil is seasonally droughty. Surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIe.

309—Allendorf silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on terraces adjacent to the major streams. Areas are irregularly shaped. Most are 5 to 50 acres in size, but some are as large as 80 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is about 5 inches of very dark grayish brown silty clay loam mixed with dark brown material. The subsoil is about 24 inches thick. The upper part is dark yellowish brown, friable silty clay loam that has dark brown coatings; the next part is dark yellowish brown, friable silty clay loam and silt loam; and the lower part is brown, friable loam. The upper part of the substratum is brown, calcareous very gravelly loamy coarse sand. The lower part to a depth of about 60 inches is yellowish brown, calcareous gravelly sand. In places the depth to sand and gravel is less than 32 or more than 40 inches.

Permeability is moderate in the upper part of the soil and very rapid in the substratum. Runoff is slow. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. If cultivated crops are grown, soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface and by field windbreaks. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion. Good tilth generally can be easily maintained.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal droughtiness is a problem. Surface mulch conserves moisture. The species that can withstand the droughtiness should be selected for planting, or

supplemental water should be applied if irrigation is practical.

The land capability classification is IIs.

309B—Allendorf silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on terraces adjacent to the major streams. Most areas are 5 to 20 acres in size and are irregularly shaped.

Typically the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is about 4 inches of very dark grayish brown silty clay loam mixed with black and dark brown material. The subsoil is about 24 inches thick. The upper part is dark yellowish brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam and silt loam; and the lower part is brown, friable loam. The substratum is brown and yellowish brown and is calcareous. The upper part is very gravelly loamy coarse sand, and the lower part to a depth of about 60 inches is gravelly sand. In some places the depth to sand and gravel is less than 32 or more than 40 inches. In other places some dark yellowish brown subsoil material has been mixed into the surface layer.

Included with this soil in mapping are small areas of sandy and gravelly soils on small knobs. These soils generally make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Allendorf soil and very rapid in the substratum. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control erosion. Good tilth generally can be easily maintained.

If this soil is used for the trees and shrubs as windbreaks or ornamental plantings, the seasonal droughtiness and erosion are problems. Surface mulch conserves moisture and helps to control erosion. The species that can withstand the droughtiness should be selected for planting, or supplemental water should be applied if irrigation is practical.

The land capability classification is IIe.

310—Galva silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad ridgetops and in plane or slightly convex areas on drainage divides. Areas are irregularly shaped. Most range from about 5 to 40 acres in size, but a few are as large as 80 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 9 inches thick. The upper part is very dark brown mixed with some very dark grayish brown, and the lower part is very dark grayish brown mixed with some dark brown and brown. The subsoil is about 22 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is silt loam. The upper part of the substratum is brown, calcareous silt loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous clay loam. In places the clay loam in the substratum is within a depth of 40 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Primghar soils. These soils are in slightly concave areas. They make up less than 5 percent of the unit.

Permeability is moderate in the Galva soil, and runoff is slow. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface and by field windbreaks. Good tilth generally can be easily maintained.

Very few hazards or limitations affect the use of this soil for the trees and shrubs grown as windbreaks or ornamental plantings.

The land capability classification is I.

310B—Galva silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on the convex tops and long sides of ridges in the uplands. Most areas range from about 5 to 60 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is silty clay loam about 8 inches thick. The upper part is very dark brown mixed with some very dark grayish brown, and the lower part is very dark grayish brown mixed with some dark brown and brown. The subsoil is about 21 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is silt loam. The upper part of the substratum is brown, calcareous silt loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous clay loam. In some places the clay loam in the substratum is within a depth of 40 inches. In other places the surface layer is very dark grayish brown and has pockets and streaks of brown subsoil material.

Included with this soil in mapping are small areas of the somewhat poorly drained Primghar soils. These soils

are in slightly concave areas. They make up less than 5 percent of the unit.

Permeability is moderate in the Galva soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, water erosion is a hazard, especially on the longer slopes. A system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces help to prevent excessive soil loss and control runoff. Good tilth generally can be easily maintained.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

311—Galva silty clay loam, gravelly substratum, 0 to 2 percent slopes. This nearly level, well drained soil is on broad stream benches. Areas are irregularly shaped. They generally are 40 to 100 acres in size but range from 5 to 700 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 10 inches thick. The subsoil is about 24 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is silt loam. The upper 13 inches of the substratum is brown silt loam. The lower part to a depth of about 60 inches is brown and yellowish brown, stratified sand and gravel (fig. 9). In places the depth to stratified sand and gravel is less than 48 inches.

Permeability is moderate in the silty upper part of the soil and very rapid in the sandy and gravelly lower part. Runoff is slow. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface and by field windbreaks. Good tilth generally can be easily maintained.

Very few hazards or limitations affect the use of this soil for the trees and shrubs grown as windbreaks or ornamental plantings.

The land capability classification is I.

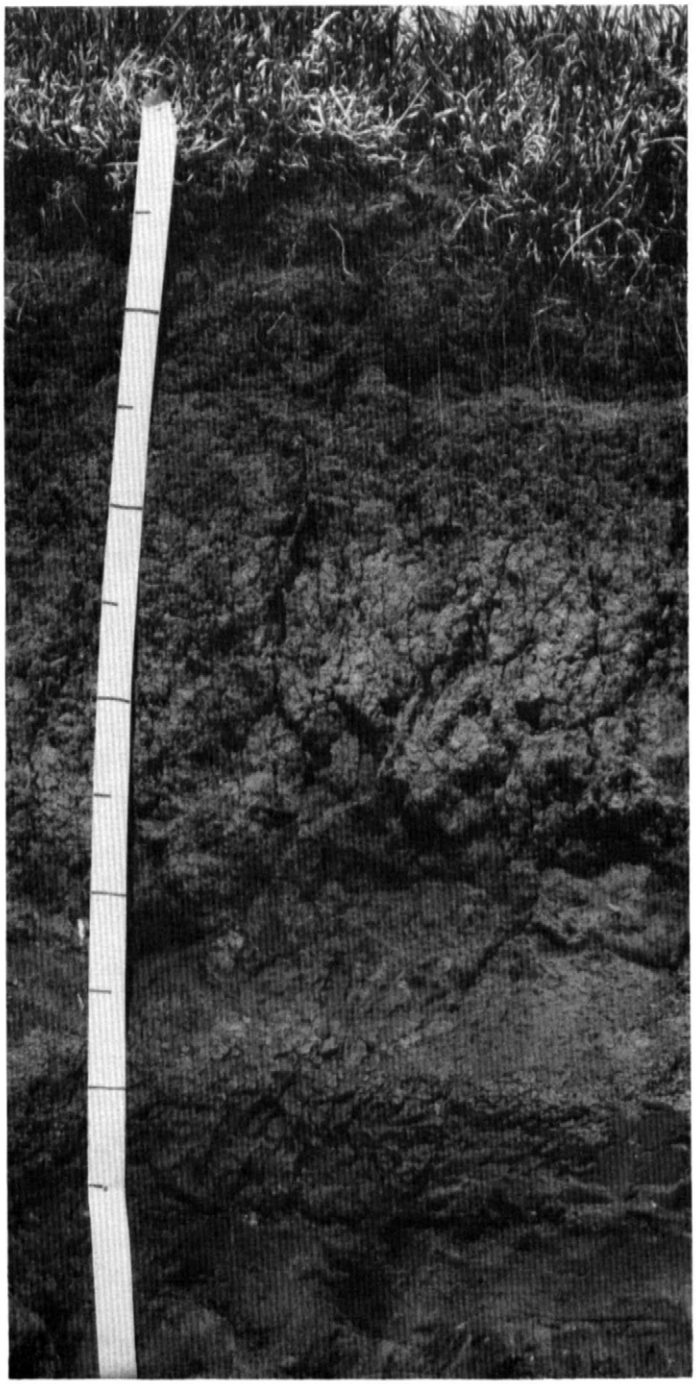


Figure 9.—Profile of Galva silty clay loam, gravelly substratum, 0 to 2 percent slopes. The depth to sand and gravel is about 5.5 feet. The marks on the tape are 6 inches apart.

311B—Galva silty clay loam, gravelly substratum, 2 to 5 percent slopes. This gently sloping, well drained soil is on stream benches. Areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 23 inches thick. It is brown and friable. It is silty clay loam in the upper part and silt loam in the lower part. The upper part of the substratum is brown silt loam about 15 inches thick. The lower part to a depth of about 60 inches is brown and yellowish brown, stratified sand and gravel. In some places the surface layer is very dark grayish brown and has pockets and streaks of brown subsoil material. In other places the depth to stratified sand and gravel is less than 48 inches.

Included with this soil in mapping are small areas of soils that have stratified sand and gravel at or near the surface. These soils are in convex areas on the slightly higher parts of the landscape. They make up less than 1 percent of the unit.

Permeability is moderate in the silty upper part of the Galva soil and very rapid in the sandy and gravelly lower part. Runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If row crops are grown year after year, water erosion and soil blowing are hazards. They can be controlled by grassed waterways, a system of conservation tillage that leaves crop residue on the surface, and contour farming. Where feasible, terracing also can prevent excessive soil loss. Good tilth can be easily maintained by returning crop residue to the soil.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

354—Aquolls, ponded. These very poorly drained soils are in depressions adjacent to lakes and in shallow depressions on uplands. They are subject to ponding by runoff from the adjacent soils. Areas range from 3 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam or clay loam about 10 inches thick. The subsurface layer is black, very dark gray, or dark gray silty clay loam, clay loam, loam, or sandy loam about 30 inches thick. The substratum to a depth of about 60 inches is very dark gray, dark gray, or gray silty clay loam, clay loam, or loam.

Permeability generally is moderately slow. Available water capacity generally is high. In most areas, either small ponds are evident or the water table is at or near the surface throughout the year. The content of organic matter ranges from about 9 to 18 percent in the surface layer.

Most areas are idle or are used as wildlife habitat. These soils generally are suited to wetland wildlife habitat but are unsuited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Installing a drainage system is very difficult because suitable outlets are not available.

The land capability classification is VIIw.

384—Collinwood silty clay loam, 0 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in slightly convex to slightly concave areas on uplands. Most areas range from 3 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay about 5 inches thick. The subsoil is mottled, firm silty clay about 18 inches thick. The upper part is dark grayish brown, and the lower part is olive brown. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous silty clay loam. In some places a substratum of loam is within a depth of 40 inches. In other places the surface soil is loam or clay loam.

Included with this soil in mapping are small areas of the well drained Kamrar and poorly drained Waldorf soils. Kamrar soils are in the higher areas. Waldorf soils are in the lower concave areas. Included soils make up about 10 percent of the unit.

Permeability is slow in the Collinwood soil. Runoff also is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drainage improves soil aeration and the timeliness of tillage in some areas. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

The seasonal high water table and a high shrink-swell potential are moderate limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The seasonal high water table generally can be overcome by planting species that can withstand occasional wetness or by installing a drainage system. The high shrink-swell potential can be overcome by

mulching and applying water, so that the soil does not become too dry.

The land capability classification is IIw.

387B—Kamrar silty clay loam, 1 to 5 percent slopes. This gently sloping, well drained soil is on the convex tops of ridges in the uplands. Most areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay about 9 inches thick. The upper part is black, and the lower part is very dark gray mixed with brown. The subsoil is firm silty clay about 18 inches thick. The upper part is brown, and the lower part is dark yellowish brown and mottled. The upper part of the substratum is olive brown, mottled, calcareous clay loam. The lower part to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some places the surface layer is less than 8 inches thick and is lighter colored. In other places the slope is more than 5 percent.

Included with this soil in mapping are small areas of the somewhat poorly drained Collinwood soils. These soils are in the lower areas. They make up about 5 percent of the unit.

Permeability is moderately slow in the Kamrar soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to erosion, especially on the longer slopes. A system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces help to control erosion and soil blowing. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch. The high shrink-swell potential is a moderate limitation. It can be overcome by mulching and applying water, so that the soil does not become too dry.

The land capability classification is IIe.

390—Waldorf silty clay loam, 0 to 1 percent slopes. This level, poorly drained soil is in plane and concave areas on uplands. Most areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is about 10 inches of black silty clay loam mixed with some very dark gray material. The subsoil is mottled, firm silty clay about 15 inches thick. The upper part is dark gray and has some pockets of very dark gray material, the next part is dark grayish brown, and the lower part is olive gray. The substratum to a depth of about 60 inches is mottled, calcareous silty clay loam. It is gray in the upper part and grayish brown in the lower part. In a few places the part of the substratum within a depth of 48 inches is clay loam. In some areas the dark surface soil is more than 24 inches thick. In other areas the surface soil is calcareous.

Included with this soil in mapping are small areas of very poorly drained soils in depressions. These soils are subject to ponding. Also included are small areas of the somewhat poorly drained Collinwood soils in the higher landscape positions. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Waldorf soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated crops can be damaged in areas where tile drainage is not adequate. Tile removes excess water more slowly from this soil than from less clayey soils. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface. If drainage tile is installed and tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

The wetness and a high shrink-swell potential are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the wetness should be selected for planting, or a drainage system should be installed. The high shrink-swell potential can be overcome by mulching and applying water, so that the soil does not become too dry.

The land capability classification is IIw.

396—Letri silty clay loam, calcareous, 0 to 2 percent slopes. This nearly level, poorly drained soil is in drainageways and on smooth divides in the uplands. Areas range from 10 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is calcareous silty clay loam about 13 inches thick. The upper part is black, and the lower part is mixed very dark gray, black, and grayish brown. The subsoil is about 19 inches thick. It is friable and calcareous. The upper part

is mixed dark gray, very dark gray, and olive brown silty clay loam; the next part is olive gray and light olive brown silty clay loam; and the lower part is mottled olive gray, light olive brown, and yellowish brown loam. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous clay loam. In some places the dark surface soil is more than 24 inches thick. In other places the surface soil and subsoil are noncalcareous.

Included with this soil in mapping are small areas of Revere and Wilmonton soils. The poorly drained, calcareous Revere soils have gypsum crystals in the upper 30 inches. They are in landscape positions similar to those of the Letri soil. The somewhat poorly drained Wilmonton soils are higher on the landscape than the Letri soil. Also, they have a brighter colored subsoil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Letri soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 8 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. A few are used for hay or pasture. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface ditches and subsurface tile are effective in removing excess water. Because of runoff from the adjacent soils higher on the landscape, crops are damaged by overflow and siltation in some areas. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. If the slopes are sufficiently long and wide, terracing the higher adjacent soils and farming them on the contour also help to prevent this damage. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface.

If drainage tile is installed and tillage is deferred when this soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

397—Letri silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in drainageways and on smooth divides in the uplands. Areas range from 3 to 60 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is silty clay loam about 13 inches thick. The upper part is black, and the lower part is mixed very dark gray, black, and grayish brown. The subsoil is about 19 inches thick. The upper part is mixed dark gray, very dark gray, and olive brown, friable silty clay loam; the next part is olive gray and light olive brown, friable silty clay loam; and the lower part is mottled olive gray, light olive brown, and yellowish brown, friable, calcareous loam. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous clay loam. In some places the dark surface soil is more than 24 inches thick. In other places the soil is calcareous throughout.

Included with this soil in mapping are small areas of the somewhat poorly drained Wilmonton soils on the higher parts of the landscape. These soils make up about 5 percent of the unit.

Permeability is moderate in the Letri soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 8 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated crops can be damaged in areas where tile drainage is not adequate. Because of runoff from the adjacent soils higher on the landscape, crops also can be damaged by overflow and siltation in the drainageways. Establishing grassed waterways in areas where runoff concentrates and installing tile in the waterways help to prevent this damage. Terracing the higher adjacent soils and farming them on the contour also help to prevent this damage. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface.

If drainage tile is installed and tillage is deferred when this soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A drainage system may be necessary. The species that can withstand the wetness should be selected for planting.

The land capability classification is IIw.

433D2—Storden clay loam, 7 to 14 percent slopes, moderately eroded. This strongly sloping, well drained, calcareous soil is on convex side slopes along streams

and upland drainageways. Slopes generally are short. Areas are long and narrow. Most are 2 to 10 acres in size, but a few, mainly along the major streams, are 25 acres or more.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous clay loam. In some places the slope is more than 14 percent. In other places the surface layer is thicker and darker.

Included with this soil in mapping are small areas of the noncalcareous Everly soils on the less sloping parts of the landscape. These soils make up about 5 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain. Erosion is a severe hazard. Much of the precipitation from intense rainfall runs off unless a plant cover protects the surface. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in areas where slopes are short and irregular. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

The excess amount of lime in this soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

Some areas are used as hayland or pasture. This soil is moderately suited to grasses and legumes for hay and pasture. A cover of grasses and legumes helps to control erosion and runoff. The species that can withstand a high pH should be selected for planting. Proper stocking rates and rotation grazing help to keep the pasture in good condition.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

433E2—Storden clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are long and narrow. Most are 2 to 10 acres in size, but a few, mainly along the major streams, are 25 acres or more.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous clay loam. In some places the slope is less than 14 or more than 18 percent. In other places the surface layer is thicker and darker.

Included with this soil in mapping are some areas of the noncalcareous Everly soils on the less sloping parts of the landscape. These soils make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is poorly suited to corn and soybeans and is moderately suited to small grain. Erosion is a severe hazard if cultivated crops are grown. A protective plant cover is needed because rainfall runs off the surface rapidly. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In many areas farming on the contour and terracing are difficult because the slopes are too steep and too short. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

The excess amount of lime in this soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

Some areas are pastured. This soil is moderately suited to grasses and legumes for hay and pasture. Erosion is a severe hazard if the pasture is overgrazed. Good stands of grasses can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

The land capability classification is IVe.

433G—Storden clay loam, 18 to 40 percent slopes. This steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Areas are long and narrow. Most are 3 to 10 acres in size, but a few along the major streams are 25 acres or more.

Typically, the surface layer is black, calcareous clay loam about 5 inches thick. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous clay loam. In places the slope is less than 18 percent. In some areas the surface layer is thinner and lighter colored. In other areas it is noncalcareous.

Permeability is moderate, and runoff is very rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The

substratum generally has a very low supply of available phosphorus and potassium.

Most areas are pastured. Some support bluegrass or native grasses. Because of the steep slope, this soil generally is unsuitable for cultivated crops. It is better suited to grasses and legumes for hay and pasture, but it is too erodible for unlimited grazing. In areas where farm machinery can be used, fertilizer can be applied and pastures renovated. The availability of plant nutrients is adversely affected by the excess amount of lime in the soil.

The land capability classification is VIIe.

456—Wilmonton silty clay loam, 0 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in broad, plane and convex areas on uplands. Most areas range from 5 to more than 100 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is about 5 inches of black silty clay loam mixed with some very dark grayish brown material. The subsoil is mottled, friable silty clay loam about 15 inches thick. The upper part is mixed very dark grayish brown and very dark gray, and the lower part is olive brown. The upper part of the substratum is grayish brown, mottled, calcareous silt loam. The next part is mottled light gray and yellowish brown, calcareous clay loam. The lower part to a depth of about 60 inches is mottled yellowish brown, light gray, strong brown, and light olive brown, calcareous loam.

Included with this soil in mapping are small areas of the well drained Everly soils in the higher landscape positions and the poorly drained Letri soils in the lower positions. Also included are small depressional areas on the lower parts of the landscape. These areas are subject to ponding. Included soils make up about 15 percent of the unit.

Permeability is moderately slow in the Wilmonton soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because of runoff from the adjacent soils, crops are damaged by overflow and siltation in some concave areas. Establishing grassed waterways in areas where runoff concentrates helps to prevent this damage. Terracing the higher adjacent soils and farming them on the contour also help to prevent this damage. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal high water table is a moderate limitation. It generally can be overcome, however, by planting the species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

507—Canisteo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil typically is in shallow swales on uplands. Areas are irregularly shaped. Most range from 5 to 50 acres in size, but a few are as large as 150 acres.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is calcareous silty clay loam about 10 inches thick. The upper part is black, and the lower part is mixed very dark gray, black, and olive gray. The subsoil is mottled, friable, calcareous clay loam about 16 inches thick. The upper part is olive gray, and the lower part is gray and olive gray. The substratum to a depth of about 60 inches is gray and olive gray, mottled, calcareous clay loam. In some places the dark surface soil extends to a depth of more than 24 inches. In other places the surface soil is noncalcareous.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions and small areas of the calcareous Revere soils. Revere soils have gypsum crystals in the surface soil and subsoil. They are in landscape positions similar to those of the Canisteo soil. Also included are areas of the somewhat poorly drained Crippin soils in the slightly higher landscape positions. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Canisteo soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 6 to 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and

shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

559—Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on stream terraces. Areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is calcareous silty clay loam about 12 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is dark gray, friable, calcareous clay loam about 16 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is olive brown and yellowish brown, calcareous sand. In a few places the depth to sand and gravel is 24 to 32 inches or is more than 40 inches. In some areas the dark surface soil is more than 24 inches thick. In other areas the surface soil is noncalcareous.

Included with this soil in mapping are small areas of the somewhat poorly drained Cylinder soils. These soils are in the slightly higher landscape positions. They make up less than 5 percent of the unit.

Permeability is moderate in the upper part of the Talcot soil and rapid in the substratum. Runoff is slow. Available water capacity is moderate. The soil has a seasonal high water table. The content of organic matter is about 5.5 to 6.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains can remove excess subsurface water, but installing the drains may be difficult because of slippage of the sand and gravel into the tile trench. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of some plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

577—Everly clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad upland ridgetops. Most areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark gray and dark brown clay loam about 7 inches thick. The subsoil is clay loam about 22 inches thick. The upper part is brown and friable; the next part is yellowish brown, calcareous, and firm; and the lower part is yellowish brown, mottled, calcareous, and firm. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Wilmonton soils in the lower landscape positions. These soils make up about 5 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is slow. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled, however, by a system of conservation tillage that leaves crop residue on the surface. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

Very few hazards or limitations affect the use of this soil for the trees and shrubs grown as windbreaks or ornamental plantings.

The land capability classification is I.

577B—Everly clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on the convex tops and long sides of ridges in the uplands. Areas are irregularly shaped. Most range from 5 to 50 acres in size, but some are as large as 100 acres.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is mixed very dark gray and dark brown clay loam about 6 inches thick. The subsoil is clay loam about 21 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the surface layer is less than 8 inches thick and is lighter colored.

Included with this soil in mapping are small areas of the somewhat poorly drained Wilmonton soils and small areas of gravelly soils that tend to be droughty. Wilmonton soils are in concave areas at the upper end

of drainageways. The gravelly soils are on knobs. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

577B2—Everly clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on the convex tops and sides of ridges in the uplands. Most areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is clay loam about 20 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the surface layer is more than 8 inches thick and is darker.

Included with this soil in mapping are small areas of the calcareous Storden soils and small areas of gravelly soils that tend to be droughty. Both of the included soils are on knobs. They make up about 10 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, further erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

577C—Everly clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in the uplands. Most areas range from 5 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark gray and dark brown clay loam about 5 inches thick. The subsoil is clay loam about 20 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the surface layer is less than 8 inches thick and is lighter colored.

