United States Department of Agriculture

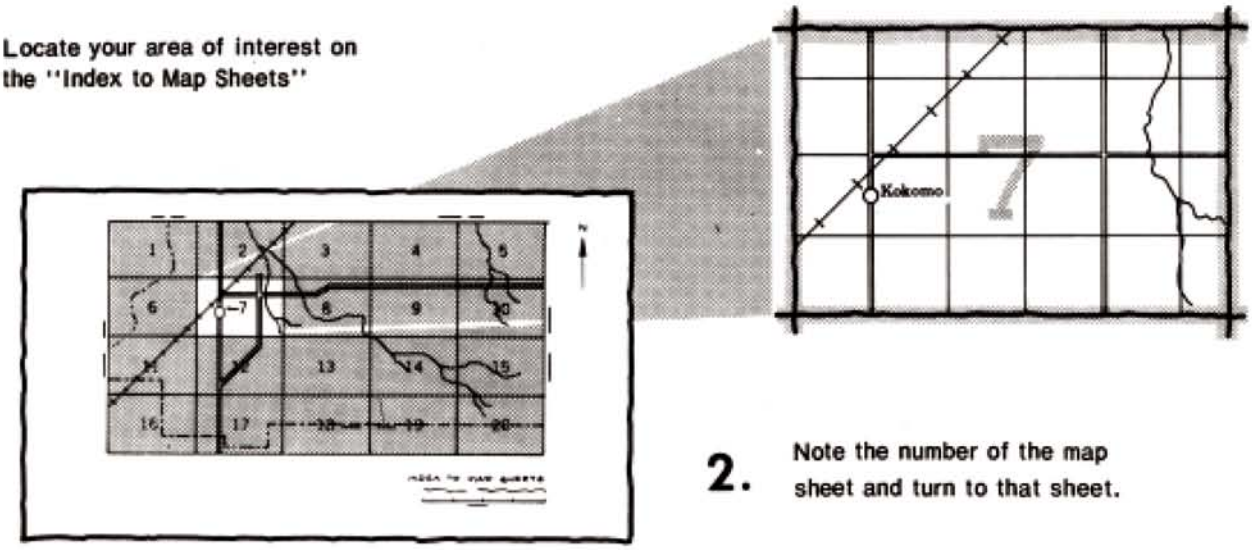
Soil Conservation Service

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 Greene County, Iowa

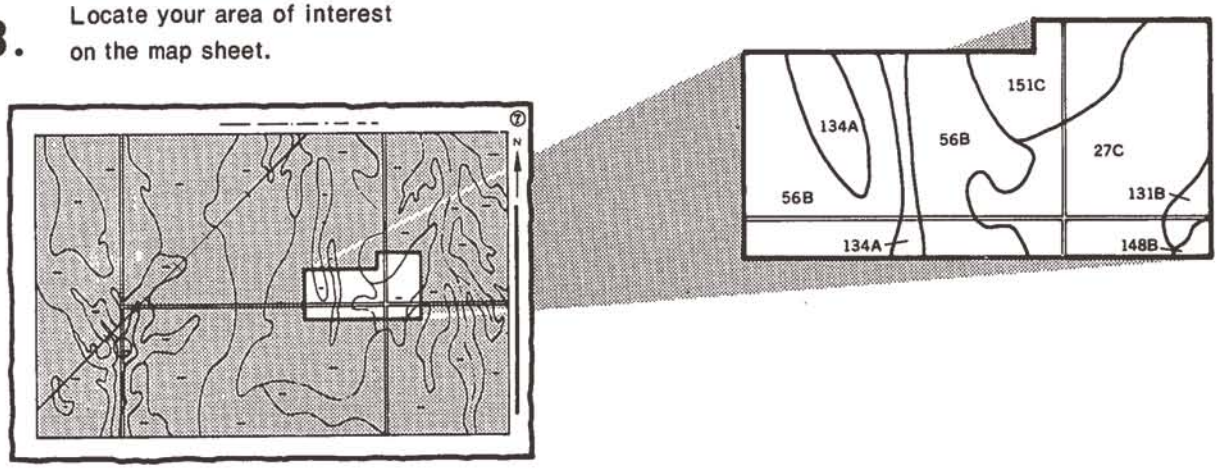
HOW TO USE

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

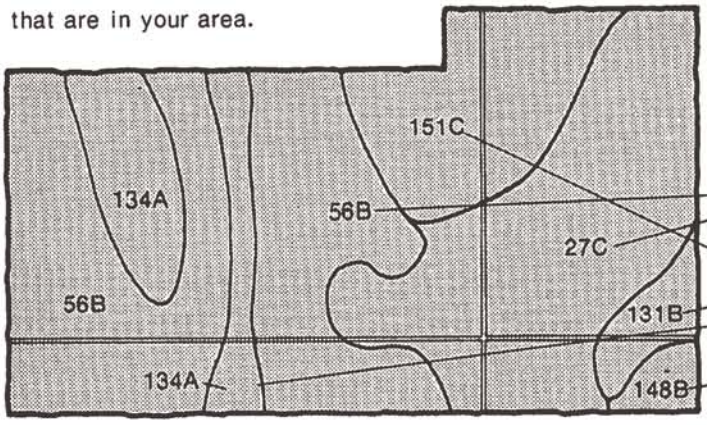


2. Note the number of the map sheet and turn to that sheet.

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



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

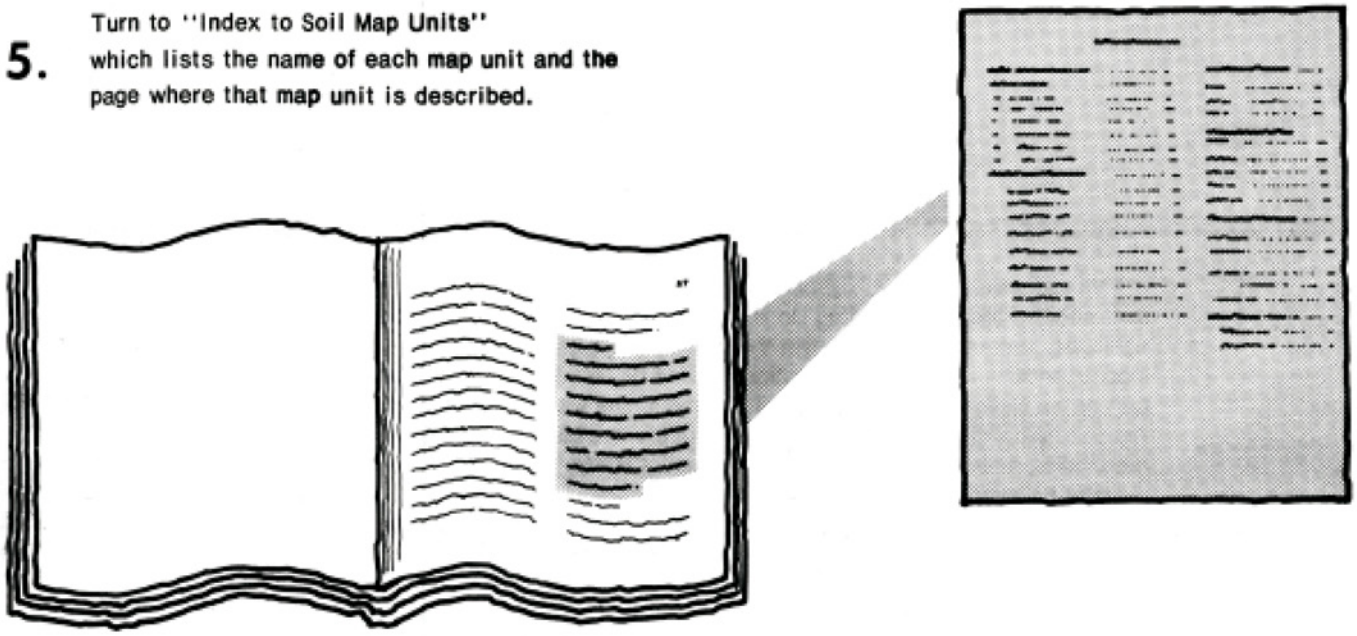


Symbols

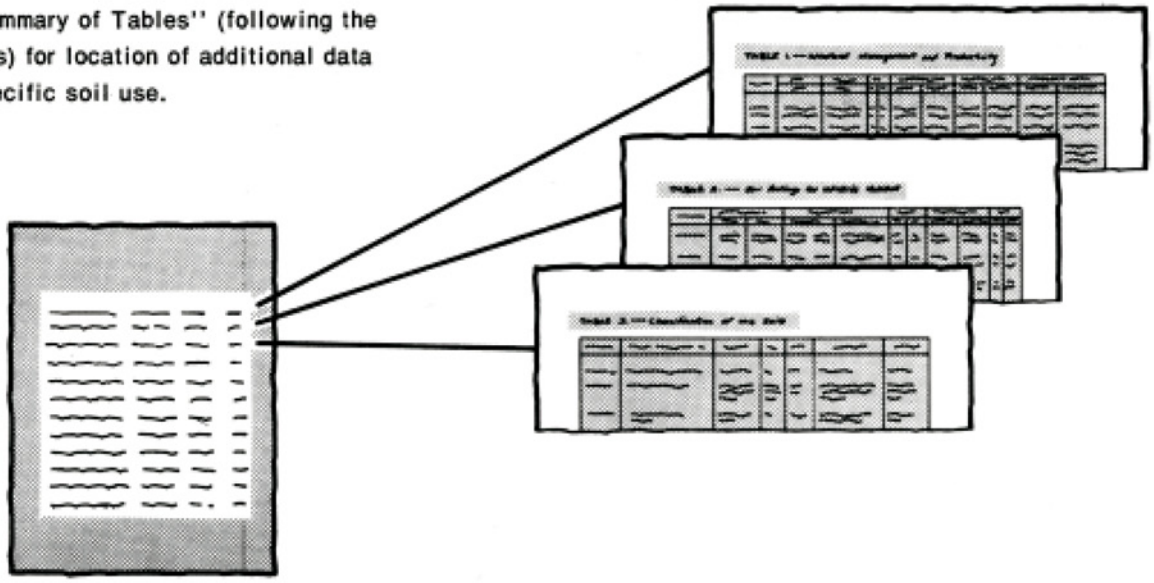
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C

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; to 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, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the 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 Greene County Soil Conservation District. Funds appropriated by Greene 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: Soybeans on a Webster clay loam. The farmstead is on a Clarion loam.

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Soil Series

Issued August 1985

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Summary of Tables

Preface

This soil survey contains information that can be used in land-planning programs in Greene 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
Greene County, Iowa

By Max A. Sherwood, Soil Conservation Service

Fieldwork by Max A. Sherwood, Mark S. Wespetal,
Paul P. Viner, Robert J. Vobora, and Kim C. Goerg,
Soil Conservation Service, and by
Gary L. Hillmer, Iowa State University

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

GREENE COUNTY is in west-central Iowa (fig. 1). It has an area of 364,096 acres, or about 569 square miles. Jefferson, the county seat, is in the central part of the county. It is about 60 miles northwest of Des Moines, the state capital. In 1980, it had a population of 4,852. The population of the county was 12,014.

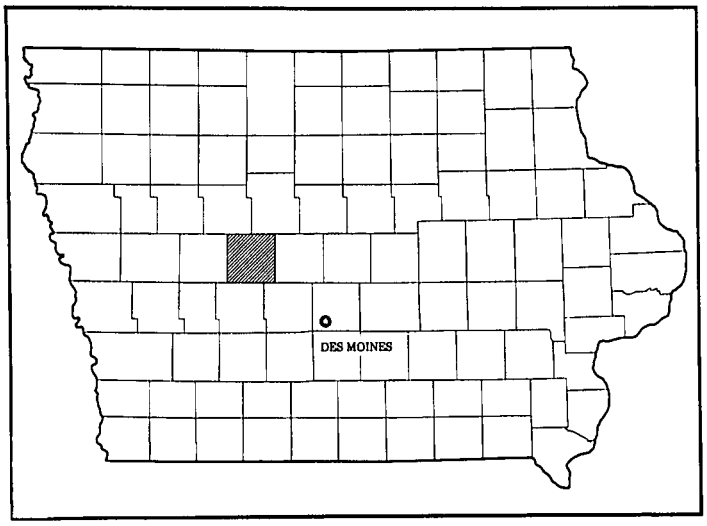

Figure 1.—Location of Greene County in Iowa.

Farming is the main enterprise in the county. The principal crops are corn, soybeans, hay, and oats. The steepest land is generally used for pasture or timbered pasture. The wettest land is generally used for wildlife preserves or pasture. Much of the grain and forage that is grown on the farms is fed to swine, beef cattle, and sheep.

This survey updates the soil survey of Greene County published in 1924 (*4*). It provides additional information and larger maps, which show the soils in greater detail.

General Nature of the County

The following paragraphs briefly describe the history and development of the county; the physiography, relief, and drainage; natural resources; farming; and climate.

History and Development

The land that became Greene County consisted of beautiful meadows of prairie grasses and sloughgrass about 3 to 7 feet high and of heavily forested areas along the streams and adjacent hills (*3*). The land probably would have been a forested area, but prairie fires caused by lightning often burned the vegetative cover (*3*). This area was part of the hunting grounds of the Sac and Fox Indian tribes (*3*). In 1849, Truman Davis, the first white settler, settled on land in the

southeastern part of the county near Rippey. Greene County was organized in 1854, when it had a population of 151 (*12*). It was named after General Nathaniel Greene, who was a hero of the Revolutionary War (*12*). By 1856, the population had grown to 1,089. In 1868, a railroad was started through the county, and by 1900, the population had reached 17,820 (*3*).

The early settlers grew corn and small grain and had vegetable gardens. They raised cattle, swine, sheep, horses, and chickens. Some attempts were made to use the peat that occurred in upland swales as a fuel for heat, but results generally were unsatisfactory (*12*).

Coal was mined on a limited scale in the southern part of the county around the 1900's, but the beds of coal were thin and were not of good quality, so mining was not continued. Some clay was used in manufacturing bricks for local building needs (*12*).

The first artesian well was developed in Hardin Township in 1882. An estimated 200 artesian wells were in the county by 1907 (*12*). Only a fraction of these are still in use.

The economy is largely dependent upon farming. Some light industry and manufacturing and transportation enterprises are in the county, especially in Jefferson and Scranton.

Physiography, Relief, and Drainage

The topography of Greene County is characteristic of Wisconsin drift areas. The surface is level to gently rolling in the uplands and slopes to stream bottoms. The uplands are dotted with depressed areas, and low knobs or swells occur along the Altamont terminal moraine, which runs across the northern part of the county. The Altamont moraine is distinct, rising as much as 100 feet above the plains to the south. Some of the larger streams have cut gorgelike valleys with narrow bottom land areas and stream terraces. All of Greene County is covered by Wisconsin till of Cary age, although the till in the northern one-third of the county is younger than that in the southern part. Older Kansan till underlies the Cary drift.

In Greene County, the surface has a maximum relief of about 300 feet. The highest point, about 1 1/2 miles southwest of Scranton, is about 1,235 feet above sea level. The lowest point, where the Raccoon River leaves the southern border of the county, is about 940 feet above sea level. The drift material is thickest, about 230 to 240 feet thick, in the Altamont moraine. In other parts of the county, it may be as thin as 50 feet but generally is 100 to 150 feet thick.

The landscape slopes to the south and southeast. The main drainage is provided by the Raccoon River and by its tributaries—Cedar Creek, Hardin Creek, West and East Buttrick Creeks, and Greenbrier Creek. Willow Creek, a tributary of the Middle Raccoon River, drains parts of Willow and Scranton Townships in the southwestern corner of the county. Tributaries of Beaver Creek, which empties into the Des Moines River, drain parts of Paton and Junction Townships in the eastern part of the county.

The bedrock directly beneath the glacial drift in the county occurs as level to gently dipping strata. In the eastern two-thirds of the county, it consists of shale with thin interbedded sandstone and one or two coalbeds representing the Des Moines Series of Pennsylvanian age. In the western townships, sandstone and shale of Cretaceous age overlap the Pennsylvanian rocks. Discontinuous sections of shale and coal layers of Pennsylvanian age are exposed along the valley of the Raccoon River and along some of the creeks in Franklin and Washington Townships. The best exposures of the Cretaceous rocks are in an area along the Raccoon River north of Scranton and in areas extending several miles upstream and downstream from this area.

The principal structural feature of the pre-Cretaceous strata is a monocline dipping gently southeastward about 8 to 10 feet per mile. There probably are some minor flexures on this monoclinal structure, but the scarcity of deep wells does not allow more detailed structural mapping. The overlapping Cretaceous strata are essentially horizontal.

From a geologic viewpoint, the drainage in the county is very immature. This is typical of areas in the Cary drift. Only the North Raccoon River has a mature development. The main creeks feeding the North Raccoon River are well established, but their tributaries are weak or nonexistent.