Included with this soil in mapping are small areas of the calcareous Storden soils and small areas of gravelly soils that tend to be droughty. Both of the included soils are on knobs. They make up about 10 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard, especially on the longer slopes. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. If slopes are sufficiently long and wide, contour farming and terraces also can help to control erosion. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

577C2—Everly clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on side slopes in the uplands. Most areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is clay loam about 19 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the surface layer is more than 8 inches thick and is darker.

Included with this soil in mapping are small areas of the calcareous Storden soils and small areas of gravelly soils that tend to be droughty. Both of the included soils are on knobs. They make up about 10 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. If slopes are sufficiently long and wide, contour farming and terraces also can help to control erosion. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

577D2—Everly clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on side slopes in the uplands. Most areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is clay loam about 18 inches thick. The upper part is brown and friable; the next part is yellowish brown, firm, and calcareous; and the lower part is yellowish brown, mottled, firm, and calcareous. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the surface layer is more than 8 inches thick and is darker.

Included with this soil in mapping are small areas of the calcareous Storden soils and small areas of gravelly soils that tend to be droughty. Both of the included soils are on knobs. They make up about 10 percent of the unit.

Permeability is moderate in the Everly soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. If slopes are sufficiently long and wide, contour farming and terraces also can help to control erosion. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

638C2—Clarion-Storden complex, 5 to 9 percent slopes, moderately eroded. These moderately sloping, well drained soils are on ridges and side slopes near large drainageways. The Clarion soil is in the smoother, less sloping areas, and the Storden soil is in the more convex areas. Individual areas range from 2 to 10 acres in size and are longer than they are wide. They are about 70 percent Clarion soil and 25 percent Storden soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable clay loam about 11 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thicker and darker. In other places the slope is more than 9 percent.

Typically, the surface layer of the Storden soil is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled,

calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is more than 9 percent. In some areas the surface layer is thicker and darker.

Included with these soils in mapping are some small areas of sandy or gravelly soils on knobs. These included soils make up less than 5 percent of the unit.

Permeability is moderate in the Clarion and Storden soils, and runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 3.0 percent in the surface layer. The subsoil of the Clarion soil and the substratum of the Storden soil have a very low supply of available phosphorus and potassium.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Farming on the contour and terracing are difficult because of an undulating topography and uneven side slopes. Good tilth generally can be easily maintained. Returning crop residue to the soils or regularly adding other organic material improves fertility and increases the rate of water infiltration.

If these soils are used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIIe.

638D2—Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on ridges and side slopes near large drainageways. The Clarion soil is in the smoother, less sloping areas, and the Storden soil is in the more convex areas (fig. 10). Individual areas range from 2 to 20 acres in size and generally are longer than they are wide. They are about 60 percent Clarion soil and 35 percent Storden soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable clay loam about 10 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thicker and darker. In other places the slope is less than 9 or more than 14 percent.

Typically, the surface layer of the Storden soil is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled, calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is less than 9 or more than 14 percent.

Included with these soils in mapping are small areas where sand and gravel are deposited on knobs. These areas make up less than 5 percent of the unit.

Permeability is moderate in the Clarion and Storden soils, and runoff is rapid. Available water capacity is high. The content of organic matter is 0.5 to 2.0 percent in the surface layer. The subsoil of the Clarion soil and the substratum of the Storden soil generally have a very low supply of available phosphorus and potassium.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Farming on the contour and terracing are difficult because of an undulating topography and uneven side slopes. Good tilth generally can be easily maintained. Returning crop residue to the soils or regularly adding other organic material improves fertility and increases the rate of water infiltration.

If these soils are used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIIe.

638E2—Clarion-Storden complex, 14 to 18 percent slopes, moderately eroded. These moderately steep, well drained soils are on side slopes near large drainageways. The Clarion soil is in the smoother, less sloping areas, and the Storden soil is in the more convex areas. Individual areas range from 2 to 20 acres in size and generally are longer than they are wide. They are about 55 percent Clarion soil and 40 percent Storden soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable clay loam about 10 inches thick. The substratum to a depth of about 60 inches is calcareous loam. The upper part is yellowish brown, the next part is mottled yellowish brown and light brownish gray, and the lower part is light olive brown and mottled. In some places the surface layer is thicker and darker. In other places the slope is less than 14 percent.

Typically, the surface layer of the Storden soil is dark grayish brown, calcareous loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brown, mottled,

Figure 10.—An area of Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded. The Storden soil is in the lighter colored areas.

calcareous loam. In some places it has strata of silt loam and sandy loam. In other places the slope is less than 14 or more than 18 percent.

Included with these soils in mapping are small areas where sand and gravel are deposited on knobs. These areas make up less than 5 percent of the unit.

Permeability is moderate in the Clarion and Storden soils, and runoff is rapid. Available water capacity is high. The content of organic matter is 0.5 to 2.0 percent in the surface layer. The subsoil of the Clarion soil and the substratum of the Storden soil have a very low supply of available phosphorus and potassium.

Most areas are cultivated. These soils are poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Farming on the contour and terracing are difficult because of an undulating topography and uneven side slopes. Good tilth generally can be easily maintained. Returning crop residue to the soils or regularly adding other organic material improves fertility and increases the rate of water infiltration.

If these soils are used for windbreaks or ornamental plantings, erosion is a hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IVe.

655—Crippin loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in broad, smooth areas and on low knolls in the uplands. Most areas range from 2 to 10 acres in size. They are irregularly shaped or are long and narrow.

Typically, the surface layer is black, calcareous loam about 9 inches thick. The subsurface layer is black, very dark gray, and dark grayish brown, calcareous loam about 6 inches thick. The subsoil is about 23 inches thick. It is olive brown, calcareous, and friable. The upper

part is loam, and the lower part is mottled clay loam. The substratum to a depth of about 60 inches is mottled grayish brown and yellowish brown, calcareous loam. In places the surface soil is noncalcareous.

Included with this soil in mapping are areas of Canisteo and Storden soils. The poorly drained Canisteo soils are in the lower areas. The well drained Storden soils are in the higher, more convex areas. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Crippin soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The high content of lime in the soil limits the number of suitable soybean varieties and pesticides.

The seasonal high water table and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The species that can withstand the occasional wetness and the excess lime should be selected for planting. A drainage system is beneficial.

The land capability classification is I.

735—Havelock clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. It is occasionally flooded. Areas range from 20 to more than 100 acres in size and are long and narrow.

Typically, the surface layer is black, calcareous clay loam about 8 inches thick. The subsurface layer is calcareous clay loam about 38 inches thick. The upper part is black, and the lower part is very dark gray. The next layer is dark gray, friable loam about 8 inches thick. The substratum to a depth of about 60 inches is dark gray, calcareous loam. In some places the dark surface soil is less than 24 inches thick. In other places the soil has sand and gravel within a depth of 48 inches. In some areas the surface soil is noncalcareous.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 7 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain if it is drained and if flooding is controlled. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

Some areas that are not protected from flooding or do not have an adequate drainage outlet are pastured. This soil is well suited to grasses and legumes for hay and pasture. Water-tolerant grasses and legumes are the best suited pasture plants.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

744—Revere loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on broad flats in the uplands. Most areas range from 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is calcareous, friable loam about 35 inches thick. The upper part is mixed dark grayish brown, olive, and very dark gray; the next part is olive gray and olive; and the lower part is olive gray and olive and is mottled. The content of gypsum crystals in the subsoil is 25 to 40 percent. The upper part of the substratum is olive gray, mottled, calcareous loam. The lower part to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In places the subsoil has no gypsum crystals.

Permeability is moderate, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 4 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface ditches and subsurface tile are effective in removing excess water. The rate at which cement tile deteriorates is increased by the content of gypsum in the soil. Unless the surface is protected by plants or crop residue, soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

If drainage tile is installed and tillage is deferred when this soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, and helps to prevent surface crusting. The high content of lime in the soil adversely

affects the availability of plant nutrients. It limits the number of suitable soybean varieties and pesticides.

The wetness and the excess amount of lime are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Only the species that can grow in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

878B—Ocheyedan loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on the convex tops and sides of ridges in the uplands. Areas are irregularly shaped. Most range from about 3 to 25 acres in size, but some are as large as 50 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. It is mixed with some brown material. The subsoil is about 24 inches thick. The upper part is dark yellowish brown, friable loam; the next part is dark yellowish brown, friable fine sandy loam; and the lower part is olive brown, mottled, friable silt loam. The upper part of the substratum is grayish brown, mottled, calcareous silt loam. The lower part to a depth of about 60 inches is dark yellowish brown, mottled, calcareous clay loam. In places the subsoil is clay loam. In some areas the surface layer is thinner, is lighter colored, and is mixed with subsoil material. In other areas the slope is more than 5 or less than 2 percent.

Included with this soil in mapping are small areas of the somewhat poorly drained Fostoria soils on the lower parts of the landscape. These soils make up about 5 percent of the unit.

Permeability is moderate in the Ocheyedan soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard, especially on the longer slopes. A system of conservation tillage that leaves crop residue on the surface, contour farming, and terraces help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for windbreaks or ornamental plantings, erosion is a slight hazard before the trees and shrubs are established. It can be controlled, however, by surface mulch.

The land capability classification is IIe.

879—Fostoria clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in broad, smooth areas on uplands. Most areas range from 2 to 15 acres in size. They are irregularly shaped or are long and narrow.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is about 14 inches thick. It is mottled and friable. The upper part is dark grayish brown clay loam, and the lower part is olive brown loam. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is mottled light brownish gray, light olive brown, and olive brown, and the lower part is light brownish gray and mottled. In places the surface soil is calcareous. In some areas clay loam glacial till is within a depth of 48 inches.

Included with this soil in mapping are small areas of the well drained Ocheyedan soils. These soils are in the higher, more convex areas. They make up about 5 percent of the unit.

Permeability is moderate in the Fostoria soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

If this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, the seasonal high water table is a moderate limitation. It generally can be overcome, however, by planting species that can withstand occasional wetness or by installing a drainage system.

The land capability classification is I.

2573—Hoopeston Variant loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in plane and convex areas on uplands. Most areas range from about 5 to 25 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. It is mixed with very dark grayish brown material. The subsoil is about 30 inches thick. The upper part is very dark grayish brown, very dark gray, and dark grayish brown, friable, calcareous loam; the next part is dark grayish brown and olive brown, friable, calcareous loam and sandy loam; and the lower part is brown and light olive brown, very friable, calcareous loamy sand. The substratum to a depth of about 60 inches is mottled yellowish brown, light gray, and strong

brown, calcareous loamy sand. In places it is calcareous silt loam.

Included with this soil in mapping are some small areas of the well drained Dickman soils. These soils are in the higher, more convex areas. They make up about 5 percent of the unit.

Permeability is moderately rapid in the upper part of the Hoopeston Variant soil and rapid in the substratum. Runoff is slow. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It has a high water table during wet periods but becomes droughty after brief dry periods. Tile drains generally should not be installed because the soil is droughty during most of the growing season. Good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

Drought is a hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Generally, the species that can withstand the seasonal wetness as well as the droughtiness should be selected for planting. Surface mulch conserves moisture.

The land capability classification is IIs.

5010—Pits, sand and gravel. This map unit is dominantly on stream benches and terraces. Most of the pits are inactive, but several are still mined for sand and gravel. Areas range from about 3 to more than 80 acres in size and commonly are square or rectangular.

Most areas have a seasonal high water table. Also, the low areas are ponded during wet periods. Stones and cobbles commonly are on the surface. Reaction typically is moderately alkaline.

Most of the inactive pits support weeds and small trees. Some have been used as refuse dumps. The pits can be developed for wildlife habitat or recreational uses. The trees and shrubs that can withstand a high content of lime and droughtiness should be selected for planting.

No land capability classification is assigned.

5040—Orthents, loamy. These nearly level to strongly sloping soils are used as borrow areas for construction activities. In some areas the original soil has been removed to a depth of 5 to more than 20 feet, and in other areas 4 to 10 inches of topsoil has been redistributed, commonly in an uneven pattern. The soils range from excessively drained to somewhat poorly drained, depending on the kind of material from which the soils were derived and the extent to which the borrow area is restored. Areas typically range from 3 to 50 acres in size.

Typically, the upper 60 inches is yellowish brown, friable and firm clay loam. In many places cobbles and pebbles are on the surface.

Permeability varies, depending on the texture and density of the soil material. Runoff is slow to rapid. Available water capacity is moderate or low. Soil that was once buried 5 to 20 feet or more beneath the surface has less pore space and a higher density than the original surface layer. It has not been appreciably affected by the processes of soil formation, such as freezing and thawing. The content of organic matter is very low unless the topsoil has been redistributed throughout the borrow area. As a result, preparing a good seedbed is difficult and drought is a hazard. Reaction typically is moderately alkaline. In most areas these soils have a very low supply of available phosphorus and potassium.

These soils are better suited to small grain and to grasses and legumes for hay and pasture than to row crops. They are suited to row crops only in some areas where the topsoil has been redistributed. Corn and soybeans are grown in these areas. If cultivated crops are grown, erosion is a moderate or severe hazard in the more sloping areas. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and tends to stabilize the soils.

No land capability classification is assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is

not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 220,000 acres in the county, or nearly 86 percent of the total acreage, meets the requirements for prime farmland. This land is throughout the county. About 210,000 acres of the prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for an estimated 75 percent of the county's total agricultural income each year.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 232,000 acres in Osceola County is used for cultivated crops and 12,000 acres for pasture (*18*). Corn and soybeans are the main cultivated crops. Oats and legume-grass hay also are grown. The paragraphs that follow describe the management concerns affecting use of the soils in the county for crops and pasture.

Water erosion is the major problem on about 40 percent of the cropland and pasture in Osceola County. It is a hazard if the slope is more than 2 percent. Most areas of Clarion, Everly, Sac, and Storden soils, for example, have a slope of more than 2 percent and are subject to erosion.

Loss of the surface layer through erosion reduces the productivity of soils and results in sedimentation in streams. Loss of the surface layer is especially damaging on soils having a subsoil that is low in fertility, such as Clarion, Everly, and Sac soils. Erosion also reduces the productivity of soils that tend to be droughty, such as Wadena soils. Control of erosion helps to maintain the productivity of the soils and improves the quality of water for municipal use, for recreation, and for fish and other kinds of wildlife by minimizing the pollution of streams.

Measures that control erosion provide a protective plant cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface can reduce soil losses to an amount that will not decrease the productive capacity of the soils. On livestock farms, where part of the acreage is hayland, including grasses and legumes in the cropping system not only provides nitrogen and improves tilth for the following crops but also helps to control erosion on the more sloping soils.

A system of conservation tillage that leaves crop residue on the surface is effective in controlling erosion. Following are examples of the major kinds of conservation tillage systems. No-till is a system in which the seedbed is prepared and the seed planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the surface. Strip-till or till-plant also is a system in which the seedbed is prepared and the seed planted in one

operation. Tillage is limited to a strip not wider than one-third of the row. A protective cover of crop residue is left on two-thirds of the surface. Chisel-disk or rotary tillage is a system in which the soil is loosened throughout the field and part of the crop residue is incorporated into the soil. Preparing the seedbed and planting may be one or separate operations.

Terraces and diversions reduce the length of slopes and thus the runoff rate and the risk of erosion. They are most practical on deep, well drained soils that have long, uniform slopes. In many areas Everly and Sac soils are well suited to terracing. Other soils are less well suited to terraces and diversions because slopes are irregular or are too steep. On these soils conservation tillage is effective in controlling erosion. Where slopes are too steep, short, or irregular for terraces, alternatives include grassed waterways and water- and sediment-control basins.

Contour farming and stripcropping are most effective in controlling erosion in areas where slopes are smooth and uniform. Examples are some areas of Everly and Sac soils.

Information about the design of erosion-control measures for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil blowing is a hazard on most of the soils in the county that are not protected by a plant cover. It is most severe in areas that have been used for soybeans. The wind can damage the soils in a few hours if it is strong and the soils are dry and have no plant cover or surface mulch. Maintaining a plant cover or a surface mulch or keeping the surface rough through proper tillage minimizes soil blowing. Windbreaks of suitable trees and shrubs, such as caragana, honeysuckle, lilac, cottonwood, or poplar, also help to control soil blowing.

Droughtiness is a limitation in some of the soils in the county. Examples are Estherville and Wadena soils. These soils can be irrigated. Areas that can supply the quantity of water needed for irrigation are very limited in the county. Those along the Ocheyedan River have the best potential for irrigation.

Wetness is a limitation on about 26 percent of the acreage used for crops and pasture in the county. Some soils, such as the depressional Knoke and Okoboji soils, are naturally so wet that they cannot be used for the crops commonly grown in the county unless a drainage system is installed. Unless drained, poorly drained soils, such as Canisteo, Letri, Marcus, and Webster soils, are so wet that crops are damaged in most years.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of tile drainage and tile intakes is needed in most areas of the very poorly drained soils that are intensively row cropped. A tile drainage system generally is less effective in slowly permeable soils than in the more rapidly permeable soils. Finding adequate outlets for tile drainage systems is difficult in many areas. Grassed waterways are needed where water concentrates.

Information about the design of drainage systems for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is affected by the supply of available phosphorus and potassium in the subsoil, by reaction, and by the content of organic matter. The amount of nitrogen available to plants is related to the content of organic matter. The soils in the county typically have a low or very low supply of available phosphorus and potassium, have a moderate or high content of organic matter, and range from slightly acid to moderately alkaline. The mildly alkaline and moderately alkaline soils, such as Canisteo, Harps, Spicer, and Storden soils, have free carbonates in the surface layer. A high pH level reduces the content of available phosphorus and micronutrients.

Applications of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of lime and fertilizer needed.

Soil tilth is an important factor affecting the germination and emergence of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. Tilth is good in most of the soils in the county. Measures that maintain or increase the content of organic matter help to maintain or improve tilth and soil structure.

Tilth is poorer in silty and clayey soils than in loamy soils. If the silty or clayey soils are cultivated when wet, they tend to become very cloddy when dry. A crust forms on these soils after heavy rains. This crust reduces the infiltration rate and increases the runoff rate and the risk of erosion. Returning crop residue to the soil and regularly adding manure and other organic material improve soil structure and help to prevent surface crusting.

Weeds on the cropland and pasture in the county can be controlled by applications of herbicide. The need for herbicides and the rate of application are affected by the organic matter content, the pH level, the depth to carbonates, and soil texture. Instructions on the label should be followed when the herbicide is applied.

Forage production in pastured areas of the county can be enhanced by planting warm-season grasses, including switchgrass, big bluestem, and indiangrass. The management needed on established stands includes applications of fertilizer, control of weeds and brush, rotation and deferred grazing in a full-season grazing system, proper stocking rates, and adequate livestock watering facilities. Erosion is a severe hazard if the protective plant cover is destroyed when the more sloping areas of pasture and hayland are renovated. If cultivated crops are grown prior to seeding, soil losses

can be reduced by contour farming, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface. Interseeding grasses and legumes into the existing sod eliminates the need for destroying the plant cover during seedbed preparation.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are 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 or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that 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.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several

rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field (fig. 11). The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, reduce energy requirements, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil

Figure 11.—Field windbreak on Primghar and Marcus soils.

Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, ash, maple, apple, hawthorn, dogwood, walnut, plum, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and cattails.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include gray partridge, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay

minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, the available water capacity in the upper 40 inches, and the content of calcium carbonate affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be

expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil

layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, and rock fragments.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table (fig. 12). Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. The content of large stones affects the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers;

Figure 12.—A pond in an area of Webster silty clay loam, 0 to 2 percent slopes. Clarion and Nicollet soils are in the background.

and potential frost action. Excavating and grading and the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, and large stones affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the

susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a

saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*20*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*19*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*20*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Afton Series

The Afton series consists of poorly drained, moderately slowly permeable soils in upland drainageways. These soils formed in loess and in local alluvium derived from loess. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Afton silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,540 feet south and 180 feet east of the northwest corner of sec. 32, T. 98 N., R. 41 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular

blocky structure; friable; common medium and fine roots; mildly alkaline; clear smooth boundary.

A1—10 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; few fine roots; mildly alkaline; clear smooth boundary.

A2—15 to 28 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine and medium granular structure; friable; few very fine and fine roots; mildly alkaline; gradual smooth boundary.

Bg1—28 to 34 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) silty clay loam; few fine prominent yellowish brown (10YR 5/4) mottles; weak fine and very fine subangular blocky structure; friable; few very fine roots; mildly alkaline; clear smooth boundary.

Bg2—34 to 40 inches; olive gray (5Y 4/2) silty clay loam; common fine distinct olive (5Y 5/3) mottles; weak fine and very fine subangular blocky structure; friable; mildly alkaline; abrupt smooth boundary.

Cg1—40 to 52 inches; olive gray (5Y 5/2) and olive (5Y 5/3) silty clay loam; few fine prominent yellowish brown (10YR 5/4) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2—52 to 60 inches; olive gray (5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 40 to 50 inches. The depth to free carbonates ranges from 36 to 50 inches. The mollic epipedon ranges from 24 to 32 inches in thickness.

The surface soil is 20 to 30 inches thick. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 or less. Some pedons have a 2Cg horizon of glacial till. This horizon is clay loam or loam. The Cg and 2Cg horizons have hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 4.

Allendorf Series

The Allendorf series consists of well drained soils on stream terraces. These soils formed in silty alluvium 32 to 40 inches deep over sandy and gravelly sediments. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Allendorf silty clay loam, 2 to 5 percent slopes, in a cultivated field; 700 feet east and 700 feet south of the northwest corner of sec. 28, T. 98 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; slightly acid; clear smooth boundary.

A—9 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; mixed with streaks and pockets of dark brown (10YR 3/3) material; moderate fine and very fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw1—13 to 18 inches; dark yellowish brown (10YR 4/4) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw2—18 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; few very fine roots; neutral; gradual smooth boundary.

Bw3—27 to 34 inches; dark yellowish brown (10YR 4/4) silt loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; few very fine roots; neutral; clear smooth boundary.

2BC—34 to 37 inches; brown (10YR 4/3) loam; weak medium and fine subangular blocky structure; friable; few very fine roots; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

2C1—37 to 40 inches; brown (10YR 4/3) very gravelly loamy coarse sand; single grained; loose; few very fine roots; few soft accumulations (calcium carbonate); about 50 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

2C2—40 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; few very fine roots in the upper part; about 30 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 32 to 40 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly silty clay loam, but the range includes silt loam. The B horizon has value of 4 or 5 and chroma of 3 or 4. It is silty clay loam or silt loam. The 2BC horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is loam or sandy loam in which the content of coarse fragments is 0 to 10 percent. The 2C horizon has value of 4 to 6 and chroma of 3 to 5. It is gravelly sand, gravelly loamy coarse sand, very gravelly sand, or very gravelly loamy coarse sand.

Biscay Series

The Biscay series consists of poorly drained soils in low areas on stream terraces. These soils formed in glacial outwash. They have a loamy mantle 32 to 40 inches deep over sandy and gravelly sediments. Permeability is moderate in the upper part of the profile and rapid in the lower part. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Biscay silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 660 feet south and 2,270 feet west of the northeast corner of sec. 16, T. 98 N., R. 39 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; clear smooth boundary.

A1—10 to 15 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine and very fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

A2—15 to 23 inches; black (10YR 2/1) clay loam; mixed with some streaks and pockets of olive gray (5Y 4/2) subsoil material; weak fine and very fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

Bg1—23 to 29 inches; olive gray (5Y 4/2) clay loam; very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; few fine dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

Bg2—29 to 34 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium and fine subangular blocky structure; friable; few fine dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

BCg—34 to 37 inches; grayish brown (2.5Y 5/2) gravelly sandy loam; common medium prominent dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); about 15 percent gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

2Cg—37 to 60 inches; olive gray (5Y 5/2) gravelly coarse sand; single grained; loose; about 20 percent gravel; strong effervescence; moderately alkaline.

The solum is 32 to 40 inches thick. The depth to free carbonates ranges from 28 to 42 inches. The mollic epipedon is 16 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly silty clay loam or clay loam, but the range includes loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 3. It is clay loam, sandy clay loam, or loam. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2. It typically is gravelly coarse sand, but in some pedons it is sand or loamy sand in which the content of gravel is 5 to 10 percent.

Canisteo Series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils in low areas on uplands. These soils formed in glacial sediments and in the underlying glacial till. The native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,250 feet east and 1,420 feet south of the northwest corner of sec. 4, T. 99 N., R. 39 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine subangular blocky structure; friable; common very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A—8 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular block structure; friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

AB—14 to 18 inches; mixed very dark gray (10YR 3/1), black (10YR 2/1), and olive gray (5Y 4/2) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg1—18 to 24 inches; olive gray (5Y 4/2 and 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2—24 to 34 inches; gray (5Y 5/1) and olive gray (5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—34 to 41 inches; gray (5Y 5/1) and olive gray (5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—41 to 50 inches; olive gray (5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y

5/4) mottles; massive; friable; common dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

Cg3—50 to 60 inches; olive gray (5Y 5/2) clay loam; common coarse distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. It has free carbonates throughout.

The A and Bg horizons are silty clay loam or clay loam. The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is 14 to 24 inches thick. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4 and has distinct mottles. It is dominantly clay loam or loam but has strata of silt loam, sandy loam, or loamy sand in some pedons.

Clarion Series

The Clarion series consists of well drained, moderately permeable soils on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 18 percent.

Typical pedon of Clarion clay loam, 2 to 5 percent slopes, in a cultivated field; 660 feet north and 2,200 feet west of the southeast corner of sec. 10, T. 100 N., R. 41 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam (about 28 percent clay), dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; friable; common fine roots; 1 to 3 percent coarse fragments; medium acid; clear smooth boundary.

AB—10 to 15 inches; mixed very dark grayish brown (10YR 3/2), brown (10YR 4/3), and black (10YR 2/1) clay loam (about 28 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common fine roots; 1 to 3 percent coarse fragments; slightly acid; clear smooth boundary.

Bw1—15 to 20 inches; dark yellowish brown (10YR 4/4) clay loam (about 29 percent clay); brown (10YR 4/3) coatings on faces of peds; weak fine prismatic structure parting to weak medium and fine subangular blocky; friable; few fine roots; 1 to 3 percent coarse fragments; neutral; clear smooth boundary.

Bw2—20 to 27 inches; dark yellowish brown (10YR 4/4) clay loam (about 30 percent clay); weak fine subangular blocky structure; friable; few fine roots; 1 to 3 percent coarse fragments; mildly alkaline; abrupt smooth boundary.

C1—27 to 31 inches; yellowish brown (10YR 5/4) loam (about 22 percent clay); massive with some horizontal cleavage planes; friable; few very fine roots; 1 to 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—31 to 45 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) loam (about 22 percent clay); massive; friable; common dark concretions (iron and manganese oxides); common soft accumulations (calcium carbonate); 2 to 4 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—45 to 60 inches; light olive brown (2.5Y 5/4) loam (about 22 percent clay); common fine distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; common dark concretions (iron and manganese oxides); disseminated lime and few soft accumulations of lime; 3 to 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 17 to 42 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is clay loam, but in some pedons it is silt loam that has a high content of sand and in other pedons it is loam. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is loam, clay loam, or sandy clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6.

Coland Series

The Coland series consists of poorly drained, moderately permeable soils on bottom land. These soils formed in alluvium. The native vegetation was water-tolerant grasses. Slopes range from 0 to 5 percent.

Typical pedon of Coland clay loam, 0 to 2 percent slopes, in a cultivated field; 625 feet south and 600 feet east of the northwest corner of sec. 27, T. 98 N., R. 42 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak fine granular; friable; common medium and fine roots; neutral; clear smooth boundary.

A1—9 to 20 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

A2—20 to 29 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium and fine

subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

A3—29 to 34 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

AB—34 to 43 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg1—43 to 48 inches; dark gray (5Y 4/1) clay loam; very dark gray (5Y 3/1) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg2—48 to 56 inches; dark gray (5Y 4/1) clay loam; few fine prominent brown (7.5YR 4/4) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; friable; few dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

Cg—56 to 60 inches; dark gray (5Y 4/1) loam; few fine prominent brown (7.5YR 4/4) and few fine distinct olive brown (2.5Y 4/4) mottles; massive with some horizontal cleavage planes; friable; few dark concretions (iron and manganese oxides); mildly alkaline.

The solum ranges from 32 to 60 inches in thickness. It does not have free carbonates. The mollic epipedon is more than 36 inches thick.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It typically is clay loam, but the range includes silty clay loam that has a moderate content of sand. The Cg horizon typically is clay loam or loam, but in some pedons it has thin strata of silty clay to loamy sand. It has hue of 2.5Y or 5Y or is neutral in hue. It has value of 2 to 5 and chroma of 0 or 1.

Collinwood Series

The Collinwood series consists of somewhat poorly drained, slowly permeable soils on glacial lake plains in the uplands. These soils formed in clayey lacustrine sediments. The native vegetation was prairie grasses. Slopes range from 0 to 3 percent.

Typical pedon of Collinwood silty clay loam, 0 to 3 percent slopes, in a cultivated field; 2,260 feet east and 2,340 feet south of the northwest corner of sec. 13, T. 100 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; firm; few very fine roots; neutral; clear smooth boundary.

A—9 to 14 inches; black (10YR 2/1) silty clay (about 42 percent clay), dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; few very fine roots; neutral; clear smooth boundary.

BA—14 to 21 inches; dark grayish brown (2.5Y 4/2) silty clay (about 48 percent clay); very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; few very fine roots; neutral; clear smooth boundary.

Bw—21 to 32 inches; olive brown (2.5Y 4/4) silty clay (about 46 percent clay); dark grayish brown (2.5Y 4/2) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; firm; few very fine roots; few dark concretions (iron and manganese oxides); neutral; abrupt smooth boundary.

Cg1—32 to 43 inches; light brownish gray (2.5Y 6/2) silty clay loam (about 38 percent clay); common fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few disseminations and soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—43 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam (about 35 percent clay); few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few disseminations and soft accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 40 inches. The mollic epipedon is 14 to 20 inches thick. The content of sand in the 10- to 40-inch control section is less than 10 percent, and that of clay ranges from 35 to 50 percent.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Crippin Series

The Crippin series consists of somewhat poorly drained, moderately permeable, calcareous soils on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Crippin loam, 1 to 3 percent slopes, in a cultivated field; 320 feet west and 300 feet north of the southeast corner of sec. 16, T. 100 N., R. 41 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few very fine roots; strong

effervescence; moderately alkaline; clear smooth boundary.

A—9 to 15 inches; black (10YR 2/1), very dark gray (10YR 3/1), and dark grayish brown (2.5Y 4/2) loam, dark gray (10YR 4/1) and grayish brown (2.5Y 5/2) dry; weak fine and very fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Bw1—15 to 20 inches; olive brown (2.5Y 4/4) loam; weak fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw2—20 to 29 inches; olive brown (2.5Y 4/4) loam; some discontinuous grayish brown (2.5Y 5/2) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw3—29 to 38 inches; olive brown (2.5Y 4/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) and few fine prominent yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C—38 to 60 inches; mottled grayish brown (2.5Y 5/2), olive brown (2.5Y 4/4), and yellowish brown (10YR 5/6) clay loam; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The solum ranges from 20 to 48 inches in thickness. The A horizon either has hue of 10YR, value of 2 or 3, and chroma of 1 or is neutral in hue and has value of 2 and chroma of 0. It is clay loam in some pedons. The B horizon is loam or clay loam. It has hue of 2.5Y or 10YR, value of 4, and chroma of 2 or 3. The lower part of this horizon typically has mottles with hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 8. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils on stream terraces and outwash plains. These soils formed in loamy alluvium overlying sand and gravel. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Cylinder clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 225 feet south and 1,620 feet west of the northeast corner of sec. 27, T. 98 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

A—9 to 14 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

AB—14 to 18 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) clay loam; mixed with some streaks and pockets of dark grayish brown (2.5Y 4/2) subsoil material; weak fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw1—18 to 23 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) clay loam; weak fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

Bw2—23 to 35 inches; olive brown (2.5Y 4/4) clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; few very fine roots; common fine dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

2BC—35 to 38 inches; olive brown (2.5Y 4/4) sandy loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

2C—38 to 60 inches; yellowish brown (10YR 5/4) sand and gravel (about 15 percent gravel); single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The A horizon has value of 2 and chroma of 1 or 2 in the upper part and value of 3 and chroma of 1 or 2 in the lower part. It is loam, clay loam, or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It has mottles with hue of 10YR or 2.5Y and value and chroma of 4 to 6. It is clay loam or loam.

Dickman Series

The Dickman series consists of well drained, moderately rapidly permeable soils on uplands. These soils formed in loamy and sandy eolian sediments. The native vegetation was prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Dickman sandy loam, 2 to 5 percent slopes, in a cultivated field; 660 feet west and 2,610 feet south of the northeast corner of sec. 10, T. 98 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable;

common fine roots; slightly acid; abrupt smooth boundary.

AB—8 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam; mixed with some streaks and pockets of black (10YR 2/1) and dark yellowish brown (10YR 4/4) material; weak medium and fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

Bw1—12 to 17 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few very fine roots; some wormholes and root channels filled with dark brown (10YR 3/3) material; neutral; clear smooth boundary.

Bw2—17 to 29 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; friable; few very fine roots; some wormholes and root channels filled with very dark grayish brown (10YR 3/2) material; neutral; clear smooth boundary.

Bw3—29 to 47 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

C1—47 to 54 inches; yellowish brown (10YR 5/4) sand; single grained; loose; neutral; abrupt smooth boundary.

C2—54 to 60 inches; brown (10YR 5/3) loamy sand; common medium distinct strong brown (7.5YR 5/6) and few fine prominent yellowish red (5YR 5/8) mottles; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The depth to free carbonates ranges from 50 to 70 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. The Bw horizon has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. The C horizon has hue of 10YR, value of 4 to 6, and chroma of 3 to 6.

Dickman sandy loam, 2 to 5 percent slopes, moderately eroded, is a taxadjunct to the series because it does not have a mollic epipedon.

Everly Series

The Everly series consists of well drained, moderately permeable soils on uplands. These soils formed in loamy erosional sediments and loess and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Everly clay loam, 2 to 5 percent slopes, in a cultivated field; 2,240 feet east and 1,175 feet north of the southwest corner of sec. 20, T. 100 N., R. 42 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; about 5 percent coarse fragments on the surface; slightly acid; clear smooth boundary.

AB—8 to 14 inches; mixed very dark gray (10YR 3/1) and dark brown (10YR 3/3) clay loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—14 to 24 inches; brown (10YR 4/3) clay loam; weak medium prismatic structure parting to weak medium and fine subangular blocky; friable; neutral; abrupt smooth boundary.

Bw2—24 to 30 inches; yellowish brown (10YR 5/4) clay loam; weak fine prismatic structure parting to weak fine subangular blocky; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2BC—30 to 35 inches; yellowish brown (10YR 5/4) clay loam; few medium distinct light gray (10YR 6/1) and few medium prominent dark reddish brown (2.5YR 2/4) mottles; weak fine subangular blocky structure; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2C1—35 to 50 inches; yellowish brown (10YR 5/4) clay loam; few medium distinct dark yellowish brown (10YR 4/4) and few medium distinct gray (10YR 5/1) mottles; massive; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

2C2—50 to 60 inches; yellowish brown (10YR 5/4) clay loam; few fine prominent light gray (5Y 6/1) and strong brown (7.5YR 5/8) mottles; massive; firm; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 24 to 40 inches in thickness. The depth to glacial till ranges from 20 to 36 inches. The depth to free carbonates typically is the same as the depth to glacial till, but in some pedons the upper few inches of the till is leached.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is typically clay loam, but the range includes silty clay loam that has a high content of sand. Some pedons have a BA horizon. This horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. The Bw horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The 2BC and 2C horizons have hue of 10YR and 2.5Y, value of 4 or 5, and chroma of 3 or 4. The mottles in these horizons have hue of 7.5YR, 10YR, 2.5Y, or 5Y, value of 2 to 6, and chroma of 1 to 8.

The moderately eroded Everly soils in this county are taxadjuncts to the series because they do not have a mollic epipedon.

Fostoria Series

The Fostoria series consists of somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loamy and silty glacial sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Fostoria clay loam, 0 to 2 percent slopes, in a cultivated field; 1,600 feet north and 80 feet west of the southeast corner of sec. 24, T. 98 N., R. 39 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; common very fine roots; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; mixed with some very dark grayish brown (2.5Y 3/2) material; weak fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

AB—14 to 19 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; mixed with some dark grayish brown (2.5Y 4/2) material; weak fine and very fine subangular blocky structure; friable; few very fine roots; mildly alkaline; gradual smooth boundary.

Bw1—19 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint olive brown (2.5Y 4/4) mottles; weak fine and very fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

Bw2—25 to 33 inches; olive brown (2.5Y 4/4) loam; discontinuous dark grayish brown (2.5Y 4/2) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

C1—33 to 48 inches; mottled light brownish gray (2.5Y 6/2), light olive brown (2.5Y 5/6), and olive brown (2.5Y 4/4) silt loam; massive; friable; common dark concretions (iron and manganese oxides); mildly alkaline; abrupt smooth boundary.

C2—48 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; few medium prominent strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The depth to carbonates ranges from 24 to 48 inches.

The Ap and A horizons have hue of 10YR or are neutral in hue. They have value of 2 and chroma of 0 or 1. They are loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5. It has chroma of 2 in the upper part and chroma of 2 to 4 in the lower part. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It typically is silt loam, but in some pedons it is loam or sandy loam or has 2- to 6-inch lenses of loamy sand.

Galva Series

The Galva series consists of well drained, moderately permeable soils on uplands and high stream benches. These soils formed in more than 40 inches of loess. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Galva silty clay loam, 2 to 5 percent slopes, in a cultivated field; 1,615 feet south and 80 feet east of the northwest corner of sec. 7, T. 98 N., R. 42 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; clear smooth boundary.

A—8 to 12 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; mixed with some very dark grayish brown (10YR 3/2) material; weak medium and fine subangular blocky structure parting to weak fine granular; friable; few very fine roots; neutral; clear smooth boundary.

AB—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam; mixed with dark brown (10YR 3/3) and brown (10YR 4/3) material; weak fine subangular blocky structure parting to moderate fine granular; friable; few very fine roots; neutral; clear smooth boundary.

Bw1—16 to 23 inches; brown (10YR 4/3) silty clay loam; mixed with very dark grayish brown (10YR 3/2) material in the upper part; moderate fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw2—23 to 32 inches; brown (10YR 4/3) silty clay loam; weak medium subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

BC—32 to 37 inches; brown (10YR 4/3) silt loam; weak fine and medium subangular blocky structure; friable; few very fine roots; mildly alkaline; abrupt smooth boundary.

C1—37 to 44 inches; brown (10YR 5/3) silt loam; massive; friable; common disseminations and soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; abrupt smooth boundary.

2C2—44 to 60 inches; yellowish brown (10YR 5/6) clay loam; massive; firm; common disseminations and soft accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 32 to 48 inches. The A horizon has hue of 10YR, value of 2, and chroma of 1 or 2. The Bw horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. Some pedons have few or common grayish mottles below a depth of 30 inches. The content of clay in the 10- to 40-inch control section ranges from 27 to 35 percent, and that of fine sand or coarser sand is 1 to 6 percent. The C and 2C horizons have hue of 10YR, value or 4 or 5, and chroma of 3 to 6. In some pedons they have mottles with hue of 10YR, 7.5YR, or 2.5Y, value of 4 to 6, and chroma of 1 to 8. A gravelly substratum phase is recognized.

Harps Series

The Harps series consists of poorly drained, moderately permeable, calcareous soils on the rims of depressions in the uplands. These soils formed in loamy glacial till or local alluvium derived from till. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Harps clay loam, 0 to 2 percent slopes, in a cultivated field; 1,900 feet east and 2,280 feet north of the southwest corner of sec. 36, T. 100 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; friable; common fine and very fine roots; violent effervescence; moderately alkaline; abrupt smooth boundary.

Ak—8 to 16 inches; black (5Y 2/1) and very dark gray (5Y 3/1) clay loam, gray (10YR 5/1) dry; some pockets of olive (5Y 5/3) material in the lower part; weak medium and fine subangular blocky structure parting to weak very fine granular; friable; few very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

ABk—16 to 20 inches; very dark gray (5Y 3/1) clay loam; mixed with about 25 percent olive (5Y 5/3) material; weak medium and fine subangular blocky structure; friable; few very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

Bgk1—20 to 26 inches; olive gray (5Y 5/2) clay loam; few pockets of very dark gray (5Y 3/1) material; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

Bgk2—26 to 31 inches; olive gray (5Y 5/2) clay loam; very few pockets of very dark gray (5Y 3/1) material; few fine prominent yellowish brown (10YR 5/6) and light olive brown (2.5Y 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; violent effervescence; moderately alkaline; clear smooth boundary.

Bgk3—31 to 36 inches; olive gray (5Y 5/2) clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; few dark concretions (iron and manganese oxides); violent effervescence; moderately alkaline; clear smooth boundary.

Bg—36 to 43 inches; olive gray (5Y 5/2) clay loam; few fine prominent light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; few very fine roots; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—43 to 53 inches; light olive gray (5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/8) and few fine prominent light olive brown (2.5Y 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—53 to 60 inches; light olive gray (5Y 6/2) loam; many coarse prominent yellowish brown (10YR 5/8) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The Ap and Ak horizons have hue of 10YR or 5Y, value of 2 or 3, and chroma of 1. They are clay loam or loam. The calcium carbonate equivalent in the upper 6 to 18 inches ranges from 15 to 40 percent. The Bgk horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is clay loam, loam, or sandy clay loam. The C horizon has colors similar to those of the Bgk horizon. It has mottles with hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 4 to 8.

Havelock Series

The Havelock series consists of poorly drained, moderately permeable, calcareous soils on bottom land. These soils formed in calcareous, loamy alluvium. The native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Havelock clay loam, 0 to 2 percent slopes, in a cultivated field; 1,070 feet north and 2,100 feet east of the southwest corner of sec. 29, T. 99 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; few fine and very fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

A1—8 to 21 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.
A2—21 to 35 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.
A3—35 to 46 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak medium and fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.
AC—46 to 54 inches; dark gray (5Y 4/1) loam; weak medium and fine subangular blocky structure; friable; about 1 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.
Cg—54 to 60 inches; dark gray (5Y 4/1) loam; massive; friable; about 5 percent gravel; strong effervescence; moderately alkaline.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon is 36 to 48 inches thick.

The upper part of the A horizon has hue of 10YR or 5Y or is neutral in hue. It has value of 2 and chroma of 0 or 1. The lower part has hue of 10YR or 5Y, value of 3, and chroma of 1. This horizon is clay loam or silty clay loam. The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is dominantly clay loam or loam, but the range includes sandy loam and sandy clay loam. In some pedons the content of gravel is as much as 8 percent below a depth of 4 feet.

Hoopeston Variant

The Hoopeston Variant consists of somewhat poorly drained soils in the uplands. These soils formed in loamy and sandy eolian sediments. Permeability is moderately rapid in the solum and rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Hoopeston Variant loam, 0 to 2 percent slopes, in a cultivated field; 1,300 feet west and 120 feet south of the northeast corner of sec. 14, T. 98 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; neutral; clear smooth boundary.
A—8 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; mixed with a small amount of very dark grayish brown (10YR 3/2) material; weak medium subangular blocky structure parting to weak fine granular; friable; few very fine roots; mildly alkaline; clear smooth boundary.
BA—14 to 21 inches; very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.
Bw1—21 to 29 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) loam; weak fine and medium subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.
Bw2—29 to 40 inches; olive brown (2.5Y 4/4) sandy loam; few fine faint light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; very friable; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.
BC—40 to 44 inches; brown (10YR 4/3) and light olive brown (2.5Y 5/4) loamy sand; weak fine subangular blocky structure; very friable; strong effervescence; moderately alkaline; clear smooth boundary.
C1—44 to 52 inches; mottled yellowish brown (10YR 5/4), light gray (10YR 6/1), yellowish brown (10YR 5/8), and strong brown (7.5YR 5/8) loamy sand that has strata of coarse silt and sand; massive; very friable; strong effervescence; moderately alkaline; clear smooth boundary.
C2—52 to 60 inches; mottled strong brown (7.5YR 5/8), reddish brown (5YR 4/4), and light gray (10YR 6/1) loamy sand that has strata of coarse silt and sand; massive; very friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The solum ranges from 30 to 48 inches in thickness. The Ap and A horizons have hue of 10YR, value of 2 or 3, and chroma of 1 or 2. They are loam, sandy clay loam, or sandy loam. The Bw horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 or 3. It is loam or sandy clay loam in the upper part and grades to sandy loam or loamy sand in the lower part. The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6, and chroma of 1 to 8. It is loamy sand or sand.

Kamrar Series

The Kamrar series consists of well drained, moderately slowly permeable soils on uplands. These soils formed in about 3 feet of lacustrine sediments and in the underlying till. The native vegetation was prairie grasses. Slopes range from 1 to 5 percent.