The Buttrick drainage system was an important discharge stream for the melt water of the glacier that produced the Altamont moraine of the Cary glacial period. The West Branch of Buttrick Creek was one of the main channels. This branch has eroded into the Altamont moraine to a depth of 50 feet and in places to a depth of nearly 100 feet. The flood plain in the moraine is about 1/4 to 1/2 mile wide. Much of the sand and gravel carried by this glacial stream was deposited on the plain south of the Altamont moraine. The excavation of this sand and gravel produced Spring Lake in Hardin Township (*3*).

A natural lake existed in Bristol Township for a brief period, following the retreat of the glaciers. The lake, known as Goose Lake, has since been drained artificially and has filled with peat and silt. It was about 665 acres of water that was 0.8 mile wide and about 1.3 miles long (*3*).

Natural Resources

The most obvious natural resource in Greene County is the soil. Other natural resources in the county are water and sand and gravel. Several parks in the county have been developed to provide an opportunity for recreation.

The supply of water for agricultural and municipal uses is moderate to good. Sufficient water can be obtained for domestic wells and some community wells from sand and gravel deposits within or at the base of the glacial drift, generally between depths of 100 and 200 feet.

The six municipal water systems in Greene County are at Churdan, Grand Junction, Jefferson, Paton, Rippey, and Scranton. All of these communities obtain their water supply from ground water sources. The aquifers used are Pleistocene sand and gravel deposits, Cretaceous (Dakota) sandstone, Pennsylvanian sandstone, Mississippian limestone and dolomite, and Cambrian (Jordan) sandstone.

Domestic and rural water supplies are obtained chiefly from wells finished in glacial sand. Most of these wells draw water from sand and gravel below the Wisconsin Drift at a depth of 100 feet or more, but depth varies considerably from area to area. Successful wells have been developed at depths of 20 to more than 200 feet. Although yields generally are less than 20 gallons per minute, favorable conditions and proper well construction can result in moderate to large supplies in some areas. The shallow city wells in Jefferson are capable of pumping as much as 500 gallons per minute for short periods. The well in the basin of Hardin Creek, east of the city, tested as high as 1,350 gallons per minute for a period of 6 hours. The Churdan wells can produce 60 to 70 gallons per minute. There apparently are some areas of flowing drift wells along Willow Creek, the Raccoon River, and Hardin Creek in the vicinity of Jefferson and along some of the streams in the northeastern part of the county. The extent of these artesian areas is not fully known.

Wells that penetrate the Dakota Sandstone in Willow, Scranton, Kendrick, and southern Cedar Townships can produce 20 to 30 gallons per minute or more, generally with only small drawdowns. The Jordan Sandstone is one of the most promising sources for large yields, as is indicated by wells at Jefferson and by other wells in the surrounding counties.

Three farm irrigation wells were drilled in the county between 1956 and 1980. They pump from a depth of 80 to 185 feet and produce 600 to 1,000 gallons per minute.

Sand and gravel are mined from several pits in the county, mostly in areas scattered along the valley of the Raccoon River. They are used locally, especially as surface material for rural roads. The railroad operated a pit for several years at the turn of the century. Spring Lake has formed in the pit and is now included in a park by that name. Some effort is being made to reclaim inactive sand and gravel pits by smoothing slopes and replacing some topsoil and subsoil in areas where the ground water table is not a problem.

Farming

In 1981, the total area of farms in Greene County was 352,700 acres. Since the 1930's, the number of farms has steadily decreased and the size has steadily increased. In 198l, there were 1,050 farms, which had an average size of 336 acres. About 313,400 acres was used for crops, 7,600 acres for hay, and 22,600 acres for pasture (*5*).

Corn is the primary crop grown in Greene County. In 1981, the 163,000 acres of corn harvested for grain yielded an average of 112.9 bushels per acre, and the 6,700 acres of corn harvested for silage yielded an average of 16.0 tons per acre. Soybeans are the second most important crop. In 1981, 135,400 acres of soybeans was harvested for grain, yielding an average of 41.9 bushels per acre. In the same year, 5,500 acres of oats was harvested, yielding an average of 82 bushels per acre, and 7,200 acres of hay was harvested, of which 5,800 acres was alfalfa (*5*).

Most farms in Greene County receive about 10 percent of their income from the sale of livestock and livestock products. In 1981, 230,000 hogs were marketed. The county had 64,000 head of cattle, of which 18,000 were beef cows; 23,000 grain-fed cattle; 200 milk cows; 6,500 sheep; and 6,800 laying hens.

Most of the cattle are trucked to markets in Denison, Sioux City, or Fort Dodge, Iowa, or to Omaha, Nebraska. Hogs are generally trucked to nearby local buyers in Perry, Grand Junction, Paton, and Churdan or to Denison, Iowa. Corn and soybeans are generally trucked to local grain elevators for storage or market but may be held in storage on the farm for a later market or for livestock feed. Silage and hay are generally fed to livestock on the farm where they are grown.

Climate

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

The climate in Greene County is subhumid and continental. Winters are cold, and summers are warm. The growing season is long enough for the crops commonly grown in the county to mature.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Jefferson, Iowa, in the period 1951 to 1979. 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 about 23 degrees F, and the average daily minimum temperature is 13 degrees. The lowest temperature on record, which occurred on March 1, 1962, is -26 degrees. In summer the average temperature is 73 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred on July 21, 1974, is 107 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 32 inches. Of this, 22 inches, or about 70 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 19 inches. The heaviest 1-day rainfall during the period of record was 5.5 inches at Jefferson on August 22, 1954. Thunderstorms occur on about 50 days each year, and most occur in spring.

The average seasonal snowfall is about 34 inches. The greatest snow depth at any one time during the period of record was 30 inches. On the average, 41 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 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

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 occur at times during the warmer part of the year in scattered small areas.

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. Clarion-Nicollet-Webster association

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

This association consists of soils on a relatively young till plain. Slopes are short and irregular in the higher areas, and slight depressions are in low areas. The surface drainage pattern is commonly not well defined, and runoff accumulates in low areas. Slopes range from 0 to 14 percent.

This association makes up about 36 percent of the county. It is about 35 percent Clarion soils, 20 percent Nicollet soils, 15 percent Webster soils, and 30 percent soils of minor extent (fig. 2).

Clarion soils are well drained and are in the higher, steeper areas of the association. Nicollet soils are somewhat poorly drained and are on the lower parts of gentle slopes. The nearly level Webster soils are poorly drained and are in the low areas.

Typically, the surface layer of the Clarion soils is black loam about 9 inches thick. The subsurface layer is mixed black and very dark grayish brown loam about 5 inches thick. The subsoil is loam about 14 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Nicollet soils is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 7 inches thick. The subsoil is clay loam about 14 inches thick. It is dark grayish brown in the upper part and mottled grayish brown and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled loam.

Typically, the surface layer of the Webster soils is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is mottled clay loam about 15 inches thick. The upper part is very dark gray, and the lower part is dark gray and olive gray. The substratum to a depth of about 60 inches is olive gray, mottled loam.

The minor soils in this association are Canisteo, Coland, Harps, Knoke, Ocheyedan, Okoboji, Storden, and Wacousta soils. Canisteo, Harps, Knoke, and Storden soils have a higher content of lime than the major soils. Coland soils formed in alluvium in the lower areas. Knoke, Okoboji, and Wacousta soils are in closed depressions. Ocheyedan soils are generally on terraces.

This association is used mainly for corn, soybeans, small grain, and hay. Some of the wettest areas and some of the steepest sloping areas are pastured. The content of organic matter and the available water capacity are moderate or high in the major soils. The main management needs are measures that improve drainage and help to control wind erosion in the nearly level areas and measures that help to control water erosion and maintain fertility in the more sloping areas.

2. Canisteo-Webster-Nicollet association

Nearly level and very gently sloping, poorly drained and somewhat poorly drained, loamy soils that formed in glacial sediments and glacial till; on uplands

This association consists of soils on a relatively young till plain. The soils are nearly level in areas with slight depressions and gently undulating in other areas. The surface drainage pattern is not well defined, and runoff commonly accumulates in the low areas. Slopes range from 0 to 3 percent.

This association makes up about 35 percent of the county. It is about 26 percent Canisteo soils, 24 percent Webster soils, 20 percent Nicollet soils, and 30 percent soils of minor extent.

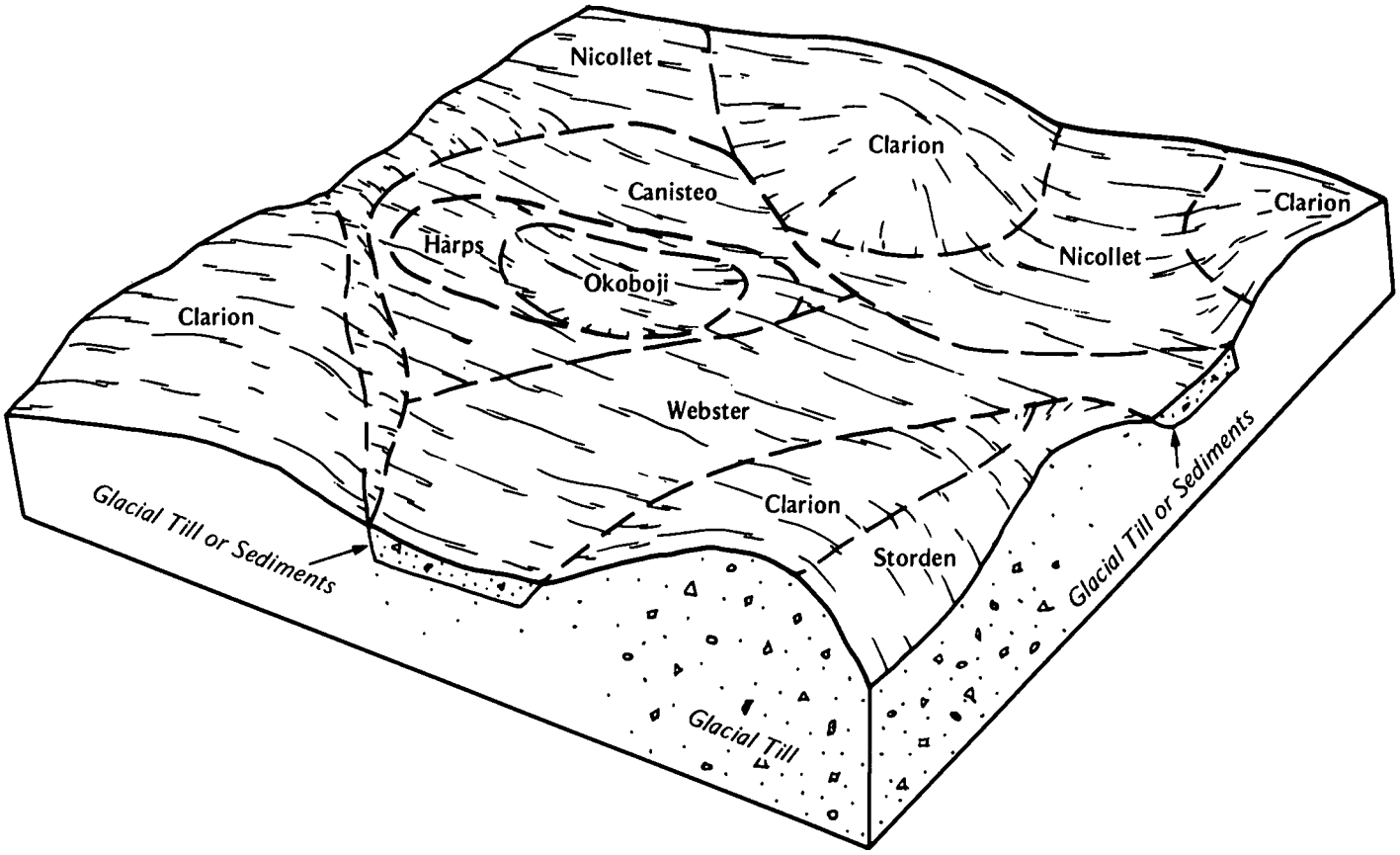

Figure 2.—Pattern of soils and parent material in the Clarion-Nicollet-Webster association.

Canisteo soils are calcareous, and Webster and Nicollet soils are noncalcareous. Canisteo and Webster soils are poorly drained and are in swales. Nicollet soils are somewhat poorly drained and are slightly higher on the landscape than Canisteo and Webster soils.

Typically, the surface layer of the Canisteo soils is black clay loam about 8 inches thick. The subsurface layer is clay loam about 11 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is mottled clay loam about 11 inches thick. The upper part is dark gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, mottled loam.

Typically, the surface layer of the Webster soils is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is mottled clay loam about 15 inches thick. The upper part is very dark gray, and the lower part is dark gray and olive gray. The substratum to a depth of about 60 inches is olive gray, mottled loam.

Typically, the surface layer of the Nicollet soils is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 7 inches thick. The subsoil is clay loam about 14 inches thick. It is dark grayish brown in the upper part and mottled grayish brown and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled loam.

Clarion soils are the most extensive of the minor soils in this association. Other soils of minor extent are Coland, Crippin, Harps, Knoke, Okoboji, and Wacousta soils. Clarion soils are well drained. Coland soils formed in alluvium in the lower areas. Crippin, Harps, and Knoke soils have a higher content of lime than the major soils. Knoke, Okoboji, and Wacousta soils are in closed depressions.

This association is used mainly for corn, soybeans, and hay. Some of the wettest areas are pastured. The content of organic matter and the available water capacity are moderate or high in the major soils. The main management needs are measures that improve drainage and help to control wind erosion. During dry

winter or early spring months when no snow is on the ground, the surface is bare and wind erosion can remove much of the productive topsoil.

3. Mayer-Biscay-Coland association

Nearly level, poorly drained, loamy and silty soils that formed in glacial outwash sediments and alluvium; on outwash plains, terraces, and bottom land

This association consists of soils that are nearly level in most areas. The surface drainage pattern is not well defined, except for drainage channels on bottom land. Slopes range from 0 to 2 percent.

This association makes up about 4 percent of the county. It is about 25 percent Mayer soils, 24 percent Biscay soils, 15 percent Coland soils, and 36 percent soils of minor extent (fig. 3).

Mayer soils are calcareous, and Biscay and Coland soils are noncalcareous. Mayer and Biscay soils are in low areas. Coland soils are on bottom land.

Typically, the surface layer of the Mayer soils is black, calcareous loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 13 inches thick. The subsoil is about 13 inches thick. The upper part is olive gray, mottled loam, and the lower part is olive gray, mottled, calcareous coarse loamy sand. The substratum to a depth of about 60 inches is grayish brown and olive sand and gravel.

Typically, the surface layer of the Biscay soils is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 14 inches thick. It is mottled in the lower part. The subsoil is dark gray and olive gray, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and olive gray. The upper part is calcareous loamy coarse sand, and the lower part is calcareous sand and gravel.

Typically, the surface layer of the Coland soils is black silty clay loam about 8 inches thick. The subsurface layer is black clay loam about 26 inches thick. It is mottled in

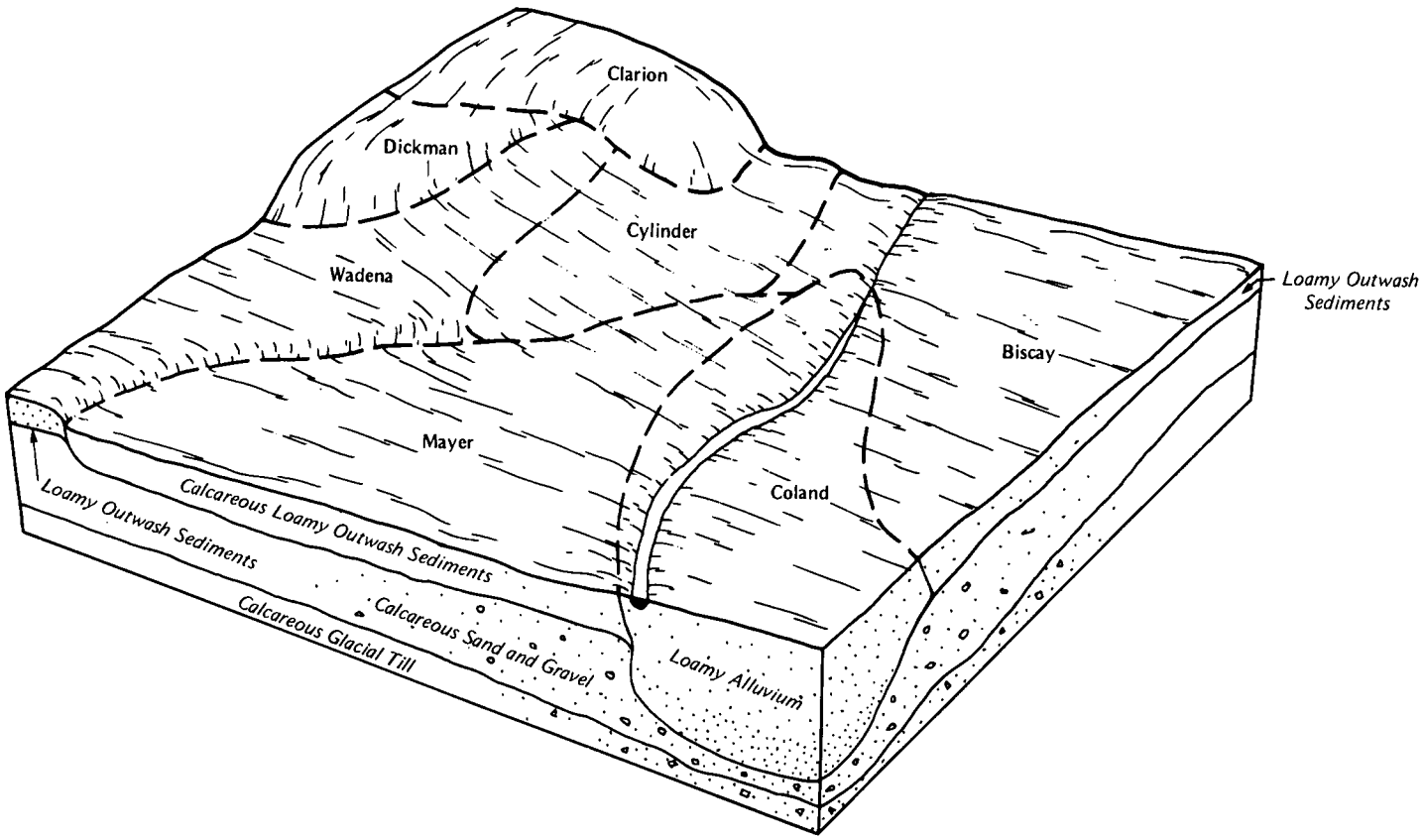

Figure 3.—Pattern of soils and parent material in the Mayer-Biscay-Coland association.

the lower part. The next 8 inches is very dark gray, mottled clay loam. The substratum to a depth of about 60 inches is mixed light brownish gray and very dark gray, mottled loam.