Typical pedon of Kamrar silty clay loam, 1 to 5 percent slopes, in a cultivated field; 190 feet north and 1,210 feet

west of the southeast corner of sec. 15, T. 100 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; weak fine and very fine granular structure; friable; few fine roots; slightly acid; clear smooth boundary.
A—8 to 12 inches; black (10YR 2/1) silty clay (about 44 percent clay), dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; firm; few very fine roots; neutral; clear smooth boundary.
AB—12 to 17 inches; very dark gray (10YR 3/1) silty clay (about 45 percent clay), dark gray (10YR 4/1) dry; mixed with some brown (10YR 4/3) material; moderate very fine subangular blocky structure; firm; few very fine roots; neutral; clear smooth boundary.
Bw1—17 to 26 inches; brown (10YR 4/3) silty clay (about 46 percent clay); mixed with black (10YR 2/1) and very dark gray (10YR 3/1) material; very dark gray (10YR 3/1) coatings on faces of peds; weak fine prismatic structure parting to moderate medium and fine subangular blocky; firm; few very fine roots; neutral; gradual smooth boundary.
Bw2—26 to 35 inches; dark yellowish brown (10YR 4/4) silty clay (about 43 percent clay); brown (10YR 4/3) coatings on faces of peds; few fine prominent yellowish red (5YR 4/6) mottles; weak fine prismatic structure parting to moderate medium and fine subangular blocky; firm; few very fine roots; few very fine dark concretions (iron and manganese oxides); neutral; clear smooth boundary.
2C1—35 to 45 inches; olive brown (2.5Y 4/4) clay loam (about 30 percent clay); common fine distinct light brownish gray (2.5Y 6/2), common fine prominent strong brown (7.5YR 5/8), and few fine prominent yellowish red (5YR 4/6) mottles; massive; friable; few very fine roots; few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; abrupt smooth boundary.
2C2—45 to 60 inches; grayish brown (2.5Y 5/2) loam (about 23 percent clay); common medium prominent strong brown (7.5YR 4/6) and few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 44 inches. The depth to a lithologic discontinuity ranges from 24 to 40 inches. The content of clay in the lacustrine sediments ranges from 35 to 50 percent.

The A and B horizons are silty clay or silty clay loam. The A horizon has hue of 10YR, value of 2, and chroma of 1 or 2. The B horizon has hue of 10YR, value of 4, and chroma of 3 or 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is clay loam or loam.

Kanaranzi Variant

The Kanaranzi Variant consists of well drained soils on stream terraces and kames in the uplands. These soils formed in loamy glacial outwash underlain by sandy and gravelly outwash. Permeability is moderate in the solum and rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Kanaranzi Variant loam, 2 to 5 percent slopes, in a cultivated field; 2,100 feet east and 1,900 feet south of the northwest corner of sec. 9, T. 98 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; mixed with some dark brown (10YR 3/3) material; weak fine subangular blocky structure parting to weak fine granular; friable; common medium and fine roots; neutral; abrupt smooth boundary.
Bw1—9 to 13 inches; brown (7.5YR 4/4) sandy clay loam; mixed with very dark grayish brown (10YR 3/2) material because of worm activity; weak fine and very fine subangular blocky structure; friable; common medium and fine roots; few reddish concretions (iron oxide); neutral; clear smooth boundary.
Bw2—13 to 20 inches; brown (7.5YR 4/4) sandy clay loam; weak medium and fine subangular blocky structure; friable; common fine and very fine roots; few reddish concretions (iron oxide); neutral; abrupt smooth boundary.
2C1—20 to 32 inches; dark yellowish brown (10YR 4/4) gravelly loamy coarse sand; single grained; loose; few very fine roots; few reddish concretions (iron oxide); about 30 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.
2C2—32 to 54 inches; yellowish red (5YR 5/6) gravelly sandy loam; single grained; loose; few very fine roots; few reddish concretions (iron oxide); about 25 percent gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.
2C3—54 to 60 inches; brown (10YR 4/3) gravelly loamy coarse sand; single grained; loose; common reddish concretions (iron oxide); about 35 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 16 to 24 inches. The mollic epipedon is 8 to 12 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 7.5YR or 10YR and value and chroma of 3 or 4. It typically is sandy clay loam, but the range includes sandy loam and loam. The 2C horizon has hue of 5YR to 10YR, value of 4 to 7, and chroma of 2 to 6.

Knoke Series

The Knoke series consists of very poorly drained, moderately slowly permeable soils in depressions on uplands. These soils formed in calcareous glacial sediments. The native vegetation was water-tolerant grasses. Slopes are 0 to 1 percent.

Typical pedon of Knoke mucky silt loam, 0 to 1 percent slopes, in a cultivated field; 1,830 feet west and 570 feet south of the northeast corner of sec. 15, T. 100 N., R. 39 W.

Ap—0 to 8 inches; black (N 2/0) mucky silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to weak fine and very fine granular; friable; common very fine roots; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

A1—8 to 17 inches; black (N 2/0) mucky silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; few very fine roots; many snail shell fragments; violent effervescence; moderately alkaline; clear smooth boundary.

A2—17 to 23 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; friable; few very fine roots; few snail shell fragments; a concentration of shells at a depth of about 23 inches; slight effervescence; mildly alkaline; abrupt smooth boundary.

A3—23 to 28 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine prismatic structure parting to moderate fine subangular blocky; friable; few very fine roots; very few snail shell fragments along faces of peds; neutral; clear smooth boundary.

Bg1—28 to 37 inches; very dark gray (N 3/0) silty clay, dark gray (10YR 4/1) dry; few coarse prominent gray (5Y 5/1) and olive brown (2.5Y 4/4) mottles; weak fine prismatic structure parting to moderate medium and fine subangular blocky; friable; few snail shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2—37 to 42 inches; dark gray (5Y 4/1) silty clay loam; few medium prominent olive brown (2.5Y 4/4) mottles; moderate fine and very fine subangular blocky structure; friable; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—42 to 48 inches; dark gray (5Y 4/1) silty clay loam; few medium prominent olive brown (2.5Y 4/4) mottles; massive; friable; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—48 to 53 inches; dark gray (5Y 4/1) silty clay loam; massive; friable; few soft accumulations (calcium carbonate) between depths of 49 and 51 inches; many snail shell fragments; violent effervescence; moderately alkaline; clear smooth boundary.

Cg3—53 to 59 inches; gray (5Y 5/1) silty clay loam; common medium prominent brown (10YR 4/3) mottles; massive; friable; few pockets of fine gypsum crystals; strong effervescence; moderately alkaline; clear smooth boundary.

Cg4—59 to 60 inches; mottled gray (5Y 5/1) and dark yellowish brown (10YR 4/4) silty clay loam; massive; friable; few pockets of fine gypsum crystals; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 36 to 50 inches. The mollic epipedon generally is more than 36 inches thick, but it is as thin as 24 inches in some pedons.

The A horizon is mucky silt loam, mucky silty clay loam, or silty clay loam. It has hue of 2.5Y, 5Y, or 10YR or is neutral in hue. It has value of 2 and chroma of 0 or 1. The Bg horizon is silty clay loam, silty clay, or clay loam. The upper part of this horizon has value of 2 or 3 and chroma of 0 or 1. The lower part has hue of 2.5Y or 5Y or is neutral in hue. It has value of 4 or 5 and chroma of 0 or 1. The Cg horizon typically is silty clay loam, but some pedons have strata of loam, silt loam, or clay loam.

Letri Series

The Letri series consists of poorly drained, moderately permeable soils on uplands. These soils formed in silty erosional sediments and in the underlying glacial till. The native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

The Letri soils in this county are taxadjuncts to the series because they are in the fine-silty family and in some pedons are calcareous throughout.

Typical pedon of Letri silty clay loam, 0 to 2 percent slopes, in a cultivated field; 250 feet north and 425 feet west of the southeast corner of sec. 33, T. 99 N., R. 40 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium and fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

A1—10 to 17 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to weak fine granular; friable; few very fine roots; neutral; gradual smooth boundary.

A2—17 to 23 inches; mixed very dark gray (10YR 3/1), black (10YR 2/1), and grayish brown (2.5Y 5/2) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine

granular; friable; few very fine roots; neutral; gradual smooth boundary.

Bg1—23 to 27 inches; mixed dark gray (5Y 4/1), very dark gray (10YR 3/1), and olive brown (2.5Y 4/4) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; few dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

Bg2—27 to 31 inches; olive gray (5Y 5/2) and light olive brown (2.5Y 5/4) silty clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

Bg3—31 to 38 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; common dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

2BC—38 to 42 inches; mottled olive gray (5Y 5/2), light olive brown (2.5Y 5/4), and yellowish brown (10YR 5/6) loam; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

2C—42 to 60 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) clay loam; massive; friable; common soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 24 to 48 inches in thickness. The mollic epipedon ranges from 16 to 24 inches in thickness. The silty erosional sediments range from 24 to 50 inches in thickness.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It typically is silty clay loam, but the range includes clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 4. The 2C horizon has hue of 5Y, 2.5Y, 10YR, or 7.5YR, value of 5 or 6, and chroma of 2 to 8. It is dominantly clay loam or loam, but coarser textured strata are in some pedons.

Marcus Series

The Marcus series consists of poorly drained, moderately slowly permeable soils on uplands. These soils formed in loess. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Marcus silty clay loam, 0 to 2 percent slopes, in a cultivated field; 155 feet east and 1,320 feet north of the southwest corner of sec. 31, T. 98 N., R. 40 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure parting to moderate fine granular; friable; common fine roots; neutral; clear smooth boundary.

A—9 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct olive gray (5Y 4/2) mottles; moderate fine granular structure; friable; few very fine roots; neutral; clear smooth boundary.

Bg1—15 to 21 inches; dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2) silty clay; few fine distinct yellowish brown (10YR 5/6) mottles; mixed with some black (10YR 2/1) material in the upper part; moderate fine and very fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bg2—21 to 28 inches; dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2) silty clay; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; friable; common dark concretions (iron and manganese oxides); disseminated lime on vertical cleavage; planes; neutral; abrupt smooth boundary.

BCg—28 to 33 inches; olive (5Y 5/3) silty clay loam; common fine distinct light olive brown (2.5Y 5/4 and 5/6) mottles; weak fine subangular blocky structure; friable; few medium old root channels; common fine dark concretions (iron and manganese oxides); disseminated lime throughout; strong effervescence; mildly alkaline; clear smooth boundary.

Cg1—33 to 40 inches; mottled light olive brown (2.5Y 5/4 and 5/6) and olive gray (5Y 5/2) silty clay loam; massive; friable; few medium old root channels; few fine dark concretions (iron and manganese oxides); disseminated lime throughout; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—40 to 60 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; common fine dark concretions (iron and manganese oxides); disseminated lime throughout; few medium pipestems; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The depth to free carbonates ranges from 24 to 48 inches.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 and chroma of 0 or 1 in the upper part, and it has value of 3 and chroma of 1 in the lower part. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 6. Some pedons have a 2C horizon at a depth of 40 to 60 inches. This horizon is clay loam or loam.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on till plains and glacial moraines. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet clay loam, 1 to 3 percent slopes, in a cultivated field; 70 feet north and 50 feet west of the southeast corner of sec. 34, T. 100 N., R. 39 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; neutral; clear smooth boundary.

A—7 to 14 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; few very fine roots; few worm casts and channels; neutral; clear smooth boundary.

AB—14 to 20 inches; very dark grayish brown (10YR 3/2) clay loam, dark gray (10YR 4/1) dry; very dark gray (10YR 3/1) coatings on faces of peds; weak medium subangular blocky structure parting to moderate fine granular; friable; few very fine roots; few worm casts and channels; neutral; clear smooth boundary.

Bw1—20 to 27 inches; mixed dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) kneaded; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw2—27 to 32 inches; dark grayish brown (2.5Y 4/2) and yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine prismatic structure parting to weak fine and medium subangular blocky; friable; few very fine roots; few fine dark concretions (iron and manganese oxides); mildly alkaline; abrupt smooth boundary.

C1—32 to 42 inches; mottled dark grayish brown (2.5Y 4/2), yellowish brown (10YR 5/4), strong brown (7.5YR 5/6), and gray (10YR 5/1) clay loam; dominantly massive but some weak fine subangular blocky structure; friable; few very fine roots; few fine dark concretions (iron and manganese oxides); common disseminations of lime; strong effervescence; moderately alkaline; clear smooth boundary.

C2—42 to 60 inches; mottled yellowish brown (10YR 5/8), gray (10YR 5/1), and strong brown (7.5YR 5/8) clay loam; massive; friable; few fine dark concretions (iron and manganese oxides); common disseminations of lime; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam. The Bw horizon also is loam or clay loam. The upper part of this horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. The lower part has hue of 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5, and chroma of 1 to 8.

Ocheyedan Series

The Ocheyedan series consists of well drained, moderately permeable soils on uplands. These soils formed in loamy and silty glacial sediments. The native vegetation was prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Ocheyedan loam, 2 to 5 percent slopes, in a cultivated field; 360 feet east and 120 feet south of the northwest corner of sec. 24, T. 98 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; medium acid; clear smooth boundary.

AB—9 to 16 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; mixed with some brown (10YR 4/3) material; weak medium and fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

Bw1—16 to 23 inches; dark yellowish brown (10YR 4/4) loam; mixed with a small amount of very dark grayish brown (10YR 3/2) material in the upper part; some dark brown (10YR 3/3) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few very fine roots; slightly acid; clear smooth boundary.

Bw2—23 to 29 inches; dark yellowish brown (10YR 4/4) fine sandy loam; some brown (10YR 4/3) coatings on faces of peds; weak very fine prismatic structure parting to weak fine and very fine subangular blocky; friable; few very fine roots; neutral; clear smooth boundary.

Bw3—29 to 34 inches; dark yellowish brown (10YR 4/4) fine sandy loam; some brown (10YR 4/3) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few fine dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

2BC—34 to 40 inches; olive brown (2.5Y 4/4) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few fine dark concretions (iron and manganese oxides); mildly alkaline; abrupt smooth boundary.

2C1—40 to 54 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct light olive brown (2.5Y 5/6) and few fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; common fine dark concretions (iron and manganese oxides); common soft masses and accumulations (calcium carbonate); strong effervescence; moderately alkaline; abrupt smooth boundary.

3C2—54 to 60 inches; dark yellowish brown (10YR 4/4) clay loam; few fine prominent light brownish gray (2.5Y 6/2) and strong brown (7.5YR 5/6) mottles; massive; friable; few fine dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); some disseminated lime; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 30 to 48 inches. The upper part of the A horizon has chroma of 1 or 2. The Bw horizon is loam, sandy clay loam, or fine sandy loam. The 2BC and 2C horizons are dominantly silt loam or clay loam, but the range includes sandy loam and sandy clay loam.

Okoboji Series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils in depressions on uplands. These soils formed in glacial sediments. The native vegetation was water-tolerant grasses. Slopes are 0 to 1 percent.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes, in a cultivated field; 100 feet west and 500 feet south of the northeast corner of sec. 22, T. 100 N., R. 41 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; moderate fine granular structure; friable; common fine roots; mildly alkaline; gradual smooth boundary.

A1—9 to 16 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine subangular blocky structure parting to moderate fine and very fine granular; friable; common very fine roots; mildly alkaline; gradual smooth boundary.

A2—16 to 21 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate fine and very fine granular; friable; few very fine roots; mildly alkaline; gradual smooth boundary.

A3—21 to 35 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to moderate fine subangular blocky; friable; few very fine roots; mildly alkaline; gradual smooth boundary.

Bg—35 to 40 inches; mixed dark gray (10YR 4/1) and very dark gray (10YR 3/1) silty clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; weak medium and fine subangular blocky structure; friable; mildly alkaline; gradual smooth boundary.

Cg1—40 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; dark gray (10YR 4/1) coatings on faces of peds; slight effervescence; moderately alkaline; clear smooth boundary.

2Cg2—44 to 60 inches; olive gray (5Y 5/2) clay loam; few fine prominent light olive brown (2.5Y 5/6) and strong brown (7.5YR 5/8) mottles; massive; friable; common accumulations of calcium carbonate between depths of 45 and 48 inches; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates commonly ranges from 25 to 40 inches. In some pedons, however, it is the same as the thickness of the solum.

The A horizon ranges from 24 to 36 inches in thickness. It has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is mucky silty clay loam, mucky silt loam, or silty clay loam. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay loam or silty clay.

Primghar Series

The Primghar series consists of somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loess. The native vegetation was prairie grasses. Slopes range from 0 to 4 percent.

Typical pedon of Primghar silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,030 feet north and 480 feet west of the southeast corner of sec. 28, T. 99 N., R. 42 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; few fine and very fine roots; neutral; clear smooth boundary.

A1—10 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; few fine and very fine roots; neutral; clear smooth boundary.

A2—16 to 21 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; mixed with dark grayish brown (10YR 4/2) and black (10YR 2/1) material; weak fine and very fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

Bw1—21 to 27 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay loam; mixed with very dark gray (10YR 3/1) material; few fine prominent reddish brown (5YR 4/4) mottles; weak

fine subangular blocky structure; friable; few fine roots; few dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

Bw2—27 to 35 inches; olive brown (2.5Y 4/4) silty clay loam; mixed with very dark grayish brown (10YR 3/2) material; dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine and very fine subangular blocky structure; friable; common dark concretions (iron and manganese oxides); mildly alkaline; gradual smooth boundary.

Bw3—35 to 42 inches; olive brown (2.5Y 4/4) silty clay loam; dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/6) and few fine distinct grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; common dark concretions (iron and manganese oxides); mildly alkaline; abrupt smooth boundary.

C—42 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct light olive brown (2.5Y 5/6) and common fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 30 to 48 inches in thickness. The depth to free carbonates ranges from 24 to 48 inches.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. Some pedons have an AB horizon. This horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR or 2.5Y 3/2). The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5 throughout. Chroma is 2 in the upper part and in most pedons increases to 3 or 4 with increasing depth. This horizon has mottles with higher or lower chroma. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It has few to many mottles, which have hue of 2.5Y to 7.5YR, value of 4 to 6, and chroma of 1 to 6. A 2C horizon is below a depth of 40 inches in some pedons. It is clay loam or loam. It has colors similar to those of the C horizon. A coarser textured band as much as 6 inches thick is between the loess and the till in some pedons.

Ransom Series

The Ransom series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. These soils formed in loess underlain by glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 3 percent.

Typical pedon of Ransom silty clay loam, 0 to 3 percent slopes, in a cultivated field; 700 feet west and 900 feet south of the northeast corner of sec. 13, T. 89 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; few medium and fine roots; neutral; clear smooth boundary.

A—9 to 16 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

AB—16 to 20 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

Bw—20 to 29 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) silty clay loam; mixed with some very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) material; weak fine and medium subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

BC—29 to 33 inches; olive brown (2.5Y 4/4) silty clay loam; mixed with some very dark grayish brown (10YR 3/2) material; weak fine subangular blocky structure; friable; few very fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

2C1—33 to 36 inches; mottled olive brown (2.5Y 4/4) and grayish brown (2.5Y 5/2) loam; massive; friable; common dark concretions (iron and manganese oxides); about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—36 to 60 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct grayish brown (2.5Y 5/2) and few fine prominent strong brown (7.5YR 5/6) mottles; massive; firm; common dark concretions (iron and manganese oxides); common soft accumulations and disseminations of lime; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to glacial till range from 24 to 40 inches. The depth to free carbonates ranges from 26 to 40 inches. The mollic epipedon is 14 to 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 2.5Y or 10YR, value of 4, and chroma of 2 to 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 5.

Revere Series

The Revere series consists of poorly drained, moderately permeable soils on uplands. These soils formed in erosional sediments. The native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Revere loam, 0 to 2 percent slopes, in a cultivated field; 820 feet east and 1,040 feet north of the southwest corner of sec. 2, T. 98 N., R. 39 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; about 3 percent gypsum crystals; common fine and very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Byg1—10 to 16 inches; mixed dark grayish brown (2.5Y 4/2), olive (5Y 5/3), and very dark gray (5Y 3/1) loam; weak medium subangular blocky structure; friable; about 40 percent gypsum crystals; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Byg2—16 to 20 inches; olive gray (5Y 5/2) loam; mixed with some olive (5Y 5/3) and very dark gray (5Y 3/1) material; weak fine and medium subangular blocky structure; friable; about 40 percent gypsum crystals; few very fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

Byg3—20 to 29 inches; olive (5Y 5/3) loam; few medium faint olive (5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; about 40 percent gypsum crystals; strong effervescence; moderately alkaline; gradual smooth boundary.

Byg4—29 to 39 inches; olive (5Y 5/3) and olive gray (5Y 5/2) loam; common fine distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; few dark concretions (iron and manganese oxides); about 25 percent nests of gypsum crystals; strong effervescence; moderately alkaline; clear smooth boundary.

Byg5—39 to 45 inches; olive gray (5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/6) and common medium prominent strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; few dark concretions (iron and manganese oxides); about 25 percent nests of gypsum crystals; about 5 percent nests of soft gypsum; strong effervescence; moderately alkaline; clear smooth boundary.

2Cyg—45 to 49 inches; olive gray (5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/6) and few fine prominent light olive brown (2.5Y 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); about 10 percent nests of gypsum crystals; about 5 percent nests of soft gypsum; strong effervescence; moderately alkaline; abrupt smooth boundary.

2Cg—49 to 60 inches; yellowish brown (10YR 5/6) clay loam; few fine distinct light gray (5Y 6/1) mottles; massive; firm; common dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The solum ranges from 30 to 48 inches in thickness. The mollic epipedon is 10 to 16 inches thick.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is loam or clay loam. The Byg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4. It is silt loam, loam, clay loam, or silty clay loam. The content of gypsum in this horizon ranges from 10 to 50 percent. Some pedons have a C horizon. This horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. it is loam or silt loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 8. It is loam or clay loam.

Rolfe Series

The Rolfe series consists of very poorly drained, slowly permeable soils in depressions on uplands. These soils formed in local alluvium and in glacial drift. The native vegetation was water-tolerant sedges, reeds, and grasses. Slopes are 0 to 1 percent.

Typical pedon of Rolfe silty clay loam, 0 to 1 percent slopes, in a cultivated field; 1,700 feet east and 120 feet north of the southwest corner of sec. 33, T. 100 N., R. 41 W.

Ap—0 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; few fine roots; medium acid; abrupt smooth boundary.

E1—12 to 17 inches; dark gray (10YR 4/1) silt loam; few fine distinct brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

E2—17 to 25 inches; dark gray (10YR 4/1) silt loam; few fine prominent brown (7.5YR 4/4) mottles; weak thin and very thin platy structure; friable; gray (10YR 5/1) silt coatings; few very fine roots; slightly acid; clear smooth boundary.

Btg1—25 to 36 inches; very dark gray (10YR 3/1) silty clay; common fine prominent brown (7.5YR 4/4) mottles; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; firm; thin continuous clay films on faces of peds; slightly acid; gradual smooth boundary.

Btg2—36 to 45 inches; very dark gray (10YR 3/1) silty clay; common fine prominent brown (7.5YR 4/4) mottles; weak fine prismatic structure parting to medium fine and very fine subangular blocky; firm; thin continuous clay films on faces of peds; dark gray (10YR 4/1) silt coatings; slightly acid; clear smooth boundary.