Wadena soils are the most extensive of the minor soils in this association. Other soils of minor extent are Canisteo, Clarion, Cylinder, Dickman, Estherville, Fostoria, Nicollet, Ocheyedan, and Webster soils. Clarion, Dickman, Ocheyedan, and Wadena soils are well drained. Canisteo and Webster soils formed in glacial till and glacial sediments in low areas. Estherville soils are somewhat excessively drained. Cylinder, Fostoria, and Nicollet soils are somewhat poorly drained.

This association is used mainly for corn, soybeans, and hay. The content of organic matter is high in the major soils. The available water capacity ranges from low to high. The main management needs are measures that improve drainage, control flooding, and maintain fertility.

4. Clarion-Coland-Storden association

Nearly level to very steep, well drained and poorly drained, loamy and silty soils that formed in glacial till and alluvium; on uplands and bottom land

This association consists of soils along creek valleys. The more gentle slopes are on valley floors, and the soils on valley sides are moderately sloping to very steep. The surface drainage pattern is well defined. Slopes range from 0 to 40 percent.

This association makes up about 7 percent of the county. It is about 35 percent Clarion soils, 25 percent Coland soils, 15 percent Storden soils, and 25 percent soils of minor extent (fig. 4).

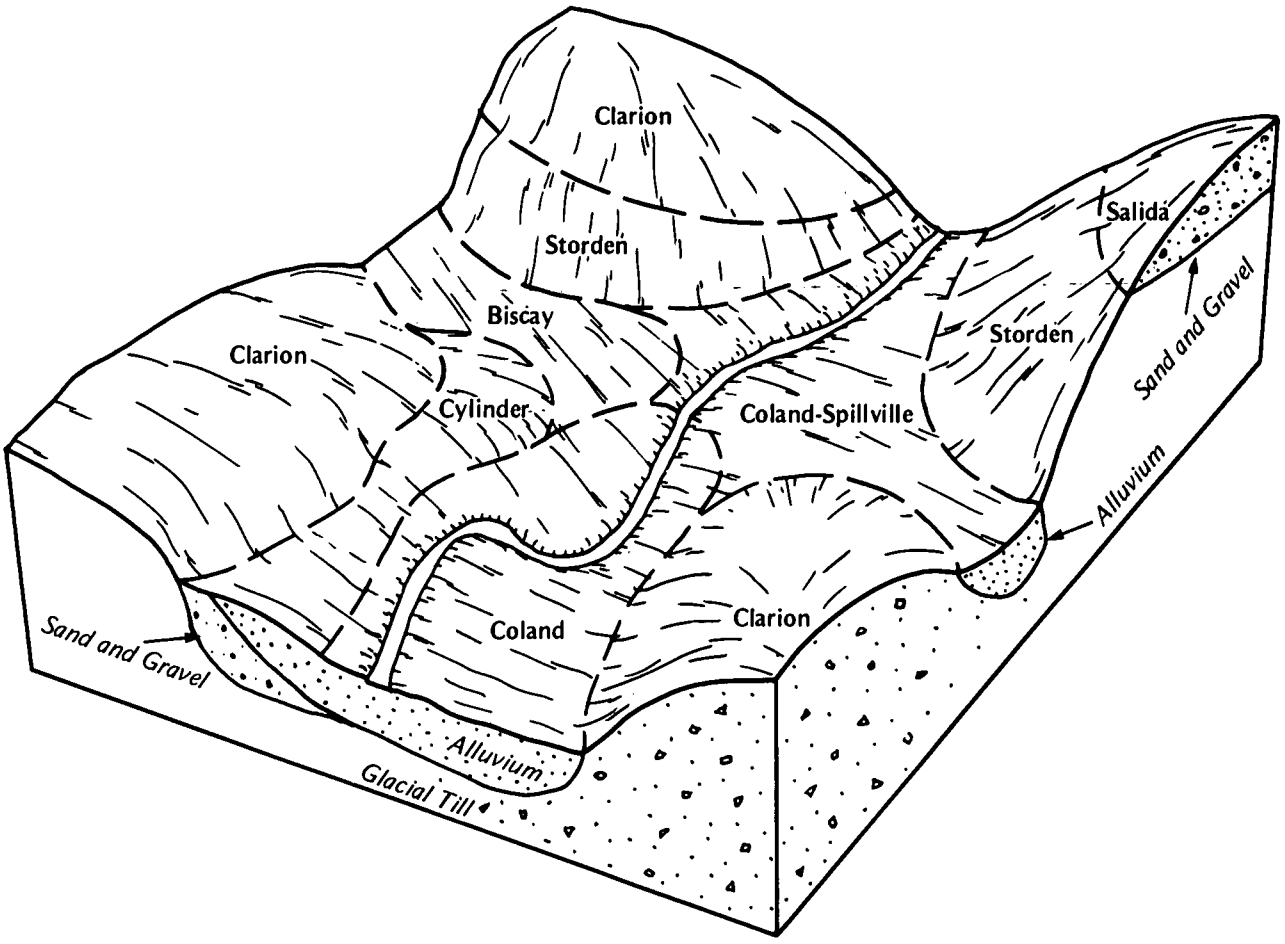

Figure 4.—Pattern of soils and parent material in the Clarion-Coland-Storden association.

Clarion soils are well drained and are on knolls and side slopes. Coland soils are poorly drained and are on bottom land. Storden soils are well drained and are on the steeper and more convex slopes.

Typically, the surface layer of the Clarion soils is black loam about 8 inches thick. The subsurface layer is mixed black and very dark grayish brown loam about 4 inches thick. The subsoil is loam about 14 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Coland soils is black silty clay loam about 8 inches thick. The subsurface layer is black clay loam about 28 inches thick. It is mottled in the lower part. The next 8 inches is very dark gray, mottled clay loam. The substratum to a depth of about 60 inches is mixed light brownish gray and very dark gray, mottled loam.

Typically, the surface layer of the Storden soils is very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The upper part of the substratum is yellowish brown, calcareous loam. The next part is light olive brown, mottled, calcareous loam. The lower part to a depth of about 60 inches is mottled yellowish brown and light olive brown, calcareous loam. Lime accumulations are throughout the profile.

The minor soils in this association are Biscay, Calco, Cylinder, Salida, Spillville, Terril, and Wadena soils. Biscay, Cylinder, Salida, and Wadena soils are underlain by sand and gravel. Calco soils are on bottom land and are calcareous. Spillville soils are somewhat poorly drained and are in valleys. Terril soils are moderately well drained and are on foot slopes and alluvial fans.

Most of this association is used for corn, soybeans, small grain, and hay, but the wettest and steepest areas are generally pastured. The available water capacity in the major soils is high. The content of organic matter ranges from low to high. The main management needs are measures that help to control water erosion and flooding, maintain fertility in the more sloping areas, and improve drainage in the low areas.

5. Lester-Fluvaquents-Wadena association

Nearly level to very steep, well drained, somewhat poorly drained, and poorly drained, loamy or variably textured soils that formed in glacial till, alluvium, and outwash sediments; on uplands, terraces, and bottom land

This association consists of soils along the valley of the Raccoon River and its adjoining tributaries. The more gentle slopes are on valley floors, and the soils on valley sides are strongly sloping to very steep. The surface drainage pattern is well defined. Slopes range from 0 to more than 40 percent.

This association makes up about 12 percent of the county. It is about 25 percent Lester soils, 16 percent Fluvaquents, 15 percent Wadena soils, and 44 percent soils of minor extent.

Lester soils are well drained and are in the smoother and less sloping areas on hillsides and ridgetops. Fluvaquents vary in texture and drainage and are on bottom land. Wadena soils are well drained and are on terraces.

Typically, the surface layer of the Lester soils is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is yellowish brown and brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam.

Typically, the Fluvaquents are stratified very dark grayish brown, grayish brown, and brown sediments. The texture of the sediments varies, including fine sand, loamy sand, sandy loam, silt loam, and silty clay loam to a depth of about 60 inches.

Typically, the surface layer of the Wadena soils is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark brown loam in the upper part, dark yellowish brown loam in the next part, and dark yellowish brown gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel.

Storden soils are the most extensive of the minor soils in this association. Other minor soils are Clarion, Coland, Cylinder, Dickman, Estherville, Knoke, Le Sueur, Moingona, Ocheyedan, Okoboji, Salida, Spillville, and Terril soils. Storden soils are calcareous and are on the steeper, more convex slopes. The upper part of the subsoil in Clarion and Ocheyedan soils is loam. Coland soils are poorly drained. Cylinder, Le Sueur, and Spillville soils are somewhat poorly drained. Dickman soils are sandy. Estherville and Salida soils are underlain by sand and gravel. Knoke and Okoboji soils are very poorly drained and are in depressions. Moingona and Terril soils are moderately well drained and are on foot slopes.

This association is used mainly for corn, soybeans, small grain, and hay. The steepest soils on sidehills and the wettest soils on bottom land are used mainly for pasture or for timber and pasture. Several sand and gravel pits are along the valley. Some of the pits that are inactive have been partially reclaimed for hay, corn, or soybeans. Fertility, the content of organic matter, and the available water capacity in the major soils range from low to high. The main management needs are measures that help to control water erosion and flooding and maintain fertility.

6. Marna-Canisteo-Guckeen association

Nearly level and very gently sloping, poorly drained and somewhat poorly drained, silty and loamy soils that formed in glacial or lacustrine sediments and glacial till; on uplands

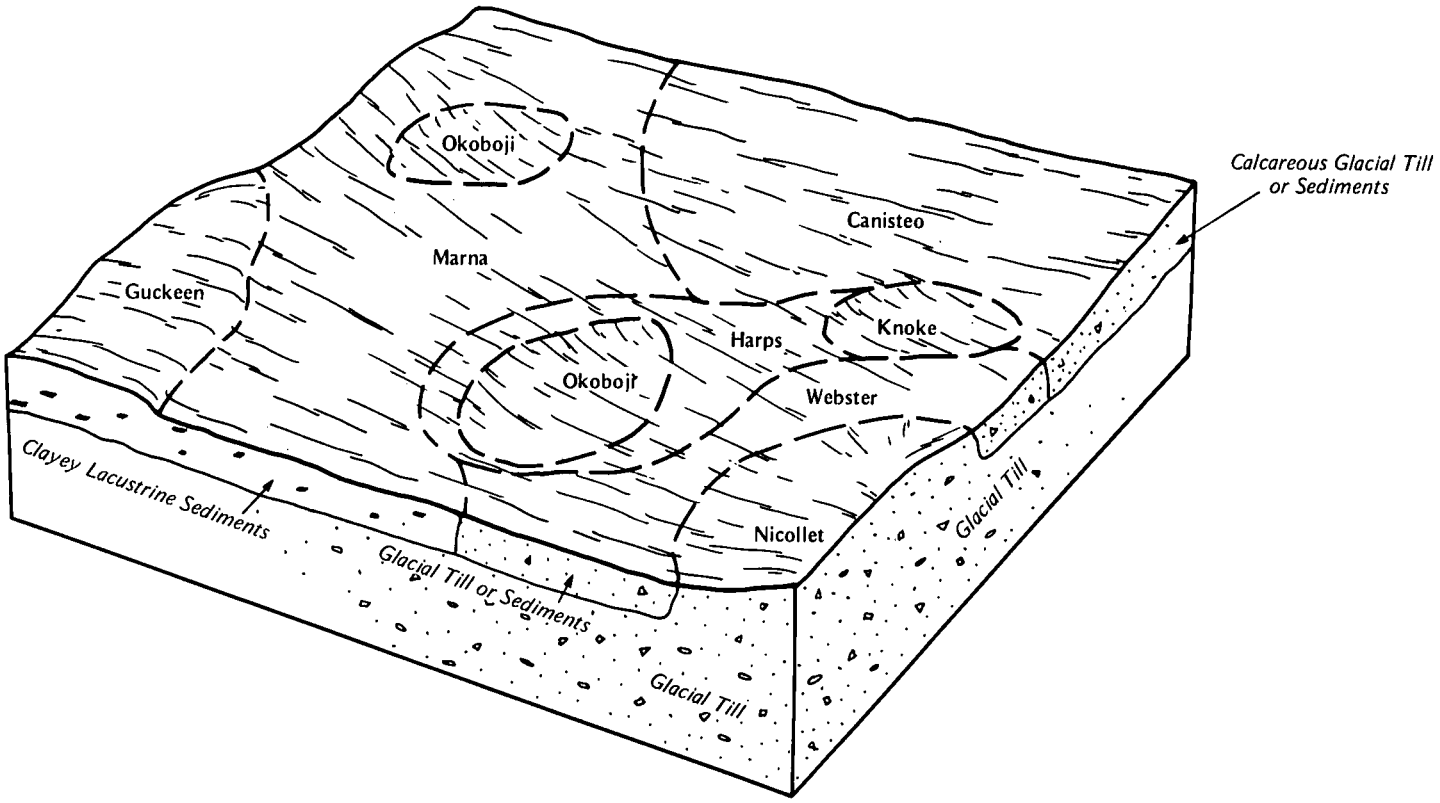

Figure 5.—Pattern of soils and parent material in the Marna-Canisteo-Guckeen association.

This association consists of soils on a relatively young till plain. The soils are nearly level in areas with slight depressions and gently undulating in other areas. The surface drainage pattern is not well defined, and runoff commonly accumulates in the low areas. Slopes range from 0 to 3 percent.

This association makes up about 3 percent of the county. It is about 29 percent Marna soils, 23 percent Canisteo soils, 10 percent Guckeen soils, and 38 percent soils of minor extent (fig. 5).

Marna and Canisteo soils are poorly drained and are nearly level. Canisteo soils are calcareous. Guckeen soils are somewhat poorly drained and are slightly higher on the landscape and more sloping than the Marna and Canisteo soils.

Typically, the surface layer of the Marna soils is black silty clay loam about 9 inches thick. The subsurface layer is about 13 inches of black silty clay loam and very dark gray clay. The subsoil is about 15 inches thick. The upper part is olive gray, mottled clay, and the lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is light brownish gray and light olive gray, mottled loam.

Typically, the surface layer of the Canisteo soils is black clay loam about 8 inches thick. The subsurface layer is clay loam about 11 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is mottled clay loam about 11 inches thick. The upper part is dark gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, mottled loam.

Typically, the surface layer of the Guckeen soils is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark grayish brown silty clay about 9 inches thick. The subsoil is about 26 inches thick. The upper part is dark grayish brown and grayish brown, mottled silty clay, and the lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam.

The minor soils in this association are Clarion, Harps, Knoke, Nicollet, Ocheyedan, Okoboji, and Webster soils. Clarion and Ocheyedan soils are well drained. Harps soils have a higher content of lime than the major soils. Knoke and Okoboji soils are in depressions. Nicollet soils have a lower content of clay than the Guckeen

soils. Webster soils have a lower content of clay than the Marna soils.

This association is used mainly for corn, soybeans, and hay. The content of organic matter and the available water capacity are high in the major soils. The main management needs are measures that improve drainage and that help to control wind erosion during dry winter or early spring months when no snow cover is on the ground.