Btg3—45 to 55 inches; olive gray (5Y 5/2) silty clay loam; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds; few dark

concretions (iron and manganese oxides); neutral; clear smooth boundary.
Cg—55 to 60 inches; olive gray (5Y 5/2) clay loam; common medium prominent dark yellowish brown (10YR 4/4) and light olive brown (2.5Y 5/4) mottles; massive; friable; few dark concretions (iron and manganese oxides); neutral.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 42 to 60 inches.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is loam, silt loam, or silty clay loam. The E horizon has value of 4 or 5. It is silt loam or loam. The Btg horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 1 or 2. It is clay or silty clay in the upper part and silty clay loam or clay loam in the lower part.

Sac Series

The Sac series consists of well drained, moderately permeable soils on convex slopes in the uplands. These soils formed in loess and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Sac silty clay loam, 0 to 2 percent slopes, in a cultivated field; 1,225 feet east and 1,000 feet north of the southwest corner of sec. 36, T. 98 N., R. 41 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure; friable; common fine and very fine roots; slightly acid; clear smooth boundary.
A—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; moderate fine granular structure; friable; few very fine roots; slightly acid; clear smooth boundary.
BA—12 to 16 inches; brown (10YR 4/3) silty clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate fine subangular blocky structure; friable; few very fine roots; slightly acid; clear smooth boundary.
Bw1—16 to 29 inches; brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.
Bw2—29 to 34 inches; brown (10YR 4/3) silty clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; abrupt smooth boundary.
2C1—34 to 50 inches; dark yellowish brown (10YR 4/4) clay loam; few fine prominent weak red (2.5YR 5/2) mottles; massive; friable; strong effervescence; moderately alkaline; clear smooth boundary.
2C2—50 to 60 inches; yellowish brown (10YR 5/6) clay loam; few fine distinct grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 30 to 40 inches in thickness. The thickness of the loess mantle and the depth to free carbonates range from 20 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6.

The moderately eroded Sac soils in this county are taxadjuncts to the series because they do not have a mollic epipedon.

Spicer Series

The Spicer series consists of poorly drained, moderately permeable soils on loess-mantled uplands. These soils formed in loess. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, 0 to 2 percent slopes, in a cultivated field; 1,400 feet west and 2,265 feet north of the southeast corner of sec. 35, T. 100 N., R. 42 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky structure; friable; few very fine roots; slight effervescence; moderately alkaline; clear smooth boundary.
A1—9 to 17 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.
A2—17 to 21 inches; very dark gray (10YR 3/1) silty clay loam; mixed with grayish brown (2.5Y 5/2) material; weak fine subangular blocky structure parting to weak fine granular; friable; few very fine roots; few accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.
BA—21 to 25 inches; mottled dark gray (5Y 4/1), olive (5Y 5/3), grayish brown (2.5Y 5/2), and very dark gray (10YR 3/1) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; few accumulations of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.
Bg1—25 to 31 inches; mottled olive gray (5Y 4/2) and olive (5Y 5/3) silty clay loam; weak fine subangular blocky structure; friable; few very fine roots; few fine dark concretions (iron and manganese oxides); few

accumulations of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

Bg2—31 to 42 inches; mottled light olive brown (2.5Y 5/4 and 5/6), olive gray (5Y 5/2), and strong brown (7.5YR 5/6) silty clay loam; weak fine subangular blocky structure; friable; common fine dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; abrupt smooth boundary.

2Cg1—42 to 46 inches; light brownish gray (2.5Y 6/2) loamy sand; few medium prominent yellowish brown (10YR 5/6) and few fine distinct light olive brown (2.5Y 5/4) mottles; single grained; loose; few medium dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; abrupt smooth boundary.

2Cg2—46 to 60 inches; light olive brown (2.5Y 5/6) clay loam; few fine distinct light brownish gray (2.5Y 6/2) and few fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 24 to 48 inches in thickness. The mollic epipedon ranges from 12 to 24 inches in thickness. Typically, free carbonates are throughout the profile.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 6. Some pedons have a C horizon, which has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. Some pedons have thin strata of coarser textured material in the 2Cg horizon.

Storden Series

The Storden series consists of well drained, moderately permeable soils on convex side slopes in the uplands. These soils formed in calcareous glacial till. The native vegetation was prairie grasses. Slopes range from 5 to 40 percent.

Typical pedon of Storden loam, 14 to 18 percent slopes, moderately eroded, in a cultivated field; 2,450 feet west and 220 feet south of the northeast corner of sec. 22, T. 99 N., R. 40 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; mixed with streaks and pockets of yellowish brown (10YR 5/4) substratum material; weak fine and medium subangular blocky structure; friable; common very fine roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—8 to 21 inches; yellowish brown (10YR 5/4) loam; few fine prominent reddish brown (5YR 4/4) mottles; massive with some horizontal and vertical cleavage planes; friable; common very fine roots; some disseminated lime along old root channels and cleavage planes; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—21 to 60 inches; brown (10YR 5/3) loam; few fine prominent reddish brown (5YR 4/4) and few medium distinct dark yellowish brown (10YR 4/4) mottles; massive with some horizontal and vertical cleavage planes; friable; few very fine roots to a depth of about 38 inches; some disseminated lime along old root channels and cleavage planes; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum is 6 to 10 inches. It is the same as the thickness of the Ap horizon. This horizon is loam or clay loam. It has hue of 10YR and chroma of 2 or 3. Value is dominantly 4 or 5 but is 2 or 3 in a few masses. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6.

Talcot Series

The Talcot series consists of calcareous, poorly drained soils in low areas on stream terraces. These soils formed in glacial outwash. They have a loamy mantle overlying sandy and gravelly sediments. Permeability is moderate in the solum and rapid in the substratum. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 60 feet north and 720 feet west of the southeast corner of sec. 27, T. 98 N., R. 39 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure parting to weak fine and very fine granular; friable; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A1—8 to 14 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine subangular blocky structure parting to weak fine and very fine granular; friable; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

A2—14 to 20 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg1—20 to 27 inches; dark gray (5Y 4/1) clay loam; weak fine and medium subangular blocky structure; friable; few very fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2—27 to 36 inches; dark gray (5Y 4/1) clay loam; few medium faint olive gray (5Y 5/2) and few fine faint olive (5Y 4/4) mottles; weak fine and medium

subangular blocky structure; friable; few very fine roots; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; abrupt smooth boundary.

2C—36 to 60 inches; olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) sand; single grained; loose; about 10 percent gravel; strong effervescence; moderately alkaline.

The solum ranges from 32 to 40 inches in thickness. The mollic epipedon typically ranges from 14 to 22 inches in thickness. Free carbonates are throughout the profile.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is clay loam or silty clay loam. The Bg horizon also is clay loam or silty clay loam. It has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on foot slopes and convex alluvial fans in the uplands. These soils formed in loamy alluvium derived from glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Terril loam, 2 to 5 percent slopes, in a cultivated field; 950 feet west and 400 feet south of the northeast corner of sec. 33, T. 98 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

A1—9 to 20 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

A2—20 to 27 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; few fine and very fine roots; neutral; gradual smooth boundary.

Bw1—27 to 33 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bw2—33 to 44 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few very fine roots; neutral; gradual smooth boundary.

Bw3—44 to 60 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; neutral.

The solum ranges from 3 to 6 feet in thickness. The A horizon has chroma of 1 or 2 in the upper part and value of 2 or 3 in the lower part. It is loam or clay loam. The Bw horizon also is loam or clay loam. It has chroma of 2 to 4.

Wadena Series

The Wadena series consists of well drained soils on stream terraces and outwash plains. These soils formed in loamy alluvium overlying sand and gravel. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 150 feet north and 1,380 feet west of the southeast corner of sec. 21, T. 98 N., R. 39 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; few fine and very fine roots; about 1 percent coarse fragments; medium acid; clear smooth boundary.

AB—10 to 13 inches; mixed very dark gray (10YR 3/1), dark brown (10YR 3/3), and brown (10YR 4/3) loam, dark gray (10YR 4/1) and brown (10YR 4/3) dry; weak fine and very fine subangular blocky structure; friable; few very fine and fine roots; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Bw1—13 to 19 inches; dark yellowish brown (10YR 4/4) loam; discontinuous brown (10YR 4/3) coatings on faces of peds; mixed with some very dark grayish brown (10YR 3/2) and very dark gray (10YR 3/1) material; weak medium and fine subangular blocky structure; friable; few very fine roots; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Bw2—19 to 28 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on faces of peds; weak fine prismatic structure parting to weak fine subangular blocky; friable; few very fine roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

2C1—28 to 34 inches; brown (7.5YR 4/4) gravelly loamy sand; single grained; loose; few very fine roots; about 20 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—34 to 42 inches; brown (10YR 4/3) sand and gravel; single grained; loose; about 25 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

2C3—42 to 60 inches; brown (10YR 4/3) sand and gravel; single grained; loose; about 30 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3,

and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam in the upper part and loam, sandy clay loam, or sandy loam in the lower part. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4.

Waldorf Series

The Waldorf series consists of poorly drained, moderately slowly permeable soils on glacial lake plains and moraines. These soils formed in lacustrine sediments. The native vegetation was water-tolerant prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Waldorf silty clay loam, 0 to 1 percent slopes, in a cultivated field; 1,530 feet south and 100 feet east of the northwest corner of sec. 2, T. 99 N., R. 39 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 37 percent clay), very dark gray (N 3/0) dry; moderate fine subangular blocky structure; firm; few fine roots; neutral; clear smooth boundary.

A—9 to 19 inches; black (5Y 2/1) silty clay loam (about 39 percent clay), dark gray (10YR 4/1) dry; mixed with very dark gray (10YR 3/1) and black (N 2/0) material; weak fine subangular blocky structure parting to weak very fine granular; firm; few very fine roots; neutral; gradual smooth boundary.

Bg1—19 to 23 inches; dark gray (5Y 4/1) silty clay (about 46 percent clay); mixed very dark gray (10YR 3/1) material in the upper part; few fine prominent light olive brown (2.5Y 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; few very fine roots; neutral; gradual smooth boundary.

Bg2—23 to 29 inches; dark grayish brown (2.5Y 4/2) silty clay (about 46 percent clay); few fine prominent strong brown (7.5YR 5/6) and few fine distinct light olive brown (2.5Y 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; few very fine roots; few dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

Bg3—29 to 34 inches; olive gray (5Y 5/2) silty clay (about 40 percent clay); few fine faint olive (5Y 5/3) and few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine and very fine subangular blocky structure; firm; few very fine roots; few dark concretions (iron and manganese oxides); neutral; abrupt smooth boundary.

Cg1—34 to 47 inches; gray (5Y 5/1) silty clay loam (about 37 percent clay); common medium prominent yellowish brown (10YR 5/8) mottles; massive with some horizontal and vertical cleavage planes; firm; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2—47 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam (about 35 percent clay); common medium prominent yellowish brown (10YR 5/8) and common fine distinct light olive brown (2.5Y 5/6) mottles; massive with some horizontal and vertical cleavage planes; firm; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 26 to 48 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches. The depth to free carbonates ranges from 26 to 55 inches.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or silty clay. The Bg horizon also is silty clay loam or silty clay. It has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is silty clay, silty clay loam, or clay.

Webster Series

The Webster series consists of poorly drained, moderately permeable soils on uplands. These soils formed in glacial till or in local alluvium derived from glacial till. The native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes, in a cultivated field; 880 feet north and 500 feet east of the southwest corner of sec. 1, T. 99 N., R. 41 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate medium and fine subangular blocky structure; friable; few fine and very fine roots; neutral; clear smooth boundary.

A—9 to 16 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine and very fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

AB—16 to 21 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine prominent olive gray (5Y 4/2) mottles; weak fine subangular blocky structure; friable; few very fine roots; neutral; clear smooth boundary.

Bg—21 to 30 inches; olive gray (5Y 4/2) clay loam; few very dark gray (10YR 3/1) peds; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; few very fine roots; neutral; abrupt smooth boundary.

BCg—30 to 38 inches; olive gray (5Y 5/2) clay loam; few fine prominent light olive brown (2.5Y 5/6) and few fine prominent olive (5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; few very fine roots; few dark concretions (iron and

manganese oxides); strong effervescence; moderately alkaline; clear smooth boundary.
Cg1—38 to 47 inches; light olive gray (5Y 6/2) clay loam; few fine prominent light olive brown (2.5Y 5/6) mottles; massive; friable; common dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; gradual smooth boundary.
Cg2—47 to 60 inches; light olive gray (5Y 6/2) loam; common fine distinct olive (5Y 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The solum ranges from 30 to 40 inches in thickness. It is silty clay loam or clay loam. The silty clay loam has a moderate content of sand. The depth to free carbonates ranges from 24 to 36 inches.

The Ap and A horizons have hue of 10YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 or 1. The Bg and BCg horizons have hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon is loam or clay loam.

Wilmonton Series

The Wilmonton series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. These soils formed in a mantle of silty erosional sediments and in the underlying calcareous glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 3 percent.

The Wilmonton soils in this county are taxadjuncts to the series because they are in the fine-silty family.

Typical pedon of Wilmonton silty clay loam, 0 to 3 percent slopes, in a cultivated field; 2,105 feet south and 1,115 feet east of the northwest corner of sec. 12, T. 98 N., R. 39 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak medium and fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; neutral; clear smooth boundary.
A—8 to 13 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine and medium granular structure; friable; few very fine roots; neutral; clear smooth boundary.
BA—13 to 18 inches; mixed very dark grayish brown (10YR 3/2) and very dark gray (10YR 3/1) silty clay loam; few fine distinct dark brown (10YR 3/3) mottles; moderate very fine and fine subangular blocky structure; friable; few very fine roots; mildly alkaline; clear smooth boundary.
Bw1—18 to 23 inches; olive brown (2.5Y 4/4) silty clay loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak very fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); few very fine roots; mildly alkaline; clear smooth boundary.
Bw2—23 to 28 inches; olive brown (2.5Y 4/4) silty clay loam; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak very fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); few very fine roots; mildly alkaline; abrupt smooth boundary.
C1—28 to 42 inches; grayish brown (2.5Y 5/2) silt loam; few fine prominent strong brown (7.5YR 5/6) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); few very fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.
2C2—42 to 48 inches; mottled light gray (10YR 6/1) and yellowish brown (10YR 5/6 and 5/8) clay loam; massive; friable; common dark concretions (iron and manganese oxides); common soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.
2C3—48 to 55 inches; yellowish brown (10YR 5/4) clay loam; few medium distinct light gray (10YR 6/1) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; clear smooth boundary.
2C4—55 to 60 inches; mottled yellowish brown (10YR 5/4), light gray (10YR 6/1), strong brown (7.5YR 5/8), and light olive brown (2.5Y 5/6) loam; massive; friable; few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The silty mantle is 30 to 45 inches deep over glacial till.

The A and Bw horizons are silty clay loam or clay loam. The A horizon has hue of 2.5Y or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. The C and 2C horizons have hue of 10YR and 2.5Y, value of 4 to 6, and chroma of 1 to 6. They are silt loam, loam, or clay loam.

Formation of the Soils

This section relates the major factors of soil formation to the soils in Osceola County. It also explains some of the processes of horizon development.

Factors of Soil Formation

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical properties and chemical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material (*8*). Human activities also affect soil formation.

Climate and plant and animal life are the active factors of soil formation. They act on unconsolidated parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and the rate at which it forms. In extreme cases it almost entirely determines profile development. Finally, time is needed for the transformation of the parent material into a soil. The amount of time needed depends on the rate of the soil-forming processes. A long period generally is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

Nearly all of the soils in Osceola County formed in glacial drift, alluvium, loess, or sandy eolian material. These parent materials were transported to the county from areas where they weathered from rocks.

Glacial drift is material deposited by glaciers. The two main kinds of glacial drift in Osceola County are glacial till and glacial outwash. The soils that formed partly or entirely in glacial drift make up more than 80 percent of the county.

Four episodes of glaciation probably occurred in what is now Osceola County. The first two, the Nebraskan and the Kansan, deposited drift throughout the entire county, but these deposits were buried during more recent episodes of glaciation. These episodes are the Tazewell substage and the Cary substage of the Wisconsin glacial period. Tazewell glacial drift was deposited throughout the county but is exposed only on the steep side slopes along the Little Rock River, the Little Ocheyedan River, Otter Creek, and the part of the Ocheyedan River in southern Osceola County. The fourth episode, the Cary substage, deposited the glacial drift that is the modern surface throughout the northeastern third of the county.

In many of the soils on uplands in the southern and western parts of the county, the lower part of the solum formed in Tazewell glacial till. For example, Everly soils have a B horizon of loam or clay loam that formed in this till. According to radiocarbon dating, this glacial till was deposited about 20,000 years ago (*12*). It contains more clay, has a higher bulk density, and is firmer than the Cary glacial till.

Cary glacial till was deposited on ground moraines and end moraines. It typically is loam or clay loam. Geologic erosion has beveled side slopes and filled the lower adjacent areas of the original glacial landscape. The textural differences between the surficial till on side slopes and the local sediment in downslope areas reflect the sorting that occurred as a result of this erosion. For example, Clarion soils on ridgetops and side slopes contain less clay and have a higher content of coarse fragments than the Nicollet and Webster soils in the lower adjacent areas. Soil material is sorted by water in areas where Clarion soils are rapidly eroding. In most of these areas, gravel, cobbles, and stones are concentrated on the surface because the water has removed the finer soil particles.

Although glacial till is considered to be relatively unsorted sediment, Cary and post-Cary geologic erosion and recent accelerated erosion have resulted in textural variations in the surficial material. The texture of the Cary glacial till varies more on ground moraines than on end moraines.

Cary glacial sediments are underlain by the older Tazewell glacial till and silt loam sediments in an area that borders the Cary terminal moraine. This area is 2 or 3 miles wide. Wilmonton, Everly, Letri, and Ocheyedan are the major soils that formed in these Tazewell sediments. The surficial sediments typically are clay loam or loam, but they are silty clay loam in areas where they have been sorted by water and are sandy loam

underlain by loamy sand and sand in a few areas where they have been sorted by wind.

Cary glaciolacustrine sediments are in scattered areas north and east of the terminal moraine. These sediments evidently were originally on top of the Cary glacial ice. Where a depression or trough in the glacial ice filled with these sediments, a ridge formed when the glacial ice melted. The sediments are in many areas on the Cary ground moraines. In other areas they are in closed depressions surrounded by glacial till. They typically are silty clay loam or silty clay. The soils that formed in these sediments, mainly Collinwood, Kamrar, and Waldorf soils, make up about about 2 percent of the county.

Alluvium is material deposited by water along the major and minor streams and drainageways. The texture of the alluvium varies widely because the source of the material and the manner in which it was deposited differ from area to area. In Osceola County the main sources of alluvium are areas of glacial till, areas of loess, and areas of outwash deposited by glacial meltwater. The soils that formed in alluvium, mainly Coland, Havelock, and Wadena soils, make up about 13 percent of the county.

When the rivers and streams overflow their channels and the water spreads outward toward the uplands, the sandy material is deposited first, adjacent to the channels. As the water moves more slowly, silt and very fine sand are deposited. During periods when it is high, the floodwater spreads slowly toward the outer border of the flood plain and deposits very fine silt and clay. This pattern of deposition is evident in an area along the Ocheyedan River south of Ocheyedan. Coland and Havelock soils are on the bottom land nearest the stream. Wadena, Cylinder, and Biscay soils are progressively farther away from the stream. These soils are underlain by sand and gravel. The sand and gravel was deposited by meltwater from the receding Cary glacial ice.

The loess in Osceola County is silty material that was deposited by the wind about 20,000 to 14,000 years ago, according to radiocarbon dating (*12*). The soils that formed partly or entirely in loess, mainly Ransom, Sac, and Primghar soils, make up about 31 percent of the county. The loess is about 2 to 5 feet thick in most places and is underlain by Tazewell glacial till. Unlike most of the other parent materials in the county, loess has a uniform texture of silt loam. It contains more sand than is typical in areas where deposits of loess are extensive. Generally, the content of clay is about 20 percent and that of sand is 5 to 10 percent. Most of the sand is fine and very fine. The content of sand tends to be highest in areas near loamy or sandy sediments.

Eolian sandy material is deposited in a few areas on uplands in the county. The soils that formed partly or entirely in this material make up less than 1 percent of the county. Bolan soils formed in loamy material underlain by sandy eolian material. The most probable source of the sandy material is the valley of the Ocheyedan River.

Climate

Climate has a major influence on soil formation. Soils form more rapidly under a warm climate than under a cold climate and more rapidly under a wet climate than under a dry climate. All of the soils in Osceola County formed under about the same climate, but the climate has not been the same during the entire period of soil formation.

Soil formation began in Osceola County about 13,000 years ago, after the glaciation in Iowa ended and the climate began a warming trend (*13*). Evidently, the climate in northern Iowa since that time has varied considerably (*21, 22*). From before 13,000 to about 11,000 years ago, the climate was cool and the vegetation was dominantly conifers. From about 11,000 to 9,000 years ago, the climate became warmer and the vegetation was mixed deciduous trees. From about 9,000 to 3,000 years ago, the climate became progressively warmer and drier. As a result, the forest vegetation was replaced by herbaceous prairie vegetation. Most of the soils in the county do not have characteristics that indicate that they were ever forested. Evidently, the rapid geologic erosion that accompanied major climate changes removed the soils that formed under forest vegetation.

The county has a midcontinental subhumid climate. The climate differs very little from one part of the county to another. The annual mean temperature increases about 1 degree F from the northern part of the county to the southern part, and the annual precipitation increases slightly more than 1 inch from the northwest corner to the southeast corner (*16*).

The effect of climate on soils is modified by relief. The more sloping soils, such as Storden, formed under a drier microclimate than the gently sloping adjacent soils, such as Clarion. In areas of poorly drained soils, such as Canisteo and Webster, the microclimate is cooler and wetter than that in areas of the well drained adjacent soils, such as Clarion.

Climate indirectly affects soil formation through its effect on the kinds of plants and animals in and on the soil. It also directly affects soil formation. For example, temperature and moisture conditions affect the rate at which the parent material weathers. The amount and seasonal distribution of precipitation determine the depth to which calcium carbonates, soluble salts, and clay are moved and the rate of erosion. Precipitation also affects the depth to the water table in poorly drained and somewhat poorly drained soils. In areas where the water table is near the surface most of the year, the subsoil does not develop to so great a depth as it does in areas where the water table is at a lower depth.

Plant and Animal Life

Living organisms affect soil formation. Micro-organisms and burrowing animals, such as worms and crawfish, influence soil properties. Plants, however, generally cause the most marked differences among soils. Grasses have a dense system of roots in the topsoil and have some roots deep in the subsoil. These roots die and commonly are replaced. The dead roots add organic matter to the soil. Grass roots also transport calcium and other plant nutrients from the subsoil to the topsoil. Tree roots live longer than grass roots. Soils that formed under grasses typically have a surface soil that is thicker, darker, and more fertile than that in soils that formed under trees. Also, they are less acid and have a subsoil that generally is thinner and less well developed.