7. Clarion-Calco-Wadena association

Nearly level to strongly sloping, well drained and poorly drained, loamy and silty soils that formed in glacial till, alluvium, and outwash sediments; on uplands, bottom land, and terraces

This association consists of soils on flood plains, terraces, and valley side slopes. The more gentle slopes are on valley floors, and the soils on valley side slopes are moderately sloping or strongly sloping. Slopes range from 0 to 14 percent.

This association makes up about 3 percent of the county. It is about 35 percent Clarion soils, 25 percent Calco soils, 10 percent Wadena soils, and 30 percent soils of minor extent.

Clarion soils are well drained and are on knolls and side slopes. Calco soils are poorly drained and are on bottom land. Wadena soils are well drained and are on terraces.

Typically, the surface layer of the Clarion soils is black loam about 9 inches thick. The subsurface layer is mixed black and very dark grayish brown loam about 5 inches thick. The subsoil is loam about 14 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Calco soils is calcareous, black silty clay loam about 8 inches thick. The subsurface layer is also calcareous, black silty clay loam. It is about 33 inches thick. The subsoil is dark grayish brown, mottled silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is light gray, mottled clay loam.

Typically, the surface layer of the Wadena soils is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark brown loam in the upper part, dark yellowish brown loam in the next part, and dark yellowish brown gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel.

The minor soils in this association are Canisteo, Coland, Dickman, Estherville, Knoke, Nicollet, Ocheyedan, Spillville, Storden, and Webster soils. Canisteo and Webster soils are poorly drained. Coland and Webster soils are not calcareous in the surface soil. Dickman soils are sandy. Estherville soils are somewhat excessively drained. Knoke soils are very poorly drained and are in depressions. Nicollet and Spillville soils are somewhat poorly drained. Ocheyedan soils formed in loamy and silty glacial sediments. The surface soil of Storden soils is thinner than that of the Clarion soils and is calcareous.

Most of this association is used for corn, soybeans, small grain, and hay, but the wettest areas are used for pasture or wildlife refuge. The content of organic matter and the available water capacity in the major soils range from low to high. The main management needs are measures that improve drainage in low areas and that help to control water erosion and wind erosion and maintain fertility in the more sloping areas.

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, Clarion loam, 2 to 5 percent slopes, is one of several phases in the Clarion 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 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. Coland-Spillville complex, 1 to 5 percent slopes, 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, 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 dominantly are 2 to 20 acres in size but range to more than 100 acres. They are generally somewhat elliptical.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam. It is about 26 inches thick. The subsoil is silty clay loam about 16 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The substratum to a depth of about 60 inches is gray and light gray, mottled silty clay loam. In some places the soil is olive gray or dark gray below a depth of 22 inches. In other places the surface layer is mucky silt loam or is noncalcareous.

Included with this soil in mapping are small areas of Harps soils. These soils are slightly higher on the landscape than the Knoke soil. Also, they have a much thinner, more calcareous surface soil. They make up about 10 percent of the unit.

The Knoke soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is very high. The content of organic matter is about 10 percent in the surface layer. The surface soil typically is mildly alkaline, and the soil is calcareous throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. Surface drains 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 high content of organic matter and clay reduces the effectiveness of applied herbicides. The high content of lime in the soil increases the possibility of herbicide damage to some crops and adversely affects the availability of plant nutrients. Soil structure tends to be weak and breaks down if the soil is cultivated when too wet. Puddling results from the breakdown of the soil structure. In some areas where soybeans are grown, applications of ferrous sulfate or other iron compounds are needed.

A cover of pasture plants or hay is helpful in the more frequently ponded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

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 needed. The species that can withstand the wetness 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. Areas dominantly are 2 to 10 acres in size but range to 60 acres. They are generally elliptical.

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 22 inches thick. The subsoil is mottled silty clay loam about 24 inches thick. The upper part is very dark gray, and the lower part is gray. The substratum to a depth of about 60 inches is gray, mottled silty clay loam. In some places it is dark gray or olive gray silty clay loam and is at a depth as shallow as 20 inches. In other places the surface layer is silty clay or clay loam or is slightly calcareous.

Included with this soil in mapping are some small areas of Harps soils, which are extremely calcareous. These soils are slightly higher on the landscape than the Okoboji soil. They make up about 10 percent of the unit.

The Okoboji soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is very high. The content of organic matter is about 10 percent in the surface layer. The surface soil typically is neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. Surface drains remove ponded water. Tile drains remove excess subsurface water. The high content of organic matter and clay reduces the effectiveness of applied herbicides. Special care generally is needed to maintain good tilth in the surface layer. Cultivating or grazing when the soil is too wet causes surface compaction and cloddiness.

A cover of pasture plants or hay is helpful in the more frequently ponded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

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.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on upland foot slopes and convex alluvial fans. Slopes generally are short. Areas are irregularly shaped or are long and narrow. Most are 2 to 10 acres in size, but a few are somewhat larger.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 21 inches thick. It grades from black to very dark grayish brown. The subsoil is more than 30 inches thick. The upper part is dark brown loam, the next part is brown clay loam, and the lower part is brown loam. In some places, the black or very dark grayish brown colors do not extend below a depth of 24 inches or the surface layer is sandy loam. In other places the lower part of the subsoil and the substratum are sandy loam. In some areas, there is no subsoil and the subsurface layer is very dark brown.

Included with this soil in mapping are small areas of soils that have stratified loamy sand and sand within a depth of 36 inches. These soils are in positions on the landscape similar to those of the Terril soil. Also included are small areas of the well drained Lester soils on the higher parts of the landscape. The subsurface layer of these soils is much thinner and lighter colored than that of the Terril soil, and the subsoil is clay loam. Included soils make up about 10 percent of the unit.

The Terril soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated, but some are pastured (fig. 6). This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas contour farming and

Figure 6.—Cultivated and pastured area of Terril loam, 2 to 5 percent slopes. The steeper Storden soils are on uplands in the background.

terracing are difficult because slopes are short and irregular. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. A cover of pasture plants or hay can be effective in controlling erosion if the pasture is not overgrazed.

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 IIe.

27C—Terril loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil generally is on foot slopes downslope from strongly sloping or very steep soils. It is also on alluvial fans, typically in long, narrow strips. Slopes generally are short. Areas are irregular in shape or are elongated. Most range from 2 to 10 acres in size, but a few are somewhat larger.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 19 inches thick. It grades from black to very dark grayish

brown. The subsoil is more than 30 inches thick. The upper part is dark brown loam, the next part is brown clay loam, and the lower part is brown loam. In some places, the black or very dark brown colors do not extend below a depth of 24 inches or the surface layer is sandy loam. In other places the lower part of the subsoil and the substratum are sandy loam.

Included with this soil in mapping are small areas of soils that have stratified loamy sand and sand within a depth of 36 inches. These soils are in positions on the landscape similar to those of the Terril soil. Also included are small areas of the well drained Lester and Storden soils. Lester soils are in the higher areas. The subsurface layer of these soils is much thinner and lighter colored than that of the Terril soil, and the subsoil is clay loam. Storden soils are calcareous and are in the higher, convex sloping areas. Included soils make up about 10 percent of the unit.

The Terril soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 5 percent in the surface layer. The soil typically is slightly acid or neutral throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated, but some are pastured. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas contour farming and terracing are difficult because slopes are short and irregular. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. A cover of pasture plants or hay is effective in controlling erosion if the pasture is not overgrazed.

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.

28B—Dickman fine sandy loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on uplands and terraces. Areas range from 2 to 30 acres in size. They are irregularly shaped.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 6 inches thick. The subsoil is about 35 inches thick. The upper part is brown loamy sand, the next part is dark yellowish brown loamy sand, and the lower part is brown sand. The substratum to a depth of about 60 inches is variegated brown and light yellowish brown sand and gravel. In some places the surface layer is eroded, is less than 8 inches thick, and is mixed with streaks and pockets of brown loamy sand subsoil material. In other places, slopes are less than 2 percent and the dark surface soil is as much as 26 inches thick. In some areas the surface layer contains gravel. In other areas the upper part of the subsoil is fine sandy loam.

Included with this soil in mapping are small areas of Clarion soils. These soils typically are loam throughout. They are in the less convex sloping areas along the edges of the unit. They make up about 10 percent of the unit.

The Dickman soil is moderately rapidly permeable in the upper part and rapidly permeable in the lower part. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 2 to 3 percent in the surface layer. Typically, the surface soil is medium acid. The subsoil generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. It is droughty, and productivity is limited greatly during dry periods. If cultivated crops are grown, erosion by wind and water is a hazard. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, destroys the vegetative cover and thus increases the erosion hazard. Proper stocking rates and pasture rotation help to keep the pasture and soil in good condition.

The land capability classification is IIIe.

28C2—Dickman fine sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on uplands and terraces. Areas range from 2 to 20 acres in size. They are irregularly shaped.

Typically, the surface layer is dark brown fine sandy loam about 8 inches thick. It is mixed with pockets of brown loamy sand subsoil material. The subsoil is about 30 inches thick. The upper part is brown grading to dark yellowish brown loamy sand, and the lower part is brown sand. The substratum to a depth of about 60 inches is variegated brown and light yellowish brown sand. In some places the surface layer is uneroded, is very dark brown, and is more than 8 inches thick. In other places it contains gravel. In some areas the upper part of the subsoil is fine sandy loam.

Included with this soil in mapping are small areas of Clarion soils. These soils typically are loam throughout. They are in the less convex sloping areas along the

edges of the unit. They make up about 10 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. It is droughty, and productivity is limited greatly during dry periods. The surface layer of this eroded Dickman soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Dickman soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, the hazard of erosion by wind and water is increased. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, destroys the vegetative cover and thus increases the erosion hazard. Proper stocking rates and pasture rotation help to keep the pasture and soil in good condition.

The land capability classification is IVe.

34—Estherville sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on terraces. Areas generally are 2 to 10 acres in size. They are irregularly shaped.

Typically, the surface layer is very dark gray and very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown sandy loam about 3 inches thick. The subsoil is about 10 inches thick. The upper part is brown and dark brown loam. The lower part is dark yellowish brown and brown loamy sand and gravel. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel. In some areas it is noncalcareous to a depth of more than 36 inches. In other areas the surface layer is loam or is gravelly.

Permeability is moderately rapid in the upper part of this soil and rapid in the lower part of the subsoil and the substratum. Surface runoff is slow or medium. Available water capacity is low. The content of organic matter is about 2 to 3 percent in the surface layer. The surface soil and the subsoil typically are neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most of the larger areas are used for hay. Smaller areas are commonly cultivated along with the more productive surrounding soils. Some areas are used for wildlife habitat. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture. It is droughty because of the sandy and gravelly substratum. Also, wind erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface conserves moisture and helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility and conserves moisture. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay can be effective in controlling erosion. Overgrazing, however, destroys the vegetative cover and thus increases the erosion hazard. Proper stocking rates help to keep the pasture and soil in good condition.

If this soil is used for windbreaks, ornamental plantings, or plantings for wildlife, drought is a severe hazard. Also, erosion is a slight hazard before the trees and shrubs are established. Only the species that can grow well in a droughty soil should be selected for planting. A permanent plant cover helps to control erosion.

The land capability classification is IIIs.

34B—Estherville sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on knolls and side slopes on terraces and uplands. Slopes typically are short and convex. Areas generally are 3 to 40 acres in size. They are irregularly shaped.

Typically, the surface layer is very dark gray and very dark grayish brown sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown sandy loam about 3 inches thick. The subsoil is about 9 inches thick. The upper part is brown and dark brown loam. The lower part is dark yellowish brown and brown loamy sand and gravel. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel. In some places it is noncalcareous to a depth of more than 36 inches. In other places the surface layer is loam or is calcareous and very gravelly.

Included with this soil in mapping are small areas of Storden and Wadena soils. Storden soils are calcareous loam throughout. They are in positions on the landscape similar to those of the Estherville soil. Wadena soils are deeper to sand and gravel than the Estherville soil and are more productive. Also, they are less sloping and are in the smoother areas. Included soils make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the lower part of the subsoil and the substratum. Surface runoff is slow or

medium. Available water capacity is low. The content of organic matter is about 2 to 3 percent in the surface layer. The surface soil and the subsoil typically are neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most of the larger areas are used for hay or pasture. The smaller areas are commonly cultivated along with the more productive surrounding soils. Some areas are used for wildlife habitat. This soil is poorly suited to corn, soybeans, and small grain. It is suited to grasses and legumes for hay and pasture. It is droughty because of the sandy and gravelly substratum. Also, wind erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface conserves moisture and helps to prevent excessive soil loss. The soil is not suitable for terracing because sand and gravel are too close to the surface. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility and conserves moisture. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay can be effective in controlling erosion. Overgrazing, however, destroys the vegetative cover and thus increases the erosion hazard. Proper stocking rates and pasture rotation help to keep the pasture and soil in good condition.

If this soil is used for windbreaks, ornamental plantings, or plantings for wildlife, drought is a severe hazard. Also, erosion is a slight hazard before the trees and shrubs are established. Only the species that can grow well in a droughty soil should be selected for planting. A permanent plant cover helps to control erosion.

The land capability classification is IIIe.

34C2—Estherville sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, somewhat excessively drained soil is on knolls and convex slopes on terraces and uplands. Slopes typically are short. Areas generally are 2 to 5 acres in size. They are irregularly shaped.

Typically, the surface layer is very dark grayish brown sandy loam about 7 inches thick. It is mixed with pockets of dark yellowish brown subsoil material. The subsoil is about 8 inches thick. It is dark yellowish brown and very friable. It is sandy loam in the upper part and loamy sand and gravel in the lower part. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel. In some areas it is noncalcareous to a depth of more than 36 inches. In other areas the surface layer is calcareous and very gravelly or is uneroded and 8 inches or more thick.

Included with this soil in mapping are small areas of Salida and Storden soils, which are calcareous in the surface layer. Storden soils contain much less sand and gravel than the Estherville soil. Included soils are in the more convex sloping areas. They make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the substratum. Surface runoff is slow or medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are used as wildlife habitat. Some are cultivated along with the more productive surrounding soils. Some are used for pasture. This soil is poorly suited to corn, soybeans, and small grain. It is moderately suited to grasses and legumes for hay and pasture. It is subject to wind erosion. Also, it is droughty because of the sandy and gravelly substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface conserves moisture and helps to prevent excessive soil loss. The soil is not suitable for terracing because sand and gravel are too close to the surface. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay can be effective in controlling erosion. Overgrazing, however, destroys the vegetative cover and thus increases the erosion hazard. Proper stocking rates and pasture rotation help to keep the pasture and soil in good condition.

Drought is a severe hazard if this soil is used for the trees and shrubs grown as windbreaks, ornamental plantings, or plantings for wildlife. Only the species that can grow well in a droughty soil should be selected for planting. A permanent plant cover helps to control erosion.

The land capability classification is IIIe.

34D2—Estherville sandy loam, 9 to 16 percent slopes, moderately eroded. This strongly sloping and moderately steep, somewhat excessively drained soil is on knolls and convex side slopes on terraces and uplands. Slopes typically are short. Areas generally are 2 to 5 acres in size. They are irregularly shaped.

Typically, the surface layer is very dark grayish brown sandy loam about 7 inches thick. It is mixed with pockets of dark yellowish brown subsoil material. The subsoil is about 8 inches thick. It is dark yellowish brown and very friable. It is sandy loam in the upper part and loamy sand and gravel in the lower part. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel. In some areas it is noncalcareous to a depth of more than 36 inches. In other areas it is dominantly loamy sand and sand in which the content of gravel is less than 10 percent. In some places slopes are 15 to

18 percent. In other places the surface layer is calcareous and very gravelly.

Included with this soil in mapping are small areas of Salida and Storden soils, which are calcareous in the surface layer. Storden soils contain much less sand and gravel than the Estherville soil. Included soils are in the more convex sloping areas. They make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the substratum. Surface runoff is slow or medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are used as wildlife habitat. A few are cultivated along with the more productive surrounding soils. Some are used for pasture. This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind erosion. Also, it is droughty because of the sandy and gravelly substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface conserves moisture and helps to prevent excessive soil loss. The soil is not suitable for terracing because sand and gravel are too close to the surface. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

This soil is moderately suited to grasses and legumes for hay and pasture. Overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion.

Drought is a severe hazard if this soil is used for the trees and shrubs grown as windbreaks, ornamental plantings, or plantings for wildlife. Only the species that can grow well in a droughty soil should be selected for planting. A permanent plant cover helps to control erosion.

The land capability classification is IVe.

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. They are irregularly shaped or are somewhat elliptical.

Typically, the surface layer is black mucky silt loam about 10 inches thick. The subsurface layer is black mucky silty clay loam about 15 inches thick. The subsoil is black silty clay loam about 28 inches thick. The substratum to a depth of about 60 inches is very dark gray and dark gray, mottled silty clay loam. In some places the surface layer is silty clay loam. In other places it is noncalcareous.

Included with this soil in mapping are small areas of Harps soils. These soils are slightly higher on the landscape than the Knoke soil. Also, their surface layer is thinner and more calcareous. Included soils make up about 10 percent of the unit.

The Knoke soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is very high. The content of organic matter is about 15 percent in the surface layer. The surface soil typically is mildly alkaline. The soil is calcareous throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. 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 commonly is evidenced by stunted soybeans that have yellow leaves. The high content of lime also increases the possibility of herbicide damage to crops. Applications of phosphorus and potassium fertilizer are needed. In some areas applications of ferrous sulfate or other iron compounds also are needed. Cultivating when the soil is wet hastens the breakdown of the soil structure.

A cover of pasture plants or hay is helpful in the more frequently ponded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

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 needed. The species that can withstand the wetness 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 loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in areas between knolls and swales on uplands. Areas are irregularly shaped. They generally are 2 to 25 acres in size, but some are 40 acres or more.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 7 inches thick. The subsoil is clay loam about 14 inches thick. It is dark grayish brown in the upper part and mottled grayish brown and dark grayish brown in the lower part. The substratum to a depth of about 60 inches is light brownish gray, mottled loam. In some places the surface layer is silty clay loam. In other places the substratum is silt loam. In some areas the dark surface soil extends to a depth of more than 24 inches.

Figure 7.—Soybeans on Nicollet loam, 1 to 3 percent slopes.

Included with this soil in mapping are small areas of Clarion, Okoboji, and Webster soils. The well drained Clarion soils are higher on the landscape than the Nicollet soil. The very poorly drained Okoboji and poorly drained Webster soils are lower on the landscape. Included soils make up about 15 percent of the unit. The Nicollet soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid. 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, small grain, and grasses and legumes. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Cultivating or grazing when the soil is too wet causes surface compaction. Wind erosion is a hazard if large areas of the soil are plowed in the fall. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and increases the runoff rate. Proper stocking rates and controlled grazing during wet periods help to keep the pasture in good condition.

The seasonal high water table is a moderate limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. It generally can be overcome, however, by selecting the 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 are 2 to 20 acres in size, but some are somewhat larger.

Typically, the surface layer is mixed very dark grayish brown, brown, and yellowish brown, calcareous loam about 8 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part, light olive brown and mottled in the next part, and mottled yellowish brown and light olive brown in the lower part. Lime accumulations are throughout the soil. In some places the surface layer is very dark grayish brown. In other places the slope is less than 5 percent.

Included with this soil in mapping are small areas of Clarion, Dickman, and Salida soils. Clarion soils are not calcareous. They are in the less sloping, lower areas. Dickman soils are in convex sloping areas. They are much more sandy than the Storden soil. Salida soils are on small scattered knobs. They contain more sand and gravel throughout than the Storden soil. Included soils make up about 15 percent of the unit.

The Storden soil is moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The soil typically is moderately alkaline and calcareous throughout. Below the surface layer, the supply of available phosphorus and potassium generally is very low.

Most areas are cultivated along with the more productive surrounding soils. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain. Erosion is a severe hazard. A conservation tillage system that leaves a protective amount of 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. The high content of lime in the soil increases the possibility of herbicide damage to some crops. Applications of additional phosphorus and potassium fertilizer are sometimes needed because of the high content of lime. In some areas where soybeans are grown, applications of iron compounds are needed. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

This soil is suited to grasses and legumes for hay and pasture. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, causes surface compaction and increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in a more productive 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.

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 are 3 to 20 acres in size, but a few, mainly along the major streams, are 50 acres or more.

Typically, the surface layer is very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part, light olive brown and mottled in the next part, and mottled yellowish brown and light olive brown in the lower part. Lime accumulations are throughout the soil. In places the surface layer is very dark grayish brown.

Included with this soil in mapping are small areas of Clarion, Dickman, and Salida soils. Clarion soils are not calcareous. They are in the less sloping areas. Dickman soils are in convex sloping areas. They are much more sandy than the Storden soil. Salida soils are on small scattered knobs. They contain more sand and gravel throughout than the Storden soil. Included soils make up about 15 percent of the unit.

The Storden soil is moderately permeable. Surface 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 soil typically is moderately alkaline and calcareous throughout. Below the surface layer, the supply of available phosphorus and potassium generally is very low.

Some areas are cultivated along with the more productive surrounding soils. Some are used for hay. 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 conservation tillage system that leaves a protective amount of 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. The high content of lime in the soil increases the possibility of herbicide damage to some crops and adversely affects the availability of plant nutrients. In some areas where soybeans are grown, applications of iron compounds are needed. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

This soil is suited to grasses and legumes for hay and pasture. The pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

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.

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 5 to 20 acres in size, but a few, mainly along the major streams, are 25 acres or more.

Typically, the surface layer is very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part, light olive brown and mottled in the next part, and mottled yellowish brown and light olive brown in the lower part. Lime accumulations are throughout the soil. In some places the surface layer is very dark grayish brown. In other places it is sandy loam.

Included with this soil in mapping are small areas of Clarion, Dickman, and Salida soils. Clarion soils are not calcareous. They are in the less sloping areas. Dickman soils are in the convex sloping areas. They are much more sandy than the Storden soil. Salida soils are on small scattered knobs. They contain more sand and gravel throughout than the Storden soil. Included soils make up about 15 percent of the unit.

The Storden soil is moderately permeable. Surface 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 soil typically is moderately alkaline and calcareous throughout. Below the surface layer, the supply of available phosphorus and potassium generally is very low.

Most areas are used for hay or pasture. A few are used for cultivated crops. Because tilling the moderately steep slopes is rather difficult, this soil is poorly suited to corn and soybeans. It 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 rapidly. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. In many areas contour farming and terracing are difficult because the slopes are too steep and too short. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer. The high content of lime in the soil increases the possibility of herbicide damage to some crops and adversely affects the availability of plant nutrients.

This soil is suited to grasses and legumes for hay and pasture. The pastures are commonly renovated by planting a row crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

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 IVe.

62F—Storden loam, 18 to 25 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 2 to 10 acres in size, but a few along the major streams are 25 acres or more.

Typically, the surface layer is mixed very dark grayish brown and brown, calcareous loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown and yellowish brown and mottled in the lower part. Lime accumulations are throughout the soil. In places the surface layer is black and very dark brown.

Included with this soil in mapping are small areas of Clarion, Dickman, Lester, Salida, and Terril soils. Clarion, Lester, and Terril soils are not calcareous and are more fertile than the Storden soil. Also, they are in the less sloping areas. Lester soils are on the north- and east-facing slopes in some areas. Dickman soils are in scattered areas along the sides of valleys. They contain much more sand than the Storden soil. Salida soils are on the higher parts of slopes and on knobs. They contain more sand and gravel than the Storden soil. Included soils make up about 15 percent of the unit.

The Storden soil is moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the

surface layer. The soil typically is moderately alkaline and calcareous throughout. Below the surface layer, the supply of available phosphorus and potassium generally is very low.

Most areas are used for pasture or hay (fig. 8). Because the slope is steep and erosion is a severe hazard, this soil is generally unsuitable for cultivated crops. It is better suited to grasses and legumes for hay and pasture, but it is too erodible for unlimited grazing.

Operating farm machinery is hazardous because of the steep slope. In the areas where farm machinery can be used, fertilizer can be applied and pastures renovated. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in a more productive 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. Planting is difficult because of the steep slope.

The land capability classification is VIe.

62G—Storden loam, 25 to 40 percent slopes. This very steep, well drained, calcareous soil is on convex side slopes along streams. Slopes are short. Areas are long and narrow or are irregularly shaped. Most are 2 to 10 acres in size, but a few are 25 acres or more.

Typically, the surface layer is mixed very dark grayish brown and brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown and yellowish brown and mottled in the lower part. It has lime accumulations throughout. In places the surface layer is black and very dark brown.

Included with this soil in mapping are small areas of Dickman, Lester, and Salida soils. Dickman soils are in scattered areas along the sides of valleys. They contain more sand than the Storden soil. Lester soils are on the north- and east-facing slopes. They are not calcareous.

Figure 8.—A pastured area of Storden loam, 18 to 25 percent slopes.

Salida soils are on the higher parts of slopes and on knobs. They contain more sand and gravel than the Storden soil. Included soils make up about 15 percent of the unit.

The Storden soil is moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The soil typically is moderately alkaline and calcareous throughout. Below the surface layer, the supply of available phosphorus and potassium generally is very low.

Most areas are used for pasture. This soil is generally unsuitable for cultivated crops or unlimited grazing because it is very steep and highly susceptible to erosion. It is poorly suited to hay because the slopes generally are too steep for the use of farm machinery.

This soil is poorly suited to pasture because of the very steep slopes. A cover of pasture plants can be effective in controlling erosion. Overgrazing, however, causes surface compaction and increases the runoff rate and the susceptibility to erosion. Proper stocking rates and controlled grazing help to keep the pasture and soil in a more productive condition.

Trees or shrubs can be planted by hand but generally cannot be planted by machine because of the equipment limitation.

The land capability classification is VIIe.

90—Okoboji mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions, generally in the middle of large depressions. It is subject to ponding. Areas are generally somewhat round, but some are irregularly shaped. Most are 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 17 inches thick. It is black mucky silty clay loam in the upper part and black silty clay loam in the lower part. The subsoil is mottled silty clay loam about 23 inches thick. It is very dark gray in the upper part and grayish brown and olive gray in the lower part. The substratum to a depth of about 60 inches is gray, mottled silty clay loam. In some places the surface layer is silty clay loam. In other places the soil is slightly calcareous.

Included with this soil in mapping are small areas of the poorly drained, highly calcareous Harps soils. These soils are in the slightly higher areas. They make up about 10 percent of the unit.

The Okoboji soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow to ponded. Available water capacity is very high. The content of organic matter is about 15 percent in the surface layer. The surface soil typically is neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. The surface layer puddles easily in areas where it is tilled or grazed when too wet. Some areas are used for pasture or hay. Restricted use during wet periods helps to keep the pasture in good condition.

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.

95—Harps loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in plane or slightly convex areas, typically on the rim of the larger upland depressions. Areas generally are 2 to 10 acres in size. They are generally somewhat elliptical, but some are irregularly shaped.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The subsurface layer is loam about 9 inches thick. It is black in the upper part and mixed dark gray and black in the lower part. The subsoil is mottled loam about 25 inches thick. The upper part is gray, and the lower part is light olive gray. The substratum to a depth of about 60 inches is light olive gray, mottled loam. In places the soil is only slightly calcareous.

Included with this soil in mapping are a few small areas of the very poorly drained, noncalcareous Okoboji soils in small depressions. These soils make up about 15 percent of the unit.

The Harps soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil is mildly alkaline and is calcareous throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. Tile drains remove excess subsurface water. Cultivating when the soil is too wet causes surface compaction and cloddiness. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. The high content of lime in the soil increases the possibility of herbicide damage to crops and adversely affects the availability of plant nutrients. In

some areas where soybeans are grown, applications of iron compounds are needed.

A cover of pasture plants or hay is effective in controlling wind erosion. Restricted use during wet periods helps to keep the pasture in good condition.

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 well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

107—Webster clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly concave areas on uplands. Areas are irregularly shaped. Most are 3 to 40 acres in size, but some are larger than 100 acres.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is mottled clay loam about 15 inches thick. The upper part is very dark gray, and the lower part is dark gray and olive gray. The substratum to a depth of about 60 inches is olive gray, mottled loam. In places the black surface soil extends to a depth of more than 24 inches.

Included with this soil in mapping are small areas of Nicollet and Okoboji soils. Nicollet soils are in the slightly higher areas and are somewhat poorly drained. Okoboji soils have a higher content of clay than the Webster soil. They are in low areas that are subject to ponding. Included soils make up about 15 percent of the unit.

The Webster soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 6 to 7 percent in the surface layer. This layer typically is neutral. The subsoil has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, small grain, and grasses and legumes. 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. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer (fig. 9).

In areas where this soil is used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 IIw.

108—Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil dominantly is on slightly convex slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on the terraces are 3 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark brown loam in the upper part, dark yellowish brown loam in the next part, and dark yellowish brown gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is multicolored, calcareous sand and gravel (fig. 10). The layers of sand and gravel generally are thicker on the terraces than on the uplands. In some areas, especially those along the valley of the Raccoon River, the substratum is fine sand. In a few small areas the depth to sand and gravel is more than 32 inches. In places the surface layer and subsoil are sandy loam.

Included with this soil in mapping are small areas of Cylinder and Estherville soils. Cylinder soils are somewhat poorly drained and are in the lower areas. Estherville soils are somewhat excessively drained and are on the slightly higher knobs and ridges. Included soils make up about 15 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil typically is neutral. 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. It is suited to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing, however, causes surface compaction and results in lower production. Proper stocking rates and controlled grazing help to keep the pasture and soil in good condition.

Figure 9.—Soybean crop residue on the surface of Webster clay loam, 0 to 2 percent slopes.

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 additional 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 dominantly is on convex slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on the terraces are 2 to 20 acres in size and those on uplands 2 to 3 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark brown loam in the upper part, brown and dark yellowish brown loam in the next part, and dark yellowish brown gravelly loamy coarse sand in the lower part. The substratum to a depth of about 60 inches is calcareous sand and gravel. It is yellowish brown and brown in the upper part and multicolored in the lower part. The layers of sand and gravel generally are thicker on the terraces than on the uplands. In some areas, especially those along the valley of the Raccoon River, the substratum is fine sand. In a few small areas the depth to sand and gravel is more than 32 inches. In places the surface layer and subsoil are sandy loam.

Included with this soil in mapping are small areas of Cylinder and Estherville soils. Cylinder soils are somewhat poorly drained and are in the lower areas. Estherville soils are somewhat excessively drained and are on the slightly higher knobs and ridges. Included soils make up about 15 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil typically is neutral. 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. It is suited to grasses and legumes for hay and pasture. If cultivated

Figure 10.—Profile of Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. Depth is marked in feet.

crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and results in lower production. Proper stocking rates and controlled grazing help to keep the pasture and soil in good condition.

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. A permanent plant cover or surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or additional water should be applied if irrigation is practical.

The land capability classification is IIe.

108C2—Wadena loam, 24 to 32 inches to sand and gravel, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil dominantly is on convex slopes on the more sloping parts of terraces but in a few areas is on uplands near stream valleys. Generally, areas are 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is about 7 inches thick. It is very dark grayish brown loam mixed with some dark brown subsoil material. The subsoil is about 18 inches thick. It is dark brown and brown loam in the upper part and dark yellowish brown loamy coarse sand in the lower few inches. The substratum to a depth of about 60 inches is variegated dark yellowish brown to pale brown, calcareous sand and gravel. In some areas the depth to calcareous gravelly loamy coarse sand is more than 36 inches. In other areas the surface layer and the subsoil are sandy loam or sandy clay loam. In places the slopes range from 9 to 14 percent.

Included with this soil in mapping are small areas of the somewhat excessively drained Estherville soils. These soils are in the more convex sloping areas. They make up about 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are cultivated, and some are pastured. This soil is poorly suited to corn and soybeans. It is moderately suited to 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 conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss. Slopes are generally too short for terracing. If terraces are built, the cuts should not expose the sand and gravel substratum and as much topsoil as possible should be returned to the site. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

In areas where this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in a productive condition.

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. A permanent plant cover or surface mulch helps to control erosion and conserves moisture. The species that can withstand the droughtiness should be selected for planting, or additional water should be applied if irrigation is practical.

The land capability classification is IIIe.

135—Coland silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land and low terraces. It is subject to flooding. Typically, areas range from 10 to 50 acres in size. They are long and narrow.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black clay loam about 28 inches thick. It is mottled in the lower part. The next 8 inches is very dark gray, mottled clay loam. The substratum to a depth of about 60 inches is mixed light brownish gray and very dark gray, mottled loam (fig. 11). In some places the dark surface soil is less than 36 inches thick and overlies a dark gray and gray substratum. In other places the surface soil is calcareous or has light colored strata. In some areas the surface layer is lighter colored, more sandy overwash more than 8 inches thick. In other small areas, the substratum is very dark brown and the soil is better drained.

Included with this soil in mapping are small areas of Biscay soils. These soils have sand and gravel at a depth of 40 inches or less. They are generally at the slightly higher elevations. They make up about 5 percent of the unit.

The Coland soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer. The surface soil typically is neutral. Below the surface layer, the supply of available phosphorus is medium and the supply of available potassium generally is very low.

Figure 11.—Profile of Coland silty clay loam, 0 to 2 percent slopes, exposed to a depth of about 60 inches along the bank of an intermittent stream.

Most areas are cultivated. Some areas that are not protected from flooding or are isolated by a meandering stream are used for pasture (fig. 12). This soil is well suited to corn, soybeans, small grain, and grasses and legumes if it is adequately drained and if flooding is controlled. Cultivating cropland or grazing pasture when the soil is too wet causes surface compaction and cloddiness. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to control wind erosion and prevent surface crusting.

Figure 12.—Intermittent stream in a pastured area of Coland silty clay loam, 0 to 2 percent slopes.

Water-tolerant grasses and legumes are the best suited pasture plants. A cover of pasture plants or hay is helpful in the more frequently flooded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and the soil surface in a productive condition.