The soils in Osceola County formed mainly under prairie grasses. Herbaceous prairie vegetation probably began to replace forest vegetation about 8,000 years ago. Erosion evidently removed the soils that formed under forest vegetation. Trees have influenced the formation of some gently sloping to very steep soils near Iowa Lake and Rush Lake. These soils are not extensive, however, and were not separated in mapping.

Large burrowing animals, such as badgers, foxes, and pocket gophers, drastically affect soil formation in small areas. Small animals, such as earthworms and ants, have a widespread influence on soil formation. As the content of soil moisture and the soil temperature change, earthworms move up and down in the soil profile. They have moved material from one horizon to another in most soils of the county.

Human Activities

The natural formation of the soils in Osceola County changed when the prairie was drained and cultivated and the lakes, sloughs, and depressions were drained. Accelerated erosion in cultivated areas of the more sloping soils caused the most significant changes. In most areas of the moderately sloping and strongly sloping Clarion soils that have been cultivated for 10 years or more, subsoil material is mixed with the plow layer. In areas where those soils have not been cultivated for more than a few years, the darker topsoil is 10 to 14 inches thick.

In many soils in Osceola County, accelerated erosion is the main cause of a reduction in the content of organic matter. Even without accelerated erosion, however, the content decreases under some cropping systems (*4*). The most significant decrease is in areas where the soils in lakes, sloughs, and depressions have been drained and cultivated. In a few areas fires burned the organic layers after the sloughs were drained.

Tillage and applications of fertilizer, lime, and pesticides have changed the biotic, chemical, and physical properties of the soils in cultivated areas. Most of these management measures have increased the productivity of the soils, but the long-term effect of some of these measures is unknown.

Relief

Relief affects the formation of soils mainly through its effect on drainage, runoff, erosion, and the depth to the water table. The soils in Osceola County range from level to very steep. Soils that formed in the same kind of parent material have different properties mainly because of relief.

Aspect affects soil formation. South-facing slopes generally are warmer and drier than north-facing slopes. In most areas of the county, other relief characteristics, such as the length and shape of slopes, affect soil formation more than aspect.

The topography in the northeastern part of the county resulted from the movement and melting of the Cary glacial ice. This glacial topography is characterized by few natural drainageways or streams and many potholes and other depressions. Geologic erosion of the older Tazewell glacial till surface resulted in the topography in the southern and western parts of the county. This topography generally is characterized by a well defined surface drainage pattern.

Several distinct types of Cary glacial topography are in the more recently glaciated part of the county. They include end moraines, ground moraines, lacustrine plains, and stream terraces.

End moraines formed in areas where the margin of glacial ice seasonally advanced and retreated, resulting in a series of aligned ridges, hills, swales, and depressions. Clarion and Nicolett are the dominant soils on the end moraines.

Ground moraines formed in areas where the glacial ice melted. Because the ice melted unevenly, the landscape is characterized by randomly oriented knobs and ridges interspersed with broad, smooth areas, depressions, and swales. Clarion, Nicollet, and Webster are the dominant soils on the ground moraines.

Lacustrine plains and stream terraces formed through the action of glacial meltwater. They typically have low relief. Collinwood and Waldorf are the dominant soils on the lacustrine plains. Wadena, Cylinder, and Talcot are the dominant soils on the stream terraces.

Geologic erosion of the older Tazewell glacial till surface resulted in the topography in the southern and western parts of the county. Loess and other sediments covered the glacial till. The present topography is similar to that of the surface of the underlying glacial till, but it is somewhat less pronounced. Sac, Primghar, and Marcus soils are dominant in the loess-covered areas, and Everly and Wilmonton soils are dominant in the sediment-covered areas.

Relief affects soil formation through its effect on the gravitational energy of water running off the surface or percolating through the profile (*14*). The color and

thickness of the A and B horizons are affected by relief. As the slopes become less steep and less convex, more water becomes available for soil formation. As a result, the A horizon is thickened and darkened and the B horizon generally is thickened. The solum of the moderately sloping and strongly sloping Clarion soils commonly is thinner than that of the gently sloping Clarion soils.

Nicollet soils commonly are less sloping than the adjacent Clarion soils and are in less convex areas. Their A horizon is thicker and darker than that of the Clarion soils. Also, their B horizon is thicker in some areas. In places, however, the thickness of the solum in the Nicollet soils is limited by the depth to the seasonal high water table.

The gravitational energy of water has differentially redistributed particles of different sizes in most glacial landscapes in the county. A higher proportion of the smaller particles has been moved downslope, leaving a higher proportion of the coarser particles on the higher parts of the landscape. As a result, Clarion soils, which are on ridgetops and side slopes, typically contain more sand, gravel, cobbles, and stones than Webster soils, which are on the lower parts of the landscape.

Nearly level soils on the low parts of the landscape generally have a thick, dark A horizon. Examples are Terril soils on foot slopes, Okoboji and Webster soils in upland depressions and swales, and Coland and Havelock soils on bottom land.

Topography affects the color of the B horizon through its effect on subsurface drainage. Well drained soils on ridgetops and side slopes, such as Clarion soils, do not have a water table within a depth of 6 feet. They have a brown subsoil because the iron compounds are oxidized and distributed throughout the profile. Poorly drained soils in swales, such as Webster soils, have a seasonal high water table at a depth of 1 to 3 feet. They have a gray or mottled subsoil because the iron compounds are reduced and in some areas have been removed.

Time

Time enables relief, climate, and plant and animal life to change the parent material. One hundred to several hundred years are needed for topsoil to form, and a period 8 to 10 times longer is needed for a subsoil to become well developed (*3, 17*). Similar soils form in different kinds of parent material if the other factors of soil formation are active for a long period. Soil formation, however, generally is interrupted by geological events that expose new parent material.

In Osceola County the bedrock has been covered by glacial drift from the Nebraskan and Kansan glaciers and more recently by Wisconsin loess and glacial drift. Except for the soils on modern surfaces, the soils that formed in each of these materials eroded away or were buried by more recent material.

Radiocarbon dating has been used to determine the age of wood, bones, and other organic material in the Wisconsin loess and glacial drift. It indicates that the loess in the southern and western parts of Osceola County was deposited about 20,000 years ago (*12*).

The glacial sediments adjacent to the loess were deposited more recently. In many areas they overlie silty sediments that appear to be loess. The silty glacial sediments between the loess-mantled areas and the areas of Cary drift were deposited when the Cary glacial ice was melting, about 13,000 years ago (*12*). The landscape that formed at that time may have been similar to the modern landscape, but it was subject to periods of erosion. Much of the deposition that formed the modern stream terraces occurred at this time. The alluvium above the sand and gravel fill along the Ocheyedan River is about 10,000 years old.

Organic carbon dating, observation of pollen and plant macrofossils, and sediment analysis indicate that rapid geologic erosion in northern Iowa ceased about 3,000 years ago. As a result, the soils on the less stable uplands in Osceola County are likely to be no more than 3,000 years old (*21, 22*). Examples are the gently sloping to strongly sloping Clarion and Everly soils.

The younger soils are in the more rapidly eroding areas or in areas that receive sediment. Examples of soils in the more rapidly eroding areas are the steep and very steep Storden soils on side slopes. Examples of soils that receive sediment are the nearly level Coland and Havelock soils on bottom land. In areas where erosion or deposition has accelerated since settlement, soil formation is retarded because the soils are losing or receiving a large amount of soil material. Examples are the strongly sloping Clarion soils, which are eroding, and the level Okoboji soils, which are receiving sediment.

Processes of Soil Formation

The processes that affect horizon differentiation are additions, removals, transfers, and transformations (*17*). Each of these determines what kind of soil that forms and how rapidly soil formation progresses. For example, as most soils form, organic material is added, soluble salts and carbonates are removed, clay is transferred from the surface downward, and primary minerals are transformed into secondary minerals that can be used by plants.

The addition of organic matter is one of the first processes that affect horizon differentiation. The dark color of the surface layer in Clarion and other soils is the result of the addition of organic matter.

In most of the soils on uplands in the county, percolating water has removed soluble salts and calcium carbonates from the upper horizons. The depth at which the calcium carbonates precipitate is an indication of the usual depth to which water percolates or the depth to the seasonal high water table. A B horizon forms as

carbonates are moved downward. This has occurred, for example, in Clarion and Nicollet soils. In a few soils, such as Canisteo, Crippin, and Spicer, water moving upward in the profile has kept the carbonates in the weakly developed upper horizons.

Transfers are also important in the differentiation of horizons. An example is the transfer of clay from the A horizon to the B horizon in Rolfe soils. The depth to which clay is moved is related to the depth of water percolation during the growing season (*14*). Transfers become removals when the substance is removed from the profile. A significant transfer during the cropping season in Osceola County is that of nitrate nitrogen. The nitrate is transferred downward with percolating water and may be removed from the profile.

Transfers from the lower horizons occur when plant roots move nitrogen and other elements upward. Evidence indicates that zinc and other elements that are relatively insoluble in water are transferred from the lower horizons to the surface by plants and are transferred from the surface to the B horizon along with clay as horizon differentation progresses (*5*).

Transformations occur in all horizons, but the rate of transformation is most rapid in the surface layer. During the growing season, organic matter is transformed into mineral elements and primary minerals are transformed into secondary mineral elements. Most transformations make the elements more available to plants. For example, if the pH level is near 7, the primary mineral apatite is weathered to secondary phosphorus compounds (*6, 15*). If the pH level is high, however, phosphorus compounds that are not available to plants form. As a result, soils that have a pH level of more than 7, such as Canisteo soils, have a lower supply of available phosphorus than soils that have a pH level near 7, such as Okoboji and Webster soils.

Some elements must be transformed before they can be translocated by water in the soil. An example is iron. In well drained soils, such as Clarion and Everly, this element is not soluble in water in its oxidized form. In poorly drained soils, such as Canisteo and Webster, however, the iron is transformed to its reduced form and moves with the water. This process results in mottles and gray or olive gray colors.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (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 moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

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

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce 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 oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

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

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

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

drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

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

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

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

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

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

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

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:
O horizon.—An organic layer of fresh and decaying plant residue.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.
E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
Cr horizon.—Soft, consolidated bedrock beneath the soil.
R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

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

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

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

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

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

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

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

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

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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 C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

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

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

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt 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."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-81 at Sibley, Iowa)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	23.8	3.6	13.7	48	-27	0	0.57	0.17	0.89	2	6.1
February---	30.4	9.8	20.1	55	-24	0	.97	.31	1.50	3	7.2
March------	40.9	20.7	30.8	73	-12	26	1.72	.81	2.50	5	9.9
April------	59.3	34.7	47.0	87	14	76	2.35	1.01	3.48	6	1.5
May--------	71.9	45.8	58.9	91	25	290	3.48	1.77	4.96	7	.0
June-------	80.9	55.8	68.4	97	38	552	4.45	2.79	5.94	8	.0
July-------	85.1	60.3	72.7	98	43	704	3.67	1.41	5.55	6	.0
August-----	82.8	57.9	70.4	96	41	632	4.36	1.77	6.54	6	.0
September--	74.4	48.3	61.4	93	27	342	2.88	1.16	4.31	5	.0
October----	63.3	37.6	50.5	87	15	130	1.86	.47	2.98	4	.5
November---	44.7	23.8	34.3	70	-4	6	1.04	.29	1.63	3	3.2
December---	29.8	11.2	20.5	54	-23	0	.83	.31	1.26	3	6.9
Yearly:											
Average--	57.3	34.1	45.7	---	---	---	---	---	---	---	---
Extreme--	---	---	---	100	-28	---	---	---	---	---	---
Total----	---	---	---	---	---	2,758	28.18	22.28	33.75	58	35.3

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-81 at Sibley, Iowa)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 29	May 14	May 25
2 years in 10 later than--	Apr. 24	May 9	May 21
5 years in 10 later than--	Apr. 15	Apr. 29	May 12
First freezing temperature in fall:			
1 year in 10 earlier than--	Sept. 30	Sept. 21	Sept. 10
2 years in 10 earlier than--	Oct. 5	Sept. 26	Sept. 15
5 years in 10 earlier than--	Oct. 15	Oct. 6	Sept. 25

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-81 at Sibley, Iowa)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	161	144	117
8 years in 10	168	149	123
5 years in 10	183	159	136
2 years in 10	197	168	148
1 year in 10	204	174	155

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
4	Knoke silty clay loam, 0 to 1 percent slopes	1,375	0.5
6	Okoboji silty clay loam, 0 to 1 percent slopes	1,980	0.8
27B	Terril loam, 2 to 5 percent slopes	525	0.2
28B	Dickman sandy loam, 2 to 5 percent slopes	835	0.3
28B2	Dickman sandy loam, 2 to 5 percent slopes, moderately eroded	250	0.1
31	Afton silty clay loam, 0 to 2 percent slopes	560	0.2
32	Spicer silty clay loam, 0 to 2 percent slopes	2,735	1.1
48	Knoke mucky silt loam, 0 to 1 percent slopes	530	0.2
55	Nicollet clay loam, 1 to 3 percent slopes	20,720	8.2
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	355	0.1
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	750	0.3
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded	315	0.1
62G	Storden loam, 18 to 40 percent slopes	465	0.2
77	Sac silty clay loam, 0 to 2 percent slopes	4,055	1.6
77B	Sac silty clay loam, 2 to 5 percent slopes	16,225	6.4
77B2	Sac silty clay loam, 2 to 5 percent slopes, moderately eroded	2,465	1.0
77C2	Sac silty clay loam, 5 to 9 percent slopes, moderately eroded	240	0.1
90	Okoboji mucky silt loam, 0 to 1 percent slopes	410	0.2
91	Primghar silty clay loam, 0 to 2 percent slopes	21,720	8.6
91B	Primghar silty clay loam, 1 to 4 percent slopes	2,405	0.9
92	Marcus silty clay loam, 0 to 2 percent slopes	10,615	4.2
95	Harps clay loam, 0 to 2 percent slopes	345	0.1
107	Webster silty clay loam, 0 to 2 percent slopes	9,600	3.8
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	2,675	1.1
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	1,015	0.4
108B2	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes, moderately eroded	270	0.1
135	Coland clay loam, 0 to 2 percent slopes	5,715	2.2
138B	Clarion clay loam, 2 to 5 percent slopes	20,710	8.2
138B2	Clarion clay loam, 2 to 5 percent slopes, moderately eroded	3,685	1.4
138C	Clarion clay loam, 5 to 9 percent slopes	1,770	0.7
138C2	Clarion clay loam, 5 to 9 percent slopes, moderately eroded	5,395	2.1
138D2	Clarion clay loam, 9 to 14 percent slopes, moderately eroded	1,205	0.5
201B	Coland-Terril complex, 2 to 5 percent slopes	420	0.2
202	Cylinder clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,085	0.4
203	Cylinder clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	2,630	1.0
259	Biscay silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,495	0.6
272	Kanaranzi Variant loam, 0 to 2 percent slopes	255	0.1
272B	Kanaranzi Variant loam, 2 to 5 percent slopes	1,015	0.4
272C2	Kanaranzi Variant loam, 5 to 9 percent slopes, moderately eroded	515	0.2
274	Rolfe silty clay loam, 0 to 1 percent slopes	365	0.1
282	Ransom silty clay loam, 0 to 3 percent slopes	5,695	2.2
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	965	0.4
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	390	0.2
309	Allendorf silty clay loam, 0 to 2 percent slopes	1,190	0.5
309B	Allendorf silty clay loam, 2 to 5 percent slopes	475	0.2
310	Galva silty clay loam, 0 to 2 percent slopes	2,905	1.1
310B	Galva silty clay loam, 2 to 5 percent slopes	4,505	1.8
311	Galva silty clay loam, gravelly substratum, 0 to 2 percent slopes	2,980	1.2
311B	Galva silty clay loam, gravelly substratum, 2 to 5 percent slopes	940	0.4
354	Aquolls, ponded	370	0.1
384	Collinwood silty clay loam, 0 to 3 percent slopes	2,845	1.1
387B	Kamrar silty clay loam, 1 to 5 percent slopes	635	0.2
390	Waldorf silty clay loam, 0 to 1 percent slopes	2,675	1.1
396	Letri silty clay loam, calcareous, 0 to 2 percent slopes	5,445	2.1
397	Letri silty clay loam, 0 to 2 percent slopes	5,570	2.2
433D2	Storden clay loam, 7 to 14 percent slopes, moderately eroded	455	0.2
433E2	Storden clay loam, 14 to 18 percent slopes, moderately eroded	360	0.1
433G	Storden clay loam, 18 to 40 percent slopes	270	0.1
456	Wilmonton silty clay loam, 0 to 3 percent slopes	19,865	7.8
507	Canisteo silty clay loam, 0 to 2 percent slopes	6,050	2.4
559	Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,140	0.4
577	Everly clay loam, 0 to 2 percent slopes	5,420	2.1
577B	Everly clay loam, 2 to 5 percent slopes	16,875	6.6
577B2	Everly clay loam, 2 to 5 percent slopes, moderately eroded	1,130	0.4

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
577C	Everly clay loam, 5 to 9 percent slopes	400	0.2
577C2	Everly clay loam, 5 to 9 percent slopes, moderately eroded	1,020	0.4
577D2	Everly clay loam, 9 to 14 percent slopes, moderately eroded	310	0.1
638C2	Clarion-Storden complex, 5 to 9 percent slopes, moderately eroded	630	0.2
638D2	Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded	730	0.3
638E2	Clarion-Storden complex, 14 to 18 percent slopes, moderately eroded	230	0.1
655	Crippin loam, 1 to 3 percent slopes	470	0.2
735	Havelock clay loam, 0 to 2 percent slopes	8,165	3.2
744	Revere loam, 0 to 2 percent slopes	370	0.1
878B	Ocheyedan loam, 2 to 5 percent slopes	1,065	0.4
879	Fostoria clay loam, 0 to 2 percent slopes	695	0.3
2573	Hoopeston Variant loam, 0 to 2 percent slopes	495	0.2
5010	Pits, sand and gravel	340	0.1
5040	Orthents, loamy	400	0.2
	Water	555	0.2
	Total	254,720	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
27B	Terril loam, 2 to 5 percent slopes
31	Afton silty clay loam, 0 to 2 percent slopes (where drained)
32	Spicer silty clay loam, 0 to 2 percent slopes (where drained)
55	Nicollet clay loam, 1 to 3 percent slopes
77	Sac silty clay loam, 0 to 2 percent slopes
77B	Sac silty clay loam, 2 to 5 percent slopes
77B2	Sac silty clay loam, 2 to 5 percent slopes, moderately eroded
91	Primghar silty clay loam, 0 to 2 percent slopes
91B	Primghar silty clay loam, 1 to 4 percent slopes
92	Marcus silty clay loam, 0 to 2 percent slopes (where drained)
95	Harps clay loam, 0 to 2 percent slopes (where drained)
107	Webster silty clay loam, 0 to 2 percent slopes (where drained)
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
108B2	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes, moderately eroded
135	Coland clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion clay loam, 2 to 5 percent slopes
138B2	Clarion clay loam, 2 to 5 percent slopes, moderately eroded
201B	Coland-Terril complex, 2 to 5 percent slopes (where drained)
202	Cylinder clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
203	Cylinder clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
259	Biscay silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
282	Ransom silty clay loam, 0 to 3 percent slopes
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes
309	Allendorf silty clay loam, 0 to 2 percent slopes
309B	Allendorf silty clay loam, 2 to 5 percent slopes
310	Galva silty clay loam, 0 to 2 percent slopes
310B	Galva silty clay loam, 2 to 5 percent slopes
311	Galva silty clay loam, gravelly substratum, 0 to 2 percent slopes
311B	Galva silty clay loam, gravelly substratum, 2 to 5 percent slopes
384	Collinwood silty clay loam, 0 to 3 percent slopes
387B	Kamrar silty clay loam, 1 to 5 percent slopes
390	Waldorf silty clay loam, 0 to 1 percent slopes (where drained)
396	Letri silty clay loam, calcareous, 0 to 2 percent slopes (where drained)
397	Letri silty clay loam, 0 to 2 percent slopes (where drained)
456	Wilmonton silty clay loam, 0 to 3 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes (where drained)
559	Talcot silty clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
577	Everly clay loam, 0 to 2 percent slopes
577B	Everly clay loam, 2 to 5 percent slopes
577B2	Everly clay loam, 2 to 5 percent slopes, moderately eroded
655	Crippin loam, 1 to 3 percent slopes
735	Havelock clay loam, 0 to 2 percent slopes (where drained)
744	Revere loam, 0 to 2 percent slopes (where drained)
878B	Ocheyedan loam, 2 to 5 percent slopes
879	Fostoria clay loam, 0 to 2 percent slopes
2573	Hoopeston Variant loam, 0 to 2 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
4---------- Knoke	IIIw	93	30	65	3.3	3.3	4.3	5.5
6---------- Okoboji	IIIw	98	31	69	3.1	3.3	4.3	7.3
27B---------- Terril	IIe	118	46	101	6.1	4.2	7.0	8.3
28B---------- Dickman	IIIe	64	22	50	2.7	1.2	3.0	3.9
28B2---------- Dickman	IIIe	61	20	45	2.6	1.0	3.0	3.7
31---------- Afton	IIw	130	49	98	3.9	3.7	4.8	5.7
32---------- Spicer	IIw	129	48	96	4.0	3.5	5.3	6.0
48---------- Knoke	IIIw	93	30	65	3.3	3.3	4.3	5.5
55---------- Nicollet	I	133	45	80	5.0	3.5	5.8	6.5
62C2---------- Storden	IIIe	105	46	81	4.5	2.4	3.8	4.5
62D2---------- Storden	IIIe	97	42	80	4.1	2.4	3.7	4.3
62E2---------- Storden	IVe	82	27	35	3.2	2.2	3.5	4.2
62G---------- Storden	VIIe	---	---	---	---	1.5	---	---
77---------- Sac	I	125	47	94	5.3	3.5	5.5	5.9
77B---------- Sac	IIe	122	46	92	5.1	3.3	5.3	5.6
77B2---------- Sac	IIe	118	44	89	5.0	3.3	5.2	5.5
77C2---------- Sac	IIIe	113	42	85	4.8	3.3	4.8	5.1
90---------- Okoboji	IIIw	101	34	73	3.0	3.3	4.3	7.3
91---------- Primghar	I	140	53	105	5.6	3.8	5.8	6.5
91B---------- Primghar	IIe	139	51	103	5.5	3.7	5.7	6.3