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 loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls in the uplands. Areas generally are 3 to 25 acres in size and are long and narrow, but some are as much as 80 acres or more and are irregularly shaped.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is mixed black and very dark grayish brown loam about 5 inches thick. The subsoil is loam about 14 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam (fig. 13). In some areas plowing has mixed part of the dark brown subsoil with the surface layer. In other small areas the soil has a silty substratum.

Included with this soil in mapping are some areas of Nicollet, Storden, and Wadena soils. Also included are some small areas of sandy or gravelly soils on knobs. The somewhat poorly drained Nicollet soils are at the lower elevations. The calcareous Storden and Wadena soils are on the higher, more convex slopes. Wadena soils are underlain by sand and gravel. Included soils make up less than 10 percent of the unit.

The Clarion soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

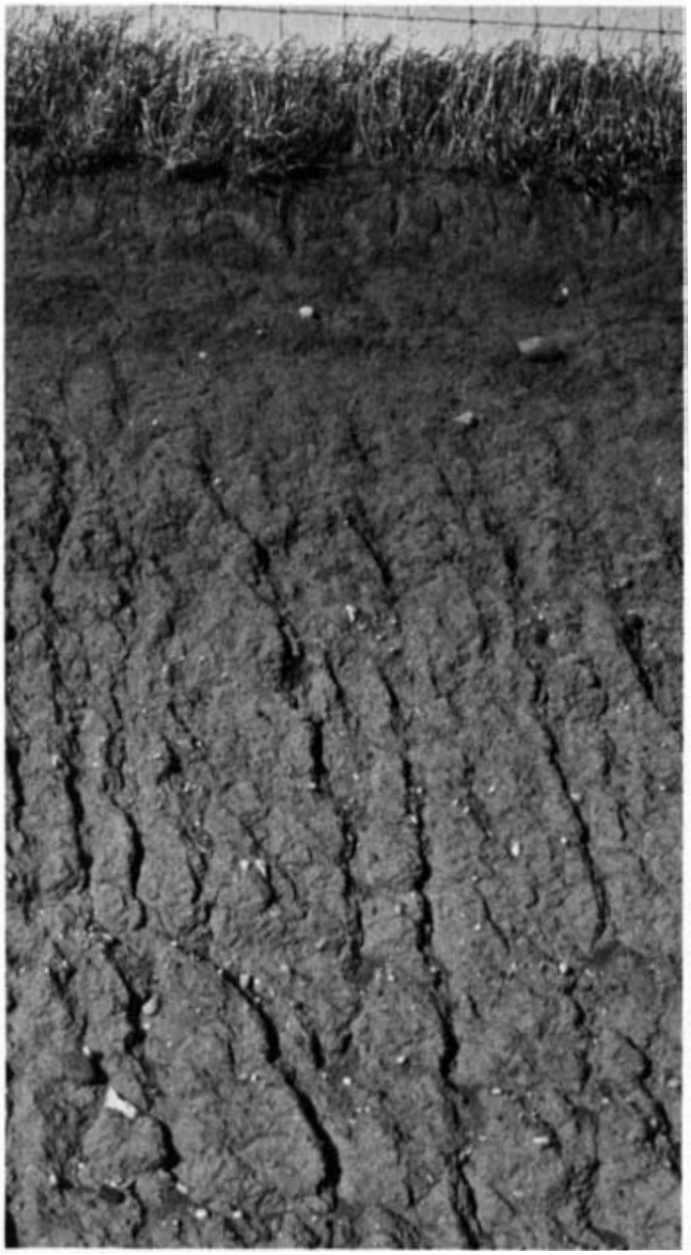

Figure 13.—Profile of Clarion loam, 2 to 5 percent slopes.

Most areas are cultivated. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Leaving a protective amount of crop residue on the surface or regularly adding other organic material, such as livestock manure, helps to control erosion and prevent surface crusting and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIe.

138B2—Clarion loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on knolls in the uplands. Slopes typically are short. Areas range from 5 to more than 50 acres in size and are irregularly shaped.

Typically, the surface layer is mixed black, very dark grayish brown, and brown loam about 8 inches thick. It is mixed with pockets and streaks of brown subsoil material. The subsoil is loam about 13 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the surface layer is sandy loam.

Included with this soil in mapping are small areas of Nicollet, Storden, and Wadena soils. The somewhat poorly drained Nicollet soils are in the slightly lower areas. The calcareous Storden and Wadena soils are in the more convex sloping areas. Wadena soils are underlain by sand and gravel. Included soils make up about 10 percent of the unit.

The Clarion soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. 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, small grain, and grasses and legumes. The surface layer of this eroded Clarion soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Clarion soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Leaving a protective amount of

crop residue on the surface or regularly adding other organic material, such as livestock manure, helps to control erosion and prevent surface crusting and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and increases the runoff rate and the susceptibility to erosion. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 IIe.

138C—Clarion 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 are 2 to 15 acres in size, but some near streams are somewhat larger.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is mixed black and very dark grayish brown loam about 4 inches thick. The subsoil is loam about 14 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some concave areas near the base of the slopes, the dark surface layer is as much as 24 inches thick. In other areas the substratum has lenses of loamy sand.

Included with this soil in mapping are small areas of the sandy Dickman soils and small areas of the calcareous Storden soils. These soils are in the more convex sloping areas. They make up about 10 percent of the unit.

The Clarion soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid or neutral. 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, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and increases the runoff rate and the susceptibility to erosion. Proper stocking rates and controlled grazing help to keep the pasture and soil in good condition.

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 loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls in the uplands. Slopes typically are short. Areas range from 5 to 80 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown and brown loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is loam about 12 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places the surface layer is sandy loam. In other places the soil is uneroded.

Included with this soil in mapping are small areas of the sandy Dickman, gravelly Salida, and calcareous Storden soils. These soils are in the more convex sloping areas. They make up about 10 percent of the unit.

The Clarion soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. The surface layer of this eroded Clarion soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Clarion soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. Contour farming and terracing are practical in some areas (fig. 14) but are not feasible in undulating areas where slopes are short. Returning crop residue to

Figure 14.—A recently constructed terrace with a tile inlet on Clarion loam, 5 to 9 percent slopes, moderately eroded.

the soil or regularly adding other organic material, such as livestock manure, helps to control erosion and prevent surface crusting and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay helps to control erosion. Overgrazing, however, results in surface compaction and a poor stand and increases the runoff rate.

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.

138D2—Clarion 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. Typically, they are 2 to 10 acres in size, but a few are larger.

Typically, the surface layer is very dark grayish brown, dark grayish brown, and brown loam about 7 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is loam about 11 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places the surface layer is sandy loam. In other places the soil is uneroded.

Included with this soil in mapping are small areas of the sandy Dickman, gravelly Salida, and calcareous Storden soils. These soils are in the more convex sloping areas. They make up about 10 percent of the unit.

The Clarion soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the

surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are cultivated. Some are used for pasture. This soil is moderately suited to corn and soybeans. It is well suited to small grain and to grasses and legumes for hay and pasture. The surface layer of this eroded Clarion soil has a lower organic matter content and is more easily eroded than the surface layer of uneroded Clarion soils. As a result, more fertilizer and more intensive management are needed. Erosion is a severe hazard if cultivated crops are grown. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer. Farm machinery can be used to renovate pastures as needed. Overgrazing the pasture results in a poor plant cover and increases the runoff rate and the susceptibility to erosion.

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.

168G—Hayden loam, 25 to 40 percent slopes. This very steep, well drained soil is on ridgetops in uplands. It is in timbered areas above the valleys of the larger streams, especially those in the southern part of the county. Areas range from 5 to more than 80 acres in size.

Typically, the surface layer is very dark grayish brown loam about 3 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is about 25 inches thick. The upper part is dark yellowish brown clay loam, and the lower part is yellowish brown, mottled loam. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are small areas of Dickman and Storden soils. Dickman soils are sandy. They are in the higher, less sloping areas. Storden soils are in the more convex, steeper sloping areas. They are calcareous throughout. Included soils make up about 15 percent of the unit.

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

Most areas are used for timbered pasture. This soil is not suited to cultivation. It is suited to grasses and legumes for pasture in areas where the timber is thinned or cleared. Overgrazing the pasture increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation and erosion are controlled. Competing vegetation can be held in check by adequate site preparation, by prescribed burning, or by spraying, cutting, or girdling. The erosion hazard is severe in areas where the soil is not protected. An adequate plant cover is needed.

The land capability classification is VIIe.

202—Cylinder 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 some areas are slightly concave. Areas are 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 10 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is about 10 inches thick. It is dark grayish brown, mottled loam in the upper part and grayish brown and light olive brown loamy sand and gravel in the lower part. The substratum to a depth of about 60 inches is variegated brown and light brownish gray, calcareous sand and gravel. In some areas the substratum is loamy sand or sand in which the content of gravel is less than 5 percent. In other areas the sand and gravel are underlain by medium textured soil material at a depth of 40 to 60 inches. In places the depth to sand and gravel is less than 18 inches.

Included with this soil in mapping are small areas of the poorly drained Biscay and Mayer soils. These soils are in the low areas. They make up about 15 percent of the unit.

The Cylinder soil is moderately permeable in the upper part and very rapidly permeable in the lower part of the subsoil and in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is low or moderate. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid or neutral. 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. It is suited 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 are not needed because of the droughtiness during most of the

growing season. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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

The land capability classification is IIs.

203—Cylinder 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 concave but in places are slightly convex. Areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is loam about 12 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is about 17 inches thick. It is dark grayish brown, mottled loam in the upper part and grayish brown and light olive brown loamy sand and gravel in the lower part. The substratum to a depth of about 60 inches is variegated brown and light brownish gray, calcareous sand and gravel. In some areas the substratum is loamy sand or sand in which the content of gravel is less than 5 percent. In other areas the sand and gravel are underlain by medium textured soil material at a depth of 50 to 60 inches.

Included with this soil in mapping are a few small areas of the poorly drained Biscay and Mayer and well drained Wadena soils. Biscay and Mayer soils are in the low areas. Wadena soils are in the higher areas. Included soils make up about 15 percent of the unit.

The Cylinder soil is moderately permeable in the upper part and very rapidly permeable in the lower part of the subsoil and in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid or neutral. 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, small grain, and grasses and legumes. It has a high water table during wet periods but becomes droughty after fairly brief dry periods. Tile drains generally are not needed because of the droughtiness during much of the growing season. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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

The land capability classification is IIs.

236B—Lester loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on ridgetops and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 3 to 20 acres in size, but a few are larger than 40 acres.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsurface layer is mixed very dark grayish brown and dark grayish brown loam about 2 inches thick. The subsoil is brown and dark yellowish brown clay loam about 18 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places it has thin lenses of sandy loam. In other places the surface layer is eroded and has been mixed with streaks and pockets of brown clay loam subsoil material. In some areas the dark surface layer is 10 or more inches thick. In other areas the subsurface layer is grayish brown and is 4 to 8 inches thick.

Included with this soil in mapping are small areas of Dickman and Le Sueur soils. Dickman soils are in the more convex sloping areas and are sandy and droughty. Le Sueur soils are in the more nearly level areas and are somewhat poorly drained. Included soils make up about 10 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer, subsurface layer, and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIe.

236B2—Lester loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on ridgetops and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 2 to 10 acres in size, but a few are larger than 20 acres.

Typically, the surface layer is very dark grayish brown and dark grayish brown loam about 8 inches thick. It is mixed with streaks and pockets of brown clay loam subsoil material. The subsoil is brown and dark yellowish brown clay loam about 16 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In some places the surface layer is gravelly. In other places the substratum has thin lenses of sandy loam. In some areas slopes range from 6 to 9 percent.

Included with this soil in mapping are some areas of Dickman and Le Sueur soils. Dickman soils are in the more convex sloping areas. They are sandy and droughty. Le Sueur soils are in the more nearly level areas and are somewhat poorly drained. Included soils make up about 10 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. The surface layer of this eroded Lester soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Lester soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, helps to control erosion and prevent surface crusting and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIe.

236C—Lester loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on ridgetops and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 5 to 20 acres in size, but a few are larger than 40 acres.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsurface layer is mixed very dark grayish brown and dark grayish brown loam about 3 inches thick (fig. 15). The subsoil is brown and dark yellowish brown clay loam about 18 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are some areas of Dickman and Storden soils. These soils are in the more convex sloping areas. Dickman soils are sandy and droughty. Storden soils are calcareous and do not have a subsoil. Included soils make up about 10 percent of the unit.

Figure 15.—Profile of Lester loam, 5 to 9 percent slopes. The arrows at depths of 6 and 10 inches indicate the thickness of the subsurface layer. Depth is marked in feet.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer, subsurface layer, and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIIe.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 2 to 15 acres in size, but a few are larger than 20 acres.

Typically, the surface layer is very dark grayish brown and dark grayish brown loam about 7 inches thick. It is mixed with streaks and pockets of clay loam subsoil material. The subsoil is brown and dark yellowish brown clay loam about 15 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are small areas of Dickman and Storden soils. These soils are in the more convex sloping areas. Dickman soils are sandy and droughty. Storden soils are calcareous and do not have a subsoil. Included soils make up about 10 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated (fig. 16). This soil is well suited to corn, soybeans, small grain, and grasses and legumes. The

surface layer of this eroded Lester soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Lester soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper

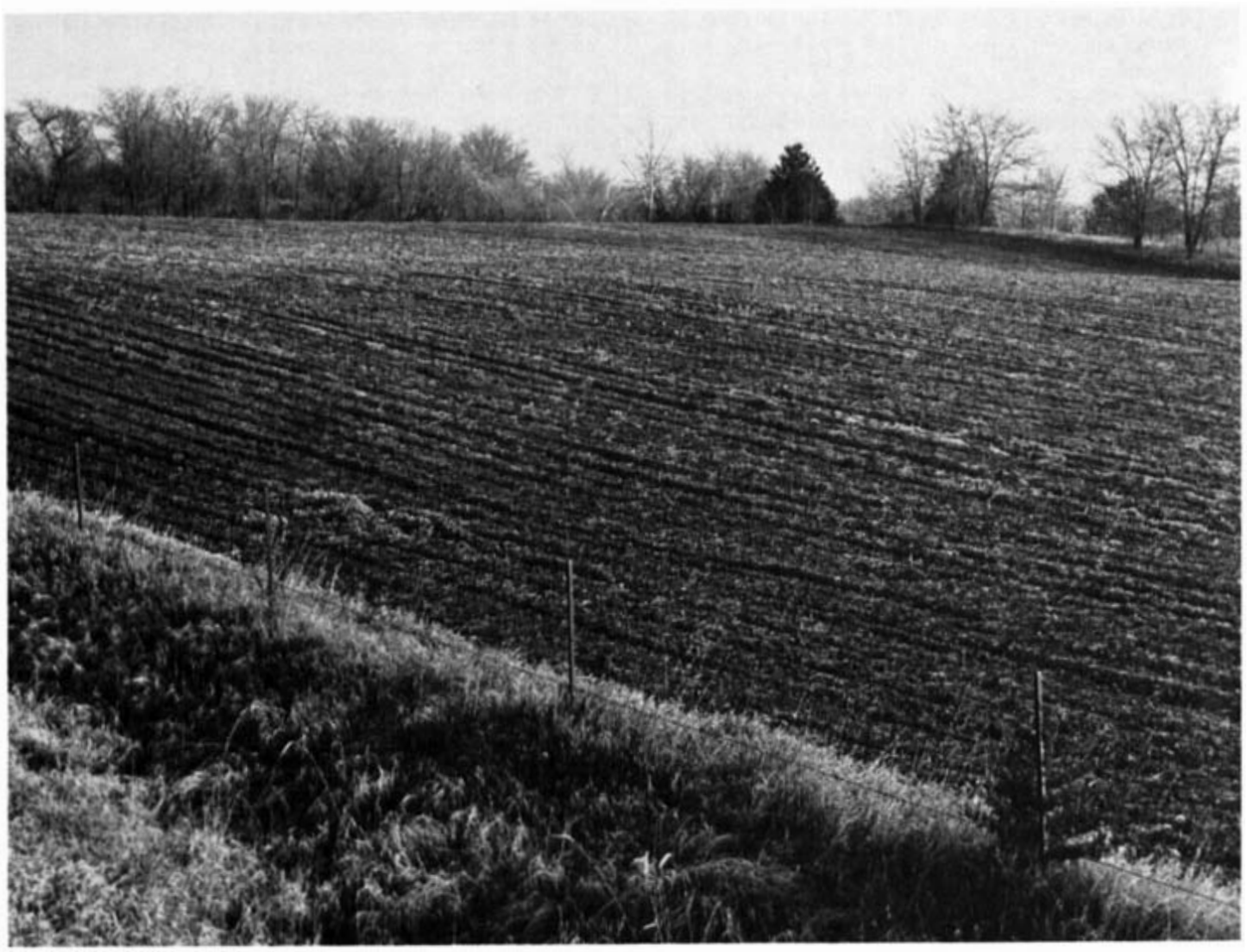

Figure 16.—A cultivated area of Lester loam, 5 to 9 percent slopes, moderately eroded.

stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIIe.