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
92--- Marcus	IIw	120	51	101	4.1	3.7	6.0	6.3
95--- Harps	IIw	106	34	74	3.8	3.3	5.0	6.6
107--- Webster	IIw	123	39	86	4.4	4.2	6.6	7.3
108--- Wadena	IIs	61	23	46	2.7	2.7	4.1	4.8
108B, 108B2--- Wadena	IIe	58	21	44	2.8	2.7	4.1	4.7
135--- Coland	IIw	122	39	85	4.1	4.1	6.0	7.6
138B--- Clarion	IIe	123	38	86	5.5	4.2	6.7	7.6
138B2--- Clarion	IIe	120	38	84	5.3	3.8	6.3	7.5
138C--- Clarion	IIIe	119	38	83	5.1	3.8	6.3	7.3
138C2--- Clarion	IIIe	116	37	81	4.9	3.8	6.2	7.1
138D2--- Clarion	IIIe	108	37	76	4.5	3.7	5.5	6.5
201B--- Coland-Terril	IIw	121	39	84	3.6	4.2	6.4	7.9
202--- Cylinder	IIs	86	32	65	4.7	3.3	5.3	6.1
203--- Cylinder	IIs	104	39	78	5.5	3.8	6.2	7.1
259--- Biscay	IIw	111	40	75	3.5	3.5	4.7	5.2
272--- Kanaranzi Variant	IIIs	65	24	49	2.2	2.2	3.0	3.5
272B--- Kanaranzi Variant	IIIe	62	23	47	2.2	2.2	2.7	3.0
272C2--- Kanaranzi Variant	IVe	53	20	40	1.6	1.4	1.4	2.5
274--- Rolfe	IIIw	98	31	69	3.5	3.3	4.5	5.0
282--- Ransom	I	127	42	84	4.5	3.9	5.9	6.4

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
308---------- Wadena	IIs	81	31	61	3.7	3.7	5.5	6.2
308B---------- Wadena	IIe	78	30	59	3.6	3.7	5.3	6.0
309---------- Allendorf	IIs	107	40	80	4.5	3.5	6.3	7.2
309B---------- Allendorf	IIe	104	39	78	4.4	3.3	6.1	7.0
310---------- Galva	I	127	50	99	5.5	3.7	5.8	6.1
310B---------- Galva	IIe	123	48	97	5.4	3.7	5.7	6.0
311---------- Galva	I	125	49	98	5.5	3.7	5.8	6.1
311B---------- Galva	IIe	127	48	95	5.3	3.7	5.7	6.0
354---------- Aquolls	VIIw	---	---	---	---	---	---	---
384---------- Collinwood	IIw	110	40	88	4.0	3.5	5.3	6.0
387B---------- Kamrar	IIe	111	42	91	5.5	3.7	5.7	6.2
390---------- Waldorf	IIw	94	40	85	4.0	3.3	5.3	6.0
396---------- Letri	IIw	123	45	95	5.3	3.6	5.9	6.2
397---------- Letri	IIw	128	42	90	5.0	3.4	5.2	6.0
433D2---------- Storden	IIIe	92	22	50	3.5	3.0	4.0	5.0
433E2---------- Storden	IVe	75	---	40	3.0	2.5	3.8	4.5
433G---------- Storden	VIIe	---	---	---	---	1.5	---	---
456---------- Wilmonton	I	121	47	91	4.5	4.2	7.7	8.4
507---------- Canisteo	IIw	118	50	97	3.5	3.0	5.5	5.2
559---------- Talcot	IIw	106	38	90	4.0	3.3	5.0	5.5
577---------- Everly	I	120	45	90	5.0	3.5	5.5	5.8