236D—Lester loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on ridgetops and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 2 to 5 acres in size, but a few are larger than 20 acres.

Typically, the surface layer is very dark gray loam about 5 inches thick. The subsurface layer is mixed very dark grayish brown and dark grayish brown loam about 3 inches thick. The subsoil is brown and dark yellowish brown clay loam about 16 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are some areas of Dickman and Storden soils. These soils are in the more convex sloping areas. Dickman soils are sandy and droughty. Storden soils are calcareous and do not have a subsoil. Included soils make up about 15 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer, subsurface layer, and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIIe.

236D2—Lester loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on ridgetops and convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 2 to 5 acres in size, but a few are larger than 20 acres.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. It is mixed with streaks and pockets of clay loam subsoil material. The subsoil is brown and dark yellowish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Included with this soil in mapping are some areas of Dickman and Storden soils. These soils are in the more convex sloping areas. Dickman soils are sandy and droughty. Storden soils are calcareous and do not have a subsoil. Included soils make up about 15 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 percent in the surface layer. The surface layer and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Some areas are used for wooded pasture. Some are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. The surface layer of this eroded Lester soil has a lower organic matter content and lower natural fertility and is more easily eroded than the surface layer of uneroded Lester soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of 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. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the

woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 a permanent plant cover or surface mulch.

The land capability classification is IIIe.

236E—Lester loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on ridgetops and side slopes in the uplands. It is in timbered areas above the valleys of the larger streams. Areas range from 3 to 15 acres in size.

Typically, the surface layer is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is brown and yellowish brown clay loam about 16 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places the surface layer is eroded and has streaks of brown subsoil material.

Included with this soil in mapping are small areas of Storden soils, which are loam throughout. These soils are in the more convex and steeper areas. They are calcareous throughout. They make up about 10 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter in the surface layer is about 2 to 3 percent. Typically, the surface layer is slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. The soil can be easily tilled.

Most areas are used for timbered pasture. This soil is poorly suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Contour farming and terracing also help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility and increases the rate of water infiltration. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation and erosion are controlled. Competing vegetation can be held in check by adequate site preparation, by prescribed burning, or by spraying, cutting, or girdling. The erosion hazard is severe in areas where the soil is not protected. An adequate plant cover is needed.

The land capability classification is IVe.

236F—Lester loam, 18 to 25 percent slopes. This steep, well drained soil is on convex side slopes along streams and drainageways in the uplands. Areas are irregularly shaped. Typically, they are 5 to 20 acres in size, but a few are larger than 30 acres.

Typically, the surface layer is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is dark yellowish brown and brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam.

Included with this soil in mapping are some areas of Dickman and Storden soils. These soils are in the more convex sloping areas. Dickman soils are sandy and droughty. Storden soils are calcareous and do not have a subsoil. Included soils make up about 15 percent of the unit.

The Lester soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer, subsurface layer, and subsoil typically are medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are used for wooded pasture. This soil is generally unsuited to cultivated crops. It is suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a severe hazard.

This soil is well suited to pasture and trees. Most areas used for pasture also support some scattered trees. Some support a dense stand of trees. Removing the trees generally improves the quality of the pasture, and restricting the grazing improves the quality of the woodland. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in a more productive condition.

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 a permanent plant cover or surface mulch.

The land capability classification is VIe.

256D2—Lester-Storden loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on convex side slopes on uplands adjacent to the major streams. In most areas the soils are dissected by gullies and deep drainageways. Areas range from 5 to 25 acres in size. They are about 60

percent Lester soil and 30 percent Storden soil. The smoother north- and east-facing slopes have a higher percentage of the Lester soil than the south- and west-facing slopes. The Storden soil is on the steeper and more convex slopes. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Lester soil is dark grayish brown loam about 6 inches thick. It is mixed with streaks and pockets of clay loam subsoil material. The subsoil is brown and dark yellowish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam. In places it is clay loam or has thin lenses of sandy loam. In some timbered areas the soil has a darker surface layer and a dark grayish brown subsurface layer.

Typically, the surface layer of the Storden soil is very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part, light olive brown and mottled in the next part, and mottled yellowish brown and light olive brown in the lower part. Lime accumulations are throughout the soil. In places the surface layer is very dark grayish brown.

Included with these soils in mapping are small areas of Dickman and Salida soils. Dickman soils are in the more convex sloping areas. They have a high content of sand. Salida soils are on small scattered knobs. They contain more sand and gravel throughout than the Lester and Storden soils. Included soils make up about 10 percent of the unit.

The Lester and Storden soils are moderately permeable. Surface runoff is medium or rapid. Available water capacity is high. The content of organic matter in the surface layer is about 1 to 2 percent. The surface layer of the Lester soil is generally medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. The Storden soil generally is moderately alkaline and calcareous throughout. Below the surface layer, it generally has a very low supply of available phosphorus and potassium.

Some areas are cultivated. Some are used for timber and pasture. If erosion is controlled and fertility improved, these soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard. Much of the precipitation from intense rainfall runs off unless a plant cover protects the surface. A conservation tillage system that leaves a protective amount of 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. In some areas where soybeans are grown, applications of iron compounds are needed on the Storden soil. Returning crop residue to the soils or regularly adding other organic material, such as livestock manure, improves fertility and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and the soils in good condition.

If these soils are 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.

256E2—Lester-Storden loams, 14 to 18 percent slopes, moderately eroded. These moderately steep, well drained soils are on convex side slopes on uplands adjacent to the major streams. In most areas the soils are dissected by gullies and deep drainageways. Areas range from 3 to 20 acres in size. They are about 55 percent Lester soil and 35 percent Storden soil. The smoother north- and east-facing slopes have a higher percentage of the Lester soil than the south- and west-facing slopes. The Storden soil is on the steeper and more convex slopes. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Lester soil is dark grayish brown loam about 6 inches thick. It is mixed with streaks and pockets of clay loam subsoil material. The subsoil is brown and dark yellowish brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light olive brown, mottled loam.

Typically, the surface layer of the Storden soil is very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part, light olive brown and mottled in the next part, and mottled yellowish brown and light olive brown in the lower part. Lime accumulations are throughout the soil.

Included with these soils in mapping are small areas of Dickman and Salida soils. Dickman soils are in the more convex sloping areas. They have a high content of sand. Salida soils are on small scattered knobs. They contain more sand and gravel throughout than the Lester and Storden soils. Included soils make up about 10 percent of the unit.

The Lester and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter in the

surface layer is about 1 to 2 percent. The surface layer of the Lester soil typically is medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. The Storden soil typically is moderately alkaline and calcareous throughout. Below the surface layer, it generally has a very low supply of available phosphorus and potassium.

Most areas are used for hay or pasture. Some are used for cultivated crops. Because tilling the moderately steep slopes is rather difficult, these soils are poorly suited to corn and soybeans. They are suited to small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard if cultivated crops are grown or if pastures are overgrazed. A protective plant cover is needed because rainfall runs off rapidly. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. In many areas contour farming and terracing are difficult because the slopes are too steep and too short. Returning crop residue to the soils or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the infiltration rate.

These soils are suited to row crops grown occasionally to renovate pastures. The pastures commonly are renovated by planting the row crop one year and reestablishing the pasture the next year. Stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and the soils in good condition.

If these soils are 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 IVe.

256F—Lester-Storden loams, 18 to 25 percent slopes. These steep, well drained soils are on convex side slopes on uplands adjacent to the major streams. In most areas the soils are dissected by gullies and deep drainageways. Areas range from 3 to 20 acres in size. They are about 50 percent Lester soil and 40 percent Storden soil. The smoother north- and east-facing slopes have a higher percentage of the Lester soil than the south- and west-facing slopes. The Storden soil is on the steeper and more convex slopes. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Lester soil is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is yellowish brown and brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam.

Typically, the surface layer of the Storden soil is very dark grayish brown and brown, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown and yellowish brown and mottled in the lower part. Lime accumulations are throughout the soil. In places the surface layer is black and very dark brown.

Included with these soils in mapping are small areas of Dickman and Salida soils. Dickman soils are sandy, and Salida soils are gravelly. Included soils are commonly on the more convex parts of the landscape. They make up about 10 percent of the unit.

The Lester and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer of the Lester soil is about 1 to 2 percent. The surface soil typically is medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. The content of organic matter in the surface layer of the Storden soil is about 1 percent. This soil typically is moderately alkaline and calcareous throughout. Below the surface layer, it generally has a very low supply of available phosphorus and potassium.

Most areas are used for pasture, hay, or woodland. These soils are generally unsuitable for cultivated crops because erosion is a severe hazard. They are better suited to grasses and legumes for hay and pasture, but they are too erodible for unlimited grazing. Overgrazing increases the runoff rate and the susceptibility to erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition. Operating farm machinery is hazardous because of the steep slope. In the areas where farm machinery can be used, fertilizer can be applied and pastures renovated.

If these soils are 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. Planting is difficult because of the steep slope.

The land capability classification is VIe.

256G—Lester-Storden loams, 25 to 40 percent slopes. These very steep, well drained soils are on convex side slopes on uplands adjacent to the major streams. In most areas the soils are dissected by gullies and by drainageways. Areas range from 2 to more than 80 acres in size. They are about 45 percent Lester soil and 45 percent Storden soil. The Storden soil is on the steeper and more convex slopes. It makes up as much as 80 percent of some small areas where the slope is more than 40 percent. The smoother north- and east-facing slopes have a higher percentage of the Lester soil

than the south- and west-facing slopes. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Lester soil is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is dark yellowish brown and brown clay loam about 14 inches thick. The substratum to a depth of about 60 inches is yellowish brown loam.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and brown, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown and yellowish brown and mottled in the lower part. Lime accumulations are throughout the soil. In some places the surface layer is black and very dark brown. In other places the slope is as much as 75 percent.

Included with these soils in mapping are areas of Dickman and Salida soils and Fluvaquents. Dickman soils are sandy, and Salida soils are gravelly. Dickman and Salida soils are commonly in the more convex sloping areas on uplands. The loamy Fluvaquents are areas of stratified alluvium. They are in drainageways. Included soils make up about 10 percent of the unit.

The Lester and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter in the surface layer of the Lester soil is about 1 to 2 percent. The surface soil typically is medium acid or slightly acid. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. The content of organic matter in the surface layer of the Storden soil is about 1 percent. This soil typically is moderately alkaline and calcareous throughout. Below the surface layer, it generally has a very low supply of available phosphorus and potassium.

Most areas are used for timbered pasture or woodland. These soils are unsuitable for cultivated crops or unlimited grazing because they are very steep and highly susceptible to erosion. They are poorly suited to hay because the slopes generally are too steep for the use of farm machinery. Proper stocking rates help to maintain the pasture and control erosion. Trees or shrubs can be planted by hand but generally cannot be planted by machine because of the equipment limitation.

The land capability classification is VIIe.

258—Biscay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil generally is in low-lying areas on terraces and in outwash areas on uplands. Areas are irregularly shaped. They generally are 5 to 20 acres in size, but some are larger than 80 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, mottled loam about 12 inches thick. The subsoil is dark gray and olive gray, mottled loam about 8 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and olive gray. The upper part is calcareous loamy coarse sand, and the lower part is calcareous sand and gravel. In some areas the substratum is sandy loam or stratified loam, sandy loam, and sand. In other areas the soil is calcareous throughout. In some places the dark surface soil is more than 24 inches thick. In other places sand and gravel are within a depth of 24 inches.

Included with this soil in mapping are small areas of the poorly drained Coland and somewhat poorly drained Cylinder soils. Coland soils are finer textured in the substratum than the Biscay soil. They are in the slightly lower areas. Cylinder soils are in the slightly higher areas. Included soils make up about 10 percent of the unit.

The Biscay soil is moderately permeable in the upper part and rapidly permeable in the lower part of the subsoil and in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is low or moderate. The content of organic matter is about 5 to 6 percent in the surface layer. This layer typically is neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. It not only is seasonally wet but also is droughty during some periods because of the gravelly substratum. Tile drains remove excess water. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

In areas where this soil is used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during the wet periods help to keep the pasture and soil in a more productive condition.

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, but the droughtiness also is a limitation in some years. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIw.

259—Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil generally is in low lying areas on terraces and in outwash areas on uplands. Areas are irregularly

shaped. They generally are 5 to 15 acres in size, but some are larger than 80 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 14 inches thick. It is mottled in the lower part. The subsoil is dark gray and olive gray, mottled loam about 13 inches thick. The substratum to a depth of about 60 inches is dark grayish brown and olive gray. The upper part is calcareous loamy coarse sand, and the lower part is calcareous sand and gravel. In some areas, the soil has a higher content of silt and clay and the substratum is loam or sandy loam. In other areas the soil is calcareous throughout. In some places the dark surface soil is more than 24 inches thick. In other places the depth to sand and gravel is more than 40 inches.

Included with this soil in mapping are small areas of the poorly drained Coland and somewhat poorly drained Cylinder soils. Coland soils are finer textured in the substratum than the Biscay soil. They are in the slightly lower areas. Cylinder soils are in the slightly higher areas. Included soils make up about 10 percent of the unit.

The Biscay soil is moderately permeable in the upper part and rapidly permeable in the lower part of the subsoil and in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 5 to 6 percent in the surface layer. This layer typically is neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, small grain, and grasses and legumes. It not only is seasonally wet but also is slightly droughty during some periods because of the gravelly substratum. Tile drains remove excess water. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, conserve moisture and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

In areas where this soil is used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during the wet periods help to keep the pasture and soil in a more productive condition.

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, but the droughtiness also is a limitation in some years. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIw.

307—Dundas silt loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly convex areas on uplands. Most areas are 3 to 10 acres in size, but some are larger. Areas are irregularly shaped.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark gray and gray silt loam about 6 inches thick. The subsoil is mottled clay loam about 34 inches thick. The upper part is dark grayish brown and grayish brown, and the lower part is light brownish gray. The substratum to a depth of about 60 inches is light olive gray, mottled loam. In places the soil has a thicker dark surface layer and does not have a subsurface layer.

Included with this soil in mapping are small areas of Le Sueur and Okoboji soils. Le Sueur soils are in the slightly higher areas and are somewhat poorly drained. Okoboji soils are in low areas that are subject to ponding. Included soils make up about 15 percent of the unit.

The Dundas soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer typically is slightly acid. The subsoil has a low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, small grain, and grasses and legumes. 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. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

In areas where this soil is used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 IIw.

308—Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil dominantly is on slightly convex to slightly concave slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those

on terraces are 2 to 40 acres in size and those on uplands 2 to 15 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is dark brown, brown, and dark yellowish brown loam about 20 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and brown sand and gravel. In some places the depth to the underlying sand and gravel is less than 32 inches. In other places it is more than 40 inches. In some areas, especially those along the larger creeks or the valley of the Raccoon River, the substratum is fine sand.

Included with this soil in mapping are small areas of the somewhat poorly drained Cylinder and Spillville soils. These soils are in the low areas. The surface soil of Spillville soils is much thicker than that of the Wadena soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the lower part of the subsoil and in the substratum. Surface runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. It is seasonally droughty because of the sandy and gravelly substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content of the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, reduces the extent of the protective plant cover and thus increases the wind erosion hazard. Proper stocking rates help to keep the pasture and soil in good condition.

Drought is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A 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 dominantly is on moderately convex to moderately concave slopes on terraces but in a few areas is on uplands. Areas generally are 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is dark brown, brown, and dark yellowish brown loam about 20 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and brown sand and gravel. On some foot slopes the surface layer is as much as 32 inches thick. In some areas, especially those along the larger creeks or the Raccoon River, the substratum is fine sand.

Included with this soil in mapping are small areas of Cylinder and Estherville soils. Cylinder soils are somewhat poorly drained. Estherville soils generally are on the more sloping parts of the landscape. Their surface soil and subsoil are thinner and sandier than those of the Wadena soil. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the lower part of the subsoil and in the substratum. Surface runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the gravelly and sandy substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss. If terraces are built, the cuts should not expose the underlying sand and gravel and as much topsoil as possible should be returned to the site. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, reduces the extent of the protective plant cover and thus increases the erosion hazard and the runoff rate. Proper stocking rates help to keep the pasture and soil in good condition.

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. A surface mulch helps to control erosion and conserves moisture.

The land capability classification is IIe.

325—Le Sueur loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in areas between knolls and swales on uplands. Areas are irregularly shaped. They generally are 15 acres in size, but some are 40 acres or more.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black and very dark grayish brown loam about 4 inches thick. The subsoil is about 38 inches thick. It is dark grayish brown loam in

the upper part, dark grayish brown, mottled clay loam in the next part, and grayish brown, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is gray, mottled loam. In places the dark surface soil extends to a depth of more than 24 inches.

Included with this soil in mapping are small areas of Dundas and Okoboji soils. These soils are very poorly drained and are lower on the landscape than the Le Sueur soil. They make up about 15 percent of the unit.