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
577B---------- Everly	IIe	117	44	88	4.9	3.3	5.3	5.6
577B2---------- Everly	IIe	113	42	85	4.8	3.3	5.2	5.5
577C---------- Everly	IIIe	112	42	84	4.7	3.3	5.0	5.3
577C2---------- Everly	IIIe	108	41	81	4.5	3.3	4.8	5.1
577D2---------- Everly	IIIe	99	37	74	4.2	2.7	4.3	4.5
638C2---------- Clarion-Storden	IIIe	119	35	86	5.0	3.5	4.8	6.5
638D2---------- Clarion-Storden	IIIe	114	36	80	4.4	3.2	4.6	5.8
638E2---------- Clarion-Storden	IVe	97	31	68	3.9	2.6	4.2	5.0
655---------- Crippin	I	128	41	90	6.0	4.2	6.5	7.1
735---------- Havelock	IIw	110	42	91	3.9	4.1	6.0	7.6
744---------- Revere	IIw	105	39	79	4.0	4.1	6.3	7.0
878B---------- Ocheyedan	IIe	109	40	80	4.6	3.3	5.0	5.8
879---------- Fostoria	I	109	35	76	5.1	3.7	5.8	6.6
2573---------- Hoopeston Variant	IIs	80	30	70	3.1	3.6	4.7	5.2
5010**. Pits								
5040. Orthents								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
4---------- Knoke	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
6---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
27B---------- Terril	---	Siberian peashrub, American plum, Tatarian honeysuckle, lilac.	Russian-olive, hackberry, blue spruce, bur oak, eastern redcedar.	Ponderosa pine, honeylocust, green ash.	---
31---------- Afton	Lilac----------	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, Russian-olive, ponderosa pine, blue spruce.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
32---------- Spicer	Lilac----------	Siberian peashrub, Tatarian honeysuckle.	Hackberry, ponderosa pine, blue spruce, Russian-olive, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
48---------- Knoke	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
55---------- Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
62C2, 62D2, 62E2, 62G---------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
77, 77B, 77B2, 77C2---------- Sac	---	Siberian peashrub, American plum, Tatarian honeysuckle, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian-olive.	Ponderosa pine, honeylocust, green ash.	---
90---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
91, 91B---------- Primghar	Peking cotoneaster	American plum, lilac, Siberian peashrub.	Eastern redcedar, ponderosa pine, Manchurian crabapple.	Golden willow, honeylocust, green ash, hackberry.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
92---------- Marcus	Lilac----------	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, blue spruce, ponderosa pine, hackberry.	Green ash, honeylocust, golden willow, silver maple.	Eastern cottonwood.
95---------- Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
107---------- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
108, 108B, 108B2-- Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
135---------- Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
138B, 138B2, 138C, 138C2, 138D2----- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
201B*: Coland----------	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
Terril----------	---	Siberian peashrub, American plum, Tatarian honeysuckle, lilac.	Russian-olive, hackberry, blue spruce, bur oak, eastern redcedar.	Ponderosa pine, honeylocust, green ash.	---
202, 203---------- Cylinder	Peking cotoneaster	American plum, Siberian peashrub, lilac.	Eastern redcedar, Manchurian crabapple, ponderosa pine.	Hackberry, honeylocust, golden willow, green ash.	Eastern cottonwood.
259---------- Biscay	Lilac----------	Siberian peashrub, Tatarian honeysuckle.	Hackberry, ponderosa pine, blue spruce, eastern redcedar.	Golden willow, silver maple, honeylocust, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
272, 272B, 272C2--Kanaranzi Variant	---	Eastern redcedar, lilac, Tatarian honeysuckle, Siberian peashrub.	Jack pine, hackberry, green ash, Russian-olive.	---	---
274--Rolfe	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Amur maple, northern white-cedar, hackberry, white spruce, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
282--Ransom	---	Tatarian honeysuckle, redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Green ash, honeylocust, eastern white pine, Austrian pine.	Silver maple.
308, 308B--Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
309, 309B--Allendorf	---	American plum, Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian-olive.	Honeylocust, ponderosa pine, green ash.	---
310, 310B--Galva	---	American plum, Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian-olive.	Honeylocust, ponderosa pine, green ash.	---
311, 311B--Galva	---	American plum, Tatarian honeysuckle, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, Russian-olive, hackberry.	Honeylocust, ponderosa pine, green ash.	---
384--Collinwood	---	Northern white-cedar, Siberian peashrub, Tatarian honeysuckle, lilac, eastern redcedar.	White spruce, Austrian pine, hackberry, Russian-olive, bur oak.	Eastern white pine, green ash.	---
387B--Kamrar	---	Redosier dogwood, Siberian peashrub, gray dogwood, lilac.	Blue spruce, Amur maple, eastern redcedar, hackberry, Russian-olive, northern white-cedar.	Eastern white pine, green ash.	---
390--Waldorf	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Northern white-cedar, white spruce, Amur maple, tall purple willow, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
396, 397---------- Letri	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Tall purple willow, hackberry, white spruce, northern white-cedar, Amur maple.	Green ash, golden willow.	Eastern cottonwood, silver maple.
433D2, 433E2, 433G---------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
456---------- Wilmonton	---	Tatarian honeysuckle, redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, green ash, eastern white pine, Austrian pine.	Silver maple.
507---------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
559---------- Talcot	Lilac----------	Siberian peashrub, Tatarian honeysuckle.	Hackberry, ponderosa pine, blue spruce, Russian-olive, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
577, 577B, 577B2, 577C, 577C2, 577D2---------- Everly	---	American plum, Siberian peashrub, Tatarian honeysuckle, lilac.	Hackberry, blue spruce, bur oak, Russian-olive, eastern redcedar.	Ponderosa pine, honeylocust, green ash.	---
638C2*, 638D2*, 638E2*: Clarion---------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden---------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
655---------- Crippin	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
735---------- Havelock	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	White spruce, hackberry, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
744---------- Revere	---	Siberian peashrub, lilac, Tatarian honeysuckle, northern white-cedar.	Eastern redcedar, bur oak, white spruce, hackberry.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
878B---------- Ocheyedan	---	Tatarian honeysuckle, lilac, Siberian peashrub, American plum.	Eastern redcedar, bur oak, blue spruce, Russian-olive, hackberry.	Honeylocust, green ash, ponderosa pine.	---
879---------- Fostoria	---	Redosier dogwood, lilac, Tatarian honeysuckle.	White spruce, blue spruce, northern white-cedar, Amur maple.	Austrian pine, green ash, eastern white pine, hackberry.	Silver maple.
2573---------- Hoopeston Variant	---	American plum, Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, ponderosa pine, blue spruce.	Hackberry, honeylocust, golden willow, green ash.	Eastern cottonwood.
5010*. Pits					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
4 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
6 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
27B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
28B, 28B2 Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
31 Afton	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
32 Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
48 Knoke	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
55 Nicollet	Slight	Slight	Moderate: slope.	Slight	Slight.
62C2 Storden	Slight	Slight	Severe: slope.	Slight	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
62E2 Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
62G Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
77 Sac	Slight	Slight	Slight	Slight	Slight.
77B, 77B2 Sac	Slight	Slight	Moderate: slope.	Slight	Slight.
77C2 Sac	Slight	Slight	Severe: slope.	Slight	Slight.
90 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
91 Primghar	Slight	Slight	Slight	Slight	Slight.
91B Primghar	Slight	Slight	Moderate: slope.	Slight	Slight.
92 Marcus	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
95--- Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107--- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
108--- Wadena	Slight---	Slight---	Slight---	Slight---	Slight.
108B, 108B2--- Wadena	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
135--- Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
138B, 138B2--- Clarion	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
138C, 138C2--- Clarion	Slight---	Slight---	Severe: slope.	Slight---	Slight.
138D2--- Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: slope.
201B*: Coland---	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Terril---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
202, 203--- Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight---	Slight.
259--- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
272--- Kanaranzi Variant	Slight---	Slight---	Slight---	Slight---	Moderate: droughty.
272B--- Kanaranzi Variant	Slight---	Slight---	Moderate: slope.	Slight---	Moderate: droughty.
272C2--- Kanaranzi Variant	Slight---	Slight---	Severe: slope.	Slight---	Moderate: droughty.
274--- Rolfe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
282--- Ransom	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight---	Slight.
308--- Wadena	Slight---	Slight---	Slight---	Slight---	Slight.
308B--- Wadena	Slight---	Slight---	Moderate: slope.	Slight---	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
309---------- Allendorf	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
309B---------- Allendorf	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
310---------- Galva	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
310B---------- Galva	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
311---------- Galva	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
311B---------- Galva	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
354. Aquolls					
384---------- Collinwood	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
387B---------- Kamrar	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----------	Slight.
390---------- Waldorf	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
396, 397---------- Letri	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
433D2---------- Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
433E2---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
433G---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
456---------- Wilmonton	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight----------	Slight.
507---------- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
559---------- Talcot	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
577---------- Everly	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
577B, 577B2---------- Everly	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
577C, 577C2---------- Everly	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
577D2---- Everly	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----	Moderate: slope.
638C2*: Clarion----	Slight----	Slight----	Severe: slope.	Slight----	Slight.
Storden----	Slight----	Slight----	Severe: slope.	Slight----	Slight.
638D2*: Clarion----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----	Moderate: slope.
Storden----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----	Moderate: slope.
638E2*: Clarion----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Storden----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
655---- Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight----	Slight.
735---- Havelock	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
744---- Revere	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
878B---- Ocheyedan	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
879---- Fostoria	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----	Slight.
2573---- Hoopeston Variant	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
5010*. Pits					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
4---------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
6---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
27B---------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
28B, 28B2---------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
31---------- Afton	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
32---------- Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
48---------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
55---------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62C2, 62D2, 62E2--- Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
62G---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
77, 77B, 77B2------ Sac	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
77C2---------- Sac	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
90---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
91, 91B---------- Primghar	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
92---------- Marcus	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
95---------- Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
108, 108B, 108B2--- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
135---------- Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
138B, 138B2--------- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C, 138C2, 138D2- Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
201B*: Coland----------	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Terril----------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
202, 203---------- Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
259---------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
272, 272B, 272C2--- Kanaranzi Variant	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
274---------- Rolfe	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
282---------- Ransom	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
308, 308B---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
309, 309B---------- Allendorf	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
310, 310B, 311, 311B---------- Galva	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
354. Aquolls										
384---------- Collinwood	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
387B---------- Kamrar	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
390---------- Waldorf	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
396, 397---------- Letri	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
433D2, 433E2------- Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
433G---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
456---------- Wilmonton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
507---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
559---------- Talcot	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
577, 577B, 577B2--- Everly	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
577C, 577C2, 577D2- Everly	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
638C2*, 638D2*: Clarion----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
638E2*: Clarion----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
655---------- Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
735---------- Havelock	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
744---------- Revere	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
878B---------- Ocheyedan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
879---------- Fostoria	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
2573---------- Hoopeston Variant	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
5010*. Pits										
5040. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
4---------- Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
6---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
27B---------- Terril	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
28B, 28B2--------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
31---------- Afton	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
32---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
48---------- Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
55---------- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
62C2---------- Storden	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
62D2---------- Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
62E2, 62G--------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
77, 77B, 77B2----- Sac	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
77C2---------- Sac	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
90---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
91, 91B---------- Primghar	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
92---------- Marcus	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
95---------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
107---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
108, 108B, 108B2-- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
135---------- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
138B, 138B2------- Clarion	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
138C, 138C2------- Clarion	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
138D2---------- Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
201B*: Coland----------	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
Terril----------	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
202, 203---------- Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
259---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
272, 272B--------- Kanaranzi Variant	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: droughty.
272C2---------- Kanaranzi Variant	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
274---------- Rolfe	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
282---------- Ransom	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
308, 308B---------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
309, 309B---------- Allendorf	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.
310, 310B---------- Galva	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
311, 311B---------- Galva	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
384---------- Collinwood	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action.	Slight.
387B---------- Kamrar	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
390---------- Waldorf	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness.
396, 397---------- Letri	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
433D2---------- Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
433E2, 433G------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
456---------- Wilmonton	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
559---------- Talcot	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
577, 577B, 577B2-- Everly	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
577C, 577C2---- Everly	Slight----	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
577D2---- Everly	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
638C2*: Clarion----	Slight----	Slight----	Slight----	Moderate: slope.	Moderate: frost action.	Slight.
Storden----	Slight----	Slight----	Slight----	Moderate: slope.	Moderate: frost action.	Slight.
638D2*: Clarion----	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden----	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
638E2*: Clarion----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
655---- Crippin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
735---- Havelock	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
744---- Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
878B---- Ocheyedan	Slight----	Slight----	Slight----	Slight----	Moderate: frost action.	Slight.
879---- Fostoria	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
2573---- Hoopeston Variant	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
5010*. Pits						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
4 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: ponding, too clayey, hard to pack.
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
27B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28B, 28B2 Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31 Afton	Severe: percs slowly, wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness.
32 Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
48 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: ponding, too clayey, hard to pack.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62C2 Storden	Slight	Severe: slope.	Slight	Slight	Good.
62D2 Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
62E2, 62G Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
77 Sac	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
77B, 77B2 Sac	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
77C2 Sac	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
90 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
91, 91B---------- Primghar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
92---------- Marcus	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness, hard to pack.
95---------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
107---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
108, 108B, 108B2---- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
135---------- Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
138B, 138B2--------- Clarion	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
138C, 138C2--------- Clarion	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.
138D2---------- Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
201B*: Coland----------	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Terril----------	Slight----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
202, 203---------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
259---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
272, 272B---------- Kanaranzi Variant	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: small stones, seepage.
272C2---------- Kanaranzi Variant	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: small stones, seepage.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
274---------- Rolfe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
282---------- Ransom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
308, 308B---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
309, 309B---------- Allendorf	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
310---------- Galva	Slight----------	Moderate: seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.
310B---------- Galva	Slight----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
311, 311B---------- Galva	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Slight----------	Fair: too clayey, thin layer.
354. Aquolls					
384---------- Collinwood	Severe: wetness, percs slowly.	Slight----------	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
387B---------- Kamrar	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Poor: too clayey.
390---------- Waldorf	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, wetness.
396, 397---------- Letri	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
433D2---------- Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
433E2, 433G---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
456---------- Wilmonton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
559---------- Talcot	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
577---------- Everly	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.
577B, 577B2--------- Everly	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
577C, 577C2--------- Everly	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
577D2---------- Everly	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
638C2*: Clarion----------	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.
Storden----------	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.
638D2*: Clarion----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
638E2*: Clarion----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
655---------- Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
735---------- Havelock	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
744---------- Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
878B---------- Ocheyedan	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
879---------- Fostoria	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
2573---------- Hoopeston Variant	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
4 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
6 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
27B Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
28B, 28B2 Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
31 Afton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
32 Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
48 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
55 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
62C2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
62D2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
62E2 Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
62G Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
77, 77B, 77B2, 77C2 Sac	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
90 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
91, 91B Primghar	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
92 Marcus	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
95--- Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
107--- Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
108, 108B, 108B2--- Wadena	Good---	Probable---	Probable---	Poor: small stones, area reclaim.
135--- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138B2, 138C, 138C2--- Clarion	Good---	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
138D2--- Clarion	Good---	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
201B*: Coland---	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Terril---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
202, 203--- Cylinder	Fair: wetness.	Probable---	Probable---	Fair: area reclaim, small stones, thin layer.
259--- Biscay	Fair: wetness.	Probable---	Probable---	Fair: area reclaim, thin layer.
272, 272B, 272C2--- Kanaranzi Variant	Good---	Probable---	Probable---	Poor: small stones, area reclaim.
274--- Rolfe	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
282--- Ransom	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
308, 308B--- Wadena	Good---	Probable---	Probable---	Poor: small stones, area reclaim.
309, 309B--- Allendorf	Good---	Probable---	Probable---	Fair: small stones, area reclaim, thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
310, 310B---------- Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
311, 311B---------- Galva	Good----------	Probable----------	Improbable: too sandy.	Poor: area reclaim.
354. Aquolls				
384---------- Collinwood	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
387B---------- Kamrar	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
390---------- Waldorf	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
396, 397---------- Letri	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
433D2---------- Storden	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
433E2---------- Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
433G---------- Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
456---------- Wilmonton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
507---------- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
559---------- Talcot	Fair: wetness.	Probable----------	Probable----------	Fair: small stones, area reclaim, thin layer.
577, 577B, 577B2, 577C, 577C2---------- Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
577D2---------- Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
638C2*: Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Storden----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
638D2*: Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
638E2*: Clarion	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
655 Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
735 Havelock	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
744 Revere	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
878B Ocheyedan	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
879 Fostoria	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
2573 Hoopeston Variant	Fair: wetness.	Probable	Improbable: too sandy.	Good.
5010*. Pits				
5040. Orthents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
4---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
6---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
27B---- Terril	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
28B, 28B2---- Dickman	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
31---- Afton	Slight	Severe: wetness.	Severe: slow refill.	Flooding, frost action.	Wetness, erodes easily.	Wetness, erodes easily.
32---- Spicer	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness, erodes easily.	Wetness, erodes easily.
48---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
55---- Nicollet	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Frost action	Wetness	Favorable.
62C2---- Storden	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
62D2, 62E2, 62G--- Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
77---- Sac	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
77B, 77B2, 77C2--- Sac	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
90---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
91, 91B---- Primghar	Moderate: seepage.	Moderate: hard to pack, wetness.	Moderate: deep to water, slow refill.	Deep to water	Erodes easily	Erodes easily.
92---- Marcus	Moderate: seepage.	Severe: hard to pack, wetness.	Severe: slow refill.	Frost action	Wetness, erodes easily.	Wetness, erodes easily.
95---- Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
107---------- Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
108, 108B, 108B2-- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
135---------- Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
138B, 138B2, 138C, 138C2---------- Clarion	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
138D2---------- Clarion	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
201B*: Coland----------	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action, slope.	Wetness--------	Wetness.
Terril----------	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
202, 203---------- Cylinder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Favorable.
259---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
272, 272B, 272C2-- Kanaranzi Variant	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy------	Droughty, rooting depth.
274---------- Rolfe	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, percs slowly, frost action.	Ponding--------	Wetness, percs slowly.
282---------- Ransom	Moderate: seepage.	Severe: piping.	Severe: slow refill.	Frost action---	Erodes easily, wetness.	Erodes easily.
308, 308B---------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
309, 309B---------- Allendorf	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Erodes easily, too sandy.	Erodes easily, rooting depth.
310---------- Galva	Moderate: seepage.	Slight---------	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
310B---------- Galva	Moderate: seepage, slope.	Slight---------	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
311---------- Galva	Moderate: seepage.	Moderate: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
311B---------- Galva	Moderate: seepage, slope.	Moderate: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
354. Aquolls						
384---------- Collinwood	Slight---------	Severe: hard to pack.	Severe: slow refill.	Percs slowly, frost action.	Wetness, percs slowly.	Percs slowly.
387B---------- Kamrar	Moderate: seepage, slope.	Moderate: hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
390---------- Waldorf	Moderate: seepage.	Severe: hard to pack, wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
396, 397---------- Letri	Moderate: seepage.	Severe: wetness.	Severe: no water.	Frost action---	Wetness--------	Wetness.
433D2, 433E2, 433G---------- Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
456---------- Wilmonton	Slight---------	Moderate: piping, wetness.	Severe: slow refill.	Frost action---	Erodes easily, wetness.	Erodes easily.
507---------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
559---------- Talcot	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
577---------- Everly	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
577B, 577B2, 577C, 577C2---------- Everly	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
577D2---------- Everly	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope----------	Slope.
638C2*: Clarion----------	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Storden----------	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
638D2*, 638E2*: Clarion----------	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
638D2*, 638E2*: Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
655--- Crippin	Moderate: seepage.	Moderate: wetness, piping.	Moderate: slow refill, deep to water.	Frost action---	Wetness, erodes easily.	Erodes easily.
735--- Havelock	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness---	Wetness.
744--- Revere	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness---	Wetness.
878B--- Ocheyedan	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable---	Favorable.
879--- Fostoria	Moderate: seepage.	Moderate: wetness, piping.	Moderate: deep to water, slow refill.	Frost action---	Wetness, erodes easily.	Erodes easily.
2573--- Hoopeston Variant	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy, soil blowing.	Wetness.
5010*. Pits						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
4----------	0-28	Silty clay loam	MH, CH	A-7	0	100	100	90-100	80-95	55-70	25-40
Knoke	28-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
6----------	0-9	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
Okoboji	9-35	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	35-44	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	44-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
27B----------	0-27	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
Terril	27-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
28B, 28B2--------	0-12	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
Dickman	12-17	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	17-60	Stratified loamy sand to coarse sand.	SP-SM	A-3	0	95-100	75-100	50-80	5-10	---	NP
31----------	0-28	Silty clay loam	MH, CH	A-7	0	100	100	100	95-100	50-65	20-35
Afton	28-40	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	100	95-100	40-60	20-35
	40-60	Clay loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	95-100	80-100	60-90	35-50	20-30
32----------	0-21	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
Spicer	21-42	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	42-46	Loamy sand-------	SM	A-2	0	100	100	95-100	15-35	---	NP
	46-60	Silt loam, silty clay loam, clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
48----------	0-17	Mucky silt loam	OH, MH	A-7	0	100	100	95-100	90-95	60-90	10-30
Knoke	17-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
55----------	0-20	Clay loam--------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
Nicollet	20-32	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	32-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
62C2, 62D2, 62E2, 62G----------	0-8	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
Storden	8-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
77, 77B, 77B2, 77C2----------	0-12	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
Sac	12-34	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	34-60	Clay loam, loam	CL	A-6	2-5	95-100	90-100	75-90	65-80	30-40	11-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
90---------- Okoboji	0-8	Mucky silt loam	MH	A-7	0	100	100	95-100	90-95	60-90	10-30
	8-28	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-42	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	42-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
91, 91B---------- Primghar	0-21	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-60	20-30
	21-60	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	20-30
92---------- Marcus	0-15	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-65	20-35
	15-33	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	95-100	90-100	50-65	20-35
	33-60	Silt loam, silty clay loam.	CL	A-7	0	100	100	95-100	85-95	40-50	20-30
95---------- Harps	0-20	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	20-43	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	43-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107---------- Webster	0-21	Silty clay loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	21-38	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	38-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
108, 108B, 108B2- Wadena	0-13	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	13-28	Loam, sandy loam, sandy clay loam.	SM, ML, CL-ML, SM-SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	28-60	Stratified gravelly coarse sand to gravelly loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
135---------- Coland	0-9	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	9-56	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	56-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	90-100	60-70	50-60	20-40	5-15
138B, 138B2, 138C, 138C2, 138D2---------- Clarion	0-15	Clay loam--------	CL	A-6	0	100	95-100	85-95	55-75	30-40	10-20
	15-27	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	27-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
201B*: Coland----------	0-9	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	9-56	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	56-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	90-100	60-70	50-60	20-40	5-15
Terril----------	0-27	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	27-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
202---------- Cylinder	0-16	Clay loam--------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
	16-29	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	29-60	Gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
203---------- Cylinder	0-18	Clay loam--------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
	18-35	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	35-60	Gravelly coarse sand, loamy sand, sandy loam.	SP-SM, SM	A-1, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
259---------- Biscay	0-10	Silty clay loam	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	10-34	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	34-37	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	37-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
272, 272B, 272C2- Kanaranzi Variant	0-9	Loam----------	ML, CL, CL-ML	A-4, A-6	0	95-100	90-100	80-90	60-85	20-40	NP-15
	9-20	Sandy clay loam, loam, sandy loam.	SM, ML	A-4	0	95-100	90-100	75-85	40-80	30-40	NP-10
	20-60	Gravelly coarse sandy loam, gravelly sandy loam, gravelly loamy coarse sand.	SM, GM-GC, GM, SP-SM	A-2, A-1	2-10	40-80	30-75	20-50	5-35	<25	NP-5
274---------- Rolfe	0-12	Silty clay loam	OL, CL, ML	A-6, A-4	0	100	95-100	90-100	80-95	30-40	5-15
	12-25	Silt loam--------	ML, CL	A-6, A-4	0	100	95-100	90-100	80-95	30-40	5-15
	25-55	Clay, silty clay, silty clay loam.	CH	A-7	0	100	95-100	90-100	75-95	50-65	25-35
	55-60	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-90	55-75	30-45	10-20
282---------- Ransom	0-20	Silty clay loam	OL, ML	A-7	0	100	100	95-100	80-95	40-50	10-20
	20-33	Silty clay loam, silt loam.	ML	A-6, A-7	0	95-100	90-100	85-100	75-95	35-50	10-20
	33-60	Silt loam, loam, clay loam.	ML, CL	A-4, A-6	0-5	95-100	85-100	75-95	55-80	30-40	5-15
308, 308B-------- Wadena	0-15	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	15-35	Loam, sandy loam, sandy clay loam.	SM, ML, CL-ML, CL, SM-SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	35-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3	0-5	45-100	35-95	10-80	2-10	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
309, 309B-------- Allendorf	0-13	Silty clay loam	ML	A-4	0	95-100	95-100	95-100	85-95	25-40	3-10
	13-34	Silty clay loam, silt loam.	ML	A-4	0	95-100	95-100	90-100	80-95	25-40	3-10
	34-37	Loam, sandy loam	ML, SM	A-4	0-5	85-100	85-100	65-90	40-60	25-35	3-10
	37-60	Very gravelly loamy coarse sand, gravelly sand, sand.	SW, SM, SP-SM	A-1	2-10	60-95	40-95	20-40	3-25	---	NP
310, 310B-------- Galva	0-16	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	16-32	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	32-44	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	85-100	35-50	15-25
	44-60	Clay loam, loam	CL	A-6	2-5	95-100	90-100	75-90	65-80	30-40	10-20
311, 311B-------- Galva	0-18	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	18-37	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	37-55	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-25
	55-60	Sand and gravel	SP-SM, SM	A-1	10-56	75-95	70-90	20-40	5-25	---	NP
354. Aquolls											
384---------- Collinwood	0-9	Silty clay loam	CL, CH, ML, MH	A-7	0	100	100	95-100	90-95	40-55	15-25
	9-32	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-95	50-65	20-35
	32-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-95	40-60	15-30
387B---------- Kamrar	0-8	Silty clay loam	CL	A-7	0	95-100	95-100	70-90	60-85	40-50	15-25
	8-35	Silty clay loam, silty clay.	CL, CH	A-7	0	90-100	90-100	70-90	60-85	40-55	15-30
	35-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	85-95	60-80	50-75	35-50	15-30
390---------- Waldorf	0-19	Silty clay loam	ML, MH	A-7	0	100	100	95-100	90-100	45-65	14-30
	19-34	Silty clay, silty clay loam.	MH	A-7	0	100	100	95-100	95-100	50-70	20-35
	34-60	Silty clay loam, silty clay, clay.	MH, CL, ML, CH	A-7, A-6	0	100	100	95-100	90-100	35-65	11-30
396, 397--------- Letri	0-23	Silty clay loam	CL	A-7	0	95-100	95-100	95-100	80-95	40-50	15-25
	23-38	Clay loam, silty clay loam.	CL	A-7	0	95-100	90-100	85-95	75-85	40-50	15-25
	38-60	Loam, clay loam	CL, ML	A-6, A-7, A-4	0-5	95-100	85-98	85-95	65-75	30-50	7-25
433D2, 433E2, 433G---------- Storden	0-8	Clay loam--------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
456---------- Wilmonton	0-13	Silty clay loam	CL	A-6, A-7	0	100	100	85-100	80-100	30-50	12-25
	13-42	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	85-100	80-100	30-50	15-25
	42-60	Clay loam, loam	CL	A-6	0-5	95-100	87-97	75-85	55-75	25-40	10-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
507----------	0-18	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
Canisteo	18-34	Clay loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	34-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	50-75	30-40	12-20
559----------	0-20	Silty clay loam	CL	A-7	0	100	100	80-90	60-85	40-50	15-25
Talcot	20-36	Clay loam, silty clay loam.	CL	A-7	0	95-100	85-100	70-90	60-85	40-50	15-25
	36-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM	A-1	0	65-90	50-85	20-50	2-10	---	NP
577, 577B, 577B2, 577C, 577C2, 577D2----------	0-14	Clay loam--------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
Everly	14-24	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	24-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
638C2*, 638D2*, 638E2*:											
Clarion--------	0-7	Clay loam--------	CL	A-6	0	100	95-100	85-95	55-75	30-40	10-20
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	17-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden--------	0-8	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
655----------	0-15	Loam----------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
Crippin	15-38	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	38-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
735----------	0-8	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Havelock	8-46	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
744----------	0-10	Loam----------	CL	A-6, A-7	0	95-100	95-100	75-95	60-80	30-45	12-20
Revere	10-45	Clay loam, loam	CL	A-6	0	95-100	95-100	65-90	60-80	25-40	10-20
	45-60	Loam, clay loam	CL	A-6	0-2	95-100	90-100	65-90	55-80	25-40	10-18
878B----------	0-23	Loam----------	CL	A-6	0	100	100	75-90	65-80	30-40	10-15
Ocheyedan	23-34	Sandy clay loam, fine sandy loam, loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0	100	100	60-80	35-55	25-40	5-15
	34-60	Sandy loam, clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	100	100	85-95	50-90	25-40	5-15
879----------	0-25	Clay loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-95	25-40	5-15
Fostoria	25-60	Silt loam, loam, sandy loam.	CL	A-6	0-5	100	100	75-100	55-95	30-40	10-20
2573----------	0-29	Loam----------	CL, SC, ML, SM	A-4, A-6, A-2	0	100	100	80-90	25-60	30-40	5-15
Hoopeston Variant	29-40	Sandy loam, loamy sand.	SC, SM, SM-SC, SP-SM	A-2, A-4	0	100	100	60-90	10-40	<25	NP-10
	40-60	Loamy sand, sand	SP-SM, SM	A-2, A-3	0	100	100	50-80	5-20	<25	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
4----------	0-28	27-36	1.30-1.40	0.2-0.6	0.21-0.23	6.6-8.4	High----------	0.37	5	7
Knoke	28-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
6----------	0-9	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.37	5	4
Okoboji	9-35	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	35-44	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
	44-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
27B----------	0-27	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
Terril	27-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
28B, 28B2--------	0-12	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-7.3	Low----------	0.20	3	3
Dickman	12-17	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low----------	0.20		
	17-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-8.4	Low----------	0.15		
31----------	0-28	33-38	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.28	5	4
Afton	28-40	25-35	1.25-1.30	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.43		
	40-60	25-30	1.30-1.45	0.2-2.0	0.14-0.16	7.9-8.4	Moderate-----	0.43		
32----------	0-21	27-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L
Spicer	21-42	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37		
	42-46	6-15	1.40-1.50	2.0-6.0	0.05-0.10	7.4-8.4	Low----------	0.28		
	46-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low----------	0.37		
48----------	0-17	20-27	1.10-1.25	0.6-2.0	0.24-0.26	7.4-8.4	Moderate-----	0.28	5	6
Knoke	17-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	6.6-8.4	High----------	0.37		
55----------	0-20	27-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	0.24	5	6
Nicollet	20-32	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32		
	32-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32		
62C2, 62D2, 62E2, 62G----------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
Storden	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
77, 77B, 77B2, 77C2----------	0-12	32-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
Sac	12-34	30-39	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43		
	34-60	22-35	1.60-1.80	0.6-2.0	0.14-0.16	6.6-8.4	Moderate-----	0.43		
90----------	0-8	20-27	1.20-1.25	0.6-2.0	0.22-0.26	6.1-7.8	Moderate-----	0.37	5	6
Okoboji	8-28	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	28-42	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
	42-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
91, 91B----------	0-21	35-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	4
Primghar	21-60	30-35	1.30-1.35	0.6-2.0	0.18-0.20	6.1-8.4	High----------	0.43		
92----------	0-15	36-40	1.30-1.35	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.28	5	4
Marcus	15-33	30-40	1.35-1.40	0.2-0.6	0.18-0.20	6.1-8.4	High----------	0.43		
	33-60	22-30	1.35-1.45	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.43		
95----------	0-20	27-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L
Harps	20-43	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32		
	43-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
107----------	0-21	27-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate-----	0.24	5	6
Webster	21-38	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-8.4	Moderate-----	0.32		
	38-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
108, 108B, 108B2-	0-13	18-27	1.30-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	4	5
Wadena	13-28	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	28-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
135----------	0-9	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
Coland	9-56	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	56-60	12-28	1.50-1.65	0.6-2.0	0.13-0.17	6.1-7.8	Low----------	0.28		
138B, 138B2, 138C, 138C2, 138D2----------	0-15	28-32	1.45-1.50	0.6-2.0	0.17-0.19	5.6-7.3	Low----------	0.28	4	6
Clarion	15-27	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	27-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
201B*:										
Coland----------	0-9	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	9-56	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	56-60	12-28	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
Terril----------	0-27	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
	27-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
202----------	0-16	27-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
Cylinder	16-29	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	29-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
203----------	0-18	27-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
Cylinder	18-35	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	35-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
259----------	0-10	27-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
Biscay	10-34	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	34-37	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low----------	0.28		
	37-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
272, 272B, 272C2-	0-9	18-25	1.40-1.45	0.6-2.0	0.16-0.20	6.1-7.3	Low----------	0.28	4	6
Kanaranzi	9-20	18-25	1.45-1.60	0.6-2.0	0.16-0.20	6.1-7.3	Low----------	0.28		
Variant	20-60	5-15	1.50-1.80	6.0-20	0.02-0.10	7.4-8.4	Low----------	0.10		
274----------	0-12	27-28	1.35-1.40	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.28	5	6
Rolfe	12-25	22-27	1.35-1.40	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.28		
	25-55	38-45	1.40-1.50	0.06-0.2	0.11-0.13	6.1-7.3	High---------	0.28		
	55-60	24-35	1.50-1.60	0.2-2.0	0.14-0.16	6.1-8.4	Moderate-----	0.28		
282----------	0-20	27-38	1.20-1.30	0.6-2.0	0.18-0.22	6.6-7.3	Moderate-----	0.32	5	7
Ransom	20-33	24-38	1.25-1.35	0.6-2.0	0.16-0.19	6.6-7.8	Moderate-----	0.43		
	33-60	18-30	1.40-1.70	0.2-0.6	0.20-0.22	7.4-8.4	Low----------	0.43		
308, 308B--------	0-15	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
Wadena	15-35	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	35-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
309, 309B--------	0-13	27-32	1.25-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6
Allendorf	13-34	24-32	1.25-1.40	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.43		
	34-37	18-24	1.40-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Low----------	0.24		
	37-60	2-8	1.50-1.75	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
310, 310B--------	0-16	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
Galva	16-32	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	32-44	25-30	1.35-1.45	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.43		
	44-60	22-30	1.60-1.80	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
311, 311B--------	0-18	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
Galva	18-37	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	37-55	25-27	1.35-1.45	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.43		
	55-60	2-8	1.60-1.75	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
354.										
Aquolls										
384--------------	0-9	35-39	1.20-1.30	0.2-0.6	0.14-0.17	5.6-7.3	Moderate-----	0.32	5	4
Collinwood	9-32	35-60	1.25-1.35	0.06-0.2	0.13-0.16	5.6-7.3	High---------	0.32		
	32-60	35-45	1.25-1.40	0.06-0.2	0.11-0.15	7.4-8.4	High---------	0.32		
387B--------------	0-8	35-40	1.20-1.30	0.6-2.0	0.17-0.19	5.6-7.3	Moderate-----	0.28	5	4
Kamrar	8-35	35-50	1.25-1.35	0.2-0.6	0.15-0.19	5.6-7.3	Moderate-----	0.28		
	35-60	20-30	1.35-1.55	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.37		
390--------------	0-19	35-40	1.20-1.30	0.2-2.0	0.18-0.25	6.1-7.3	Moderate-----	0.28	5	4
Waldorf	19-34	40-55	1.25-1.35	0.2-0.6	0.13-0.16	6.6-7.8	High---------	0.28		
	34-60	35-45	1.25-1.35	0.2-0.6	0.20-0.22	7.4-8.4	Moderate-----	0.28		
396, 397---------	0-23	27-35	1.20-1.30	0.6-2.0	0.18-0.22	6.1-7.8	Moderate-----	0.28	5	7
Letri	23-38	27-35	1.25-1.35	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-----	0.28		
	38-60	22-32	1.40-1.70	0.2-0.6	0.17-0.19	6.6-8.4	Moderate-----	0.28		
433D2, 433E2,										
433G------------	0-8	27-32	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
Storden	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
456--------------	0-13	27-35	1.25-1.35	0.6-2.0	0.20-0.26	6.1-7.3	Moderate-----	0.28	5	6
Wilmonton	13-42	25-32	1.30-1.45	0.2-0.6	0.15-0.19	6.1-8.4	Moderate-----	0.28		
	42-60	22-32	1.45-1.70	0.2-0.6	0.14-0.19	7.4-8.4	Moderate-----	0.37		
507--------------	0-18	27-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L
Canisteo	18-34	27-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32		
	34-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32		
559--------------	0-20	27-35	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.28	4	7
Talcot	20-36	27-35	1.25-1.35	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.28		
	36-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15		
577, 577B, 577B2,										
577C, 577C2,										
577D2-----------	0-14	27-30	1.40-1.45	0.6-2.0	0.17-0.19	5.6-7.3	Moderate-----	0.24	5	6
Everly	14-24	25-35	1.45-1.55	0.6-2.0	0.15-0.17	6.1-7.3	Moderate-----	0.32		
	24-60	22-32	1.55-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
638C2*, 638D2*,										
638E2*:										
Clarion--------	0-7	28-32	1.45-1.50	0.6-2.0	0.17-0.19	5.6-7.3	Low----------	0.28	4	6
	7-17	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	17-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
Storden--------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
655--------------	0-15	22-27	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.28	5	6
Crippin	15-38	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
	38-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low----------	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
735----------	0-8	27-35	1.40-1.50	0.6-2.0	0.20-0.22	7.4-8.4	High----------	0.28	5	7
Havelock	8-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	7.4-8.4	High----------	0.28		
	46-60	12-26	1.50-1.65	2.0-6.0	0.13-0.17	7.4-8.4	Low----------	0.28		
744----------	0-10	22-27	1.10-1.40	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	4L
Revere	10-45	22-35	1.35-1.55	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32		
	45-60	18-32	1.35-1.65	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.32		
878B----------	0-23	24-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	6
Ocheyedan	23-34	14-24	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
	34-60	12-28	1.45-1.70	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.32		
879----------	0-25	27-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
Fostoria	25-60	16-26	1.40-1.75	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43		
2573----------	0-29	18-27	1.25-1.35	0.6-6.0	0.16-0.20	6.1-8.4	Low----------	0.28	4	3
Hoopeston	29-40	10-20	1.35-1.70	2.0-6.0	0.12-0.15	7.4-8.4	Low----------	0.28		
Variant	40-60	2-10	1.50-1.80	6.0-20	0.05-0.10	7.4-8.4	Low----------	0.28		
5010*. Pits										
5040. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "occasional," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
4---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
6---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
27B---------- Terril	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
28B, 28B2---------- Dickman	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
31---------- Afton	C/D	Occasional	Very brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
32---------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
48---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
55---------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jul	High-----	High-----	Low.
62C2, 62D2, 62E2, 62G---------- Storden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
77, 77B, 77B2, 77C2---------- Sac	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
90---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
91, 91B---------- Primghar	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	High-----	Moderate	Moderate.
92---------- Marcus	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
95---------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
107---------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
108, 108B, 108B2-- Wadena	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
135---------- Coland	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
138B, 138B2, 138C, 138C2, 138D2----- Clarion	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
201B*: Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
Terril	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
202, 203 Cylinder	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	High	Moderate	Low.
259 Biscay	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jul	High	Moderate	Low.
272, 272B, 272C2 Kanaranzi Variant	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
274 Rolfe	C	None	---	---	+1-1.0	Apparent	Nov-Jul	High	High	Moderate.
282 Ransom	B	None	---	---	2.5-5.0	Apparent	Nov-Jul	High	High	Low.
308, 308B Wadena	B	None	---	---	>6.0	---	---	Low	Low	Low.
309, 309B Allendorf	B	None	---	---	>6.0	---	---	Moderate	Low	Moderate.
310, 310B, 311, 311B Galva	B	None	---	---	>6.0	---	---	High	Moderate	Moderate.
354. Aquolls										
384 Collinwood	C	None	---	---	2.0-5.0	Apparent	Nov-Jul	High	High	Low.
387B Kamrar	B	None	---	---	>6.0	---	---	Moderate	High	Low.
390 Waldorf	C/D	None	---	---	0-3.0	Apparent	Nov-Jul	High	High	Low.
396, 397 Letri	B/D	None	---	---	0.5-2.0	Perched	Nov-Jul	High	High	Low.
433D2, 433E2, 433G Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
456 Wilmonton	B	None	---	---	2.5-5.0	Apparent	Nov-Jul	High	Moderate	Low.
507 Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
559 Talcot	B/D	None	---	---	1.0-2.5	Apparent	Nov-Jul	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
577, 577B, 577B2, 577C, 577C2, 577D2---------- Everly	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
638C2*, 638D2*, 638E2*: Clarion---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Storden---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
655---------- Crippin	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
735---------- Havelock	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
744---------- Revere	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
878B---------- Ocheyedan	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
879---------- Fostoria	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
2573---------- Hoopeston Variant	B	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	Low------	Moderate.
5010*. Pits										
5040. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Afton	Fine-silty, mixed, mesic Cumulic Haplaquolls
Allendorf	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Aquolls	Loamy, mixed, mesic Haplaquolls
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Collinwood	Fine, montmorillonitic, mesic Aquic Hapludolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Everly	Fine-loamy, mixed, mesic Typic Hapludolls
Fostoria	Fine-loamy, mixed, mesic Aquic Hapludolls
Galva	Fine-silty, mixed, mesic Typic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Havelock	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Hoopeston Variant	Fine-loamy, mixed, mesic Aquic Hapludolls
Kamrar	Fine, montmorillonitic, mesic Typic Hapludolls
Kanaranzi Variant	Coarse-loamy, mixed, mesic Typic Hapludolls
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
*Letri	Fine-loamy, mixed, mesic Typic Haplaquolls
Marcus	Fine-silty, mixed, mesic Typic Haplaquolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Ocheyedan	Fine-loamy, mixed, mesic Typic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Udorthents
Primghar	Fine-silty, mixed, mesic Aquic Hapludolls
Ransom	Fine-silty, mixed, mesic Aquic Hapludolls
Revere	Fine-loamy, mesic Typic Calciaquolls
Rolfe	Fine, montmorillonitic, mesic Typic Argialbolls
Sac	Fine-silty, mixed, mesic Typic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Waldorf	Fine, montmorillonitic, mesic Typic Haplaquolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
*Wilmonton	Fine-loamy, mixed, mesic Aquic Hapludolls

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