The Le Sueur soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a very 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. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Cultivating or grazing when the soil is too wet causes surface compaction. Wind erosion is a hazard if large areas of the soil are plowed in the fall. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

In areas used for pasture, overgrazing increases the erosion hazard and grazing when the soil is too wet lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

The seasonal high water table is a moderate limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. The limitation 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.

383—Marna silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in shallow swales on uplands. Areas generally are 5 to more than 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 13 inches of black silty clay loam and very dark gray clay. The subsoil is about 15 inches thick. The upper part is olive gray, mottled clay, and the lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is light brownish gray and olive gray, mottled loam.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils. These soils are in depressions. They make up less than 10 percent of the unit.

The Marna soil is slowly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 6 to 7 percent in the surface layer. The surface soil typically is neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately 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. Cultivating when the soil is too wet causes surface compaction and cloddiness. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. Overgrazing or grazing when the soil is too wet lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

The wetness 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 wetness should be selected for planting, or a drainage system should be installed.

The land capability classification is IIw.

385—Guckeen silty clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is in slightly convex areas between knolls and swales in the uplands. Areas are irregularly shaped. They generally are 2 to 10 acres in size, but a few are 25 acres or more.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark grayish brown silty clay about 9 inches thick. The subsoil is about 26 inches thick. The upper part is dark grayish brown and grayish brown, mottled silty clay. The lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled clay loam.

Included with this soil in mapping are some areas of the poorly drained Marna and very poorly drained Okoboji soils. These soils are in the lower landscape positions. They make up about 15 percent of the unit.

The Guckeen soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid. 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, small grain, and grasses and legumes. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Cultivating or grazing when the soil is wet causes surface compaction. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. Overgrazing or grazing when the soil is too wet lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

The wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. It generally is a slight limitation, and most of the commonly grown trees and shrubs can be planted.

The land capability classification is I.

386—Cordova loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly convex areas on uplands. Areas are irregularly shaped. Most are 3 to 15 acres in size, but some are larger than 25 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 11 inches thick. The subsoil is about 19 inches thick. It is olive gray and mottled. It is clay loam in the upper part and loam in the lower part. The substratum to a depth of about 60 inches is olive gray loam mottled with yellowish brown. In places, the black surface soil extends to a depth of only a few inches and the subsurface layer is dark gray silt loam.

Included with this soil in mapping are small areas of Le Sueur and Okoboji soils. Le Sueur soils are in the slightly higher areas and are somewhat poorly drained. Okoboji soils are in the slightly lower areas and are very poorly drained. Included soils make up about 15 percent of the unit.

The Cordova soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The surface soil typically is slightly acid. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately 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. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface layer.

In areas used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 IIw.

458—Millington loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on flood plains along the larger streams. It is subject to flooding. Areas range from 5 to more than 100 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark gray, mottled loam about 15 inches thick. The subsoil is very dark gray, mottled loam about 11 inches thick. The substratum to a depth of about 60 inches is stratified black, very dark grayish brown, dark grayish brown, grayish brown, and light brownish gray, mottled loam, sand, loamy fine sand, and sandy loam. In places the soil is noncalcareous and is not stratified within a depth of 40 inches.

Included with this soil in mapping are small areas of stratified sands and silts that do not have a subsurface layer or a subsoil. These areas are in positions on the landscape similar to those of the Millington soil. They make up about 10 percent of the unit.

The Millington soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high or very high. The content of organic matter is about 4 to 6 percent in the surface layer. This layer typically is mildly alkaline or moderately alkaline. The supply of available phosphorus and potassium in the subsoil is generally very low.

Some of the acreage is used for crops, and some is used for pasture or supports trees. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Flooding and wind erosion are hazards. A conservation tillage system that leaves a protective amount of crop residue on the soil helps to control wind erosion. The more frequently flooded areas are better suited to pasture or hay than to row crops. Overgrazing or grazing when the soil is too wet causes surface compaction and puddling, reduces the infiltration

rate, and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

This soil is suited to wetland wildlife habitat. It is rather poorly suited to trees. The species selected for planting should be those that are somewhat tolerant of the flooding.

The land capability classification is IIw.

485—Spillville loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land. It is subject to flooding. Most areas are 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 45 inches thick. The substratum to a depth of about 60 inches is dark grayish brown clay loam. In some areas it has lenses of loamy sand and sand. In other areas the dark surface layer is clay loam and is 26 to 36 inches thick.

Included with this soil in mapping are small areas of Coland and Cylinder soils. Coland soils are poorly drained and are in the lower areas. Cylinder soils are underlain by sand and gravel. They are on low terraces. Included soils make up about 15 percent of the unit.

The Spillville soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high or very high. The content of organic matter is about 4 to 6 percent in the surface layer. The soil typically is neutral or slightly acid throughout. Below the surface layer, the supply of available phosphorus and potassium is very low.

Most areas are cultivated, but some are pastured (fig. 17). If flooding is controlled, this soil is well suited to corn, soybeans, small grain, and grasses and legumes. In cultivated areas, wetness is a limitation. It can be reduced by diversion terraces and surface or tile drains. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The residue also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is helpful in the more frequently flooded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition. In most areas farm machinery can be used to renovate

Figure 17.—Beef cattle grazing on residue in a harvested cornfield on Spillville loam, 0 to 2 percent slopes.

pasture as needed. Weed control is important because weed seeds are carried in by floodwater.

The wetness and the flooding are the main limitations if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Unless flooding is controlled, only the trees that can withstand the wetness should be planted.

The land capability classification is IIw.

485B—Spillville loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on foot slopes and alluvial fans. Areas are generally long and narrow. Most are 2 to 30 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 44 inches thick. The upper part is black, and the lower part is very dark gray and has faint mottles. The substratum to a depth of about 60 inches is very dark grayish brown clay loam. In some areas it has lenses of loamy sand and sand. In other areas the dark surface layer is clay loam and is 26 to 36 inches thick.

Included with this soil in mapping are small areas of Coland and Cylinder soils. Coland soils are poorly drained and are in the lower areas. Cylinder soils are underlain by sand and gravel. They are in positions on the landscape similar to those of the Spillville soil. Included soils make up about 15 percent of the unit.

The Spillville soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high or very high. The content of organic matter is about 4 to 6 percent in the surface layer. The soil typically is neutral or slightly acid throughout. Below the surface layer, the supply of available phosphorus and potassium is generally very low.

Most areas are cultivated, but some are pastured. This soil is well suited to corn, soybeans, small grain, and grasses and legumes if runoff from adjacent soils is controlled. Erosion and the deposition of silty sediments are hazards in areas where excess water runs across the soil. In places diversion terraces are used to divert runoff from the adjacent hillsides. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to control erosion and prevent surface crusting and increases the infiltration rate. The residue also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay helps to control erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition. In most areas farm machinery can be used to renovate pasture as needed.

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 a permanent plant cover or surface mulch. Unless flooding is controlled, only the species that can withstand the wetness should be planted.

The land capability classification is IIe.

506—Wacousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Areas are irregularly shaped. They generally are 5 to 25 acres in size, but a few are as large as 50 acres.

Typically, the surface layer is black silty clay loam about 14 inches thick. The subsoil is very dark gray and olive gray mottled, silty clay loam about 2 inches thick. The upper part of the substratum dominantly is light gray and olive gray, mottled silty clay loam. The lower part to a depth of about 60 inches is olive gray, mottled very fine sandy loam and light gray loam.

Included with this soil in mapping are small areas of Harps soils. These soils have a higher content of lime than the Wacousta soil. They are poorly drained and are in the slightly higher areas. They make up about 5 percent of the unit.

The Wacousta soil is moderately permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is high. The content of organic matter is about 8 to 9 percent in the surface layer. This layer is neutral. The subsurface layer is neutral or mildly alkaline. The subsoil is neutral to moderately alkaline. It generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. If adequately drained, this soil is suited to corn, soybeans, small grain, and grasses and legumes. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. Maintaining good tilth generally is difficult. Cultivating when the soil is too wet causes cloddiness and surface compaction. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent surface crusting and control wind erosion.

A cover of pasture plants or hay is helpful in the more frequently ponded areas. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

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. Only the species that can withstand the wetness should be selected for planting, or drainage tile should be installed.

The land capability classification is IIIw.

507—Canisteo clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil typically is in shallow swales on uplands. Areas generally range

from 10 to more than 80 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is clay loam about 11 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is mottled clay loam about 11 inches thick. The upper part is dark gray, and the lower part is grayish brown. The substratum to a depth of about 60 inches is light brownish gray, mottled loam. In some places the surface layer is not calcareous. In other places the soil is extremely calcareous. In some areas the substratum is silt loam or sandy loam to a depth of 48 to 60 inches or more.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils. These soils are in depressions. They make up about 15 percent of the unit.

The Canisteo soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow to ponded. Available water capacity is high. The content of organic matter is about 6 to 7 percent in the surface layer. The soil typically is mildly alkaline or moderately alkaline throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated (fig. 18). If adequately drained, this soil is well suited to corn, soybeans, small grain, and grasses and legumes. 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. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. The high content of lime in the soil increases the possibility of herbicide damage to crops and adversely affects the availability of plant nutrients. In some areas where soybeans are grown, applications of iron compounds are needed.

In areas used for pasture, grazing when this soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

508—Calcousta 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 irregularly shaped. They generally are 5 to 20 acres in size, but a few are as large as 50 acres.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsoil is gray and light gray silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is gray and light gray, mottled loam and silt loam.

Included with this soil in mapping are small areas of Okoboji and Harps soils. Harps soils have a higher pH level and lime content than the Calcousta soil. They are in the slightly higher areas. Okoboji soils are in positions on the landscape similar to those of the Calcousta soil. Their dark surface layer is noncalcareous and is much thicker than that of the Calcousta soil, and the content of clay in the subsoil is higher. Included soils make up about 10 percent of the unit.

The Calcousta soil is moderately permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is high. The content of organic matter is about 8 to 9 percent in the surface layer. The soil typically is moderately alkaline throughout. 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 suited to corn, soybeans, small grain, and grasses and legumes if it is adequately drained and if the proper kind and amount of fertilizer is applied. Surface drains remove ponded water, and tile drains remove excess subsurface water. Because the soil commonly is in the lowest part of depressions, however, a suitable drainage outlet is not available in many places. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes cloddiness and surface compaction. The high content of lime increases the possibility of herbicide damage to crops and adversely affects the availability of plant nutrients. In some areas where soybeans are grown, applications of iron compounds are needed.

In the more frequently ponded areas, this soil is better suited to pasture plants or hay than to row crops. Overgrazing or grazing when the soil is too wet lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

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. Only the species that can grow well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIIw.

566—Moingona loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on terraces. Slopes generally are short. Areas are irregular in shape or elongated. Most range from 2 to 10 acres in size, but a few are somewhat larger.

Figure 18.—Young corn plants on Canisteo clay loam, 0 to 2 percent slopes.

Typically, the surface layer is black loam about 11 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is loam about 45 inches thick. The upper part is dark grayish brown, and the lower part is brown and mottled. In some places the dark surface soil is more than 24 inches thick. In other places a loamy sand or sand substratum is below a depth of 30 inches.

Included with this soil in mapping are small areas of Spillville soils. These soils are somewhat poorly drained and are in the lower areas. They make up about 10 percent of the unit.

The Moingona soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer typically is slightly acid or neutral. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated, but some are pastured. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. Wind erosion is a hazard if cultivated areas are plowed in the fall. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. A cover of pasture plants or hay is effective in controlling erosion if the pasture is not overgrazed.

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 I.

566C—Moingona loam, 2 to 7 percent slopes. This gently sloping and moderately sloping, moderately well drained soil is on foot slopes, alluvial fans, and terraces

downslope from strongly sloping or very steep soils. Slopes generally are short. Areas are irregular in shape or elongated. Most range from 2 to 10 acres in size, but a few are somewhat larger.

Typically, the surface layer is black loam about 11 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 45 inches thick. The upper part is dark grayish brown loam, and the lower part is brown, mottled sandy loam. In some places the dark surface soil is more than 24 inches thick. In other places a loamy sand or sand substratum is below a depth of 30 inches. In some areas slopes are more than 7 percent.

Included with this soil in mapping are small areas of Spillville and Storden soils. Spillville soils are somewhat poorly drained and are in the lower areas. Storden soils are calcareous and are less fertile than the Moingona soil. They are in the higher, convex sloping areas. Included soils make up about 10 percent of the unit.

The Moingona soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer typically is slightly acid or neutral. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated, but some are pastured. This soil is well suited to corn, soybeans, small grain, and grasses and legumes. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas contour farming and terracing are difficult because slopes are short and irregular. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil. A cover of pasture plants or hay is effective in controlling erosion if the pasture is not overgrazed.

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 IIe.

585B—Coland-Spillville complex, 1 to 5 percent slopes. These gently sloping soils are in small valleys and upland drainageways (fig. 19). Areas generally are 2 to 10 acres in size. They are about 50 to 70 percent Coland soil and 20 to 40 percent Spillville soil. The poorly drained Coland soil is in the lower areas near the drainageway or channel. It is subject to flooding. The somewhat poorly drained Spillville soil is on the higher parts of the landscape. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 28 inches thick. It is mottled in the lower part. The next 8 inches is very dark gray, mottled clay loam. The substratum to a depth of about 60 inches is very dark gray, mottled loam.

Typically, the Spillville soil has a surface layer of black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 45 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some places it has thin layers of sandy loam, sandy clay loam, or silt loam. In other places the surface layer is lighter colored, more sandy overwash more than 8 inches thick.

These soils are moderately permeable. They have a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer of the Coland soil and 4 to 6 percent in that of the Spillville soil. The surface layer and subsurface layer of both soils typically are slightly acid or neutral. Below the surface layer, the supply of available phosphorus is low and the supply of available potassium very low.

Most areas are cultivated. Some are pastured. If adequately drained, these soils are well suited to corn, soybeans, small grain, and grasses and legumes. Wetness and flooding commonly are problems, especially in areas where excess water runs in from the adjoining hillsides. Diversion terraces can be built in the sloping areas above these soils, and tile drains have been installed in many areas. Grassed waterways help to prevent gully erosion. Special care generally is needed to maintain good tilth in the surface layer of the Coland soil. Cultivating when the soils are too wet causes surface compaction and cloddiness. A conservation tillage system that leaves a protective amount of crop residue on the surface or regularly adding other organic material, such as livestock manure, helps to control wind erosion and prevent surface crusting and increases the infiltration rate in both soils. The residue or manure also helps to maintain the organic matter content in the surface soil.

Most areas used for pasture are in narrow valleys. Some are cut by a meandering drainageway. The wetness is the main problem. Diversion terraces and drainage tile reduce the number of days that the pasture is too wet for normal use and increase the number of suitable pasture plants. Overgrazing or grazing when the soils are too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a productive condition.

The wetness and the flooding are the main limitations if these soils are 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.

Figure 19.—A noncrossable drainageway in an area of Coland-Spillville complex, 1 to 5 percent slopes. The channel has been straightened.

The land capability classification is IIw.

638C2—Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded. These moderately sloping, well drained soils are on knobs, ridgetops, and side slopes in the uplands. Slopes typically are short. Areas range from 2 to 30 acres in size and are irregular in shape. They are about 60 percent Clarion soil and 25 percent Storden soil. The Clarion soil is on the smoother ridgetops, in concave swales, and on the lower side slopes. The Storden soil is on the more sloping, convex knobs and the upper part of the side slopes. It can be readily identified because its surface layer is lighter colored than that of the Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, dark grayish brown, and brown loam about 8 inches thick. It is mixed with streaks of brown subsoil material. The subsoil is loam about 11 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and yellowish brown, calcareous loam about 8 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown in the lower part. Lime accumulations are throughout the soil.

Included with these soils in mapping are small areas of Salida soils in the more convex landscape positions. These included soils contain less organic matter than the Clarion soil. Also, they contain more sand and gravel than the Clarion and Storden soils and are droughty. They make up about 5 percent of the unit. Also included

are small areas of Dickman and Nicollet soils, which make up about 10 percent of the unit. Dickman soils are sandy and droughty. They are in positions on the landscape similar to those of the Clarion and Storden soils. Nicollet soils are in the lower lying areas and are somewhat poorly drained.

The Clarion and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. Reaction typically is slightly acid or neutral in the surface layer of the Clarion soil and is moderately alkaline in the surface layer of the Storden soil. Both soils typically have a very low supply of available phosphorus and potassium below the surface layer. The excess lime in the surface layer of the Storden soil adversely affects crop response to fertilizer and herbicides. Tilth typically is good in both soils, but surface crusting is a problem after heavy rains.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain. They are suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are difficult because of the undulating topography and the short slopes. Only some areas can be farmed on the contour and terraced. Returning crop residue to the soils or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The residue or manure also helps to maintain the organic matter content in the surface layer. Applying additional phosphorus can overcome the phosphorus deficiency in the Storden soil for a number of years.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

If these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings, further erosion is a severe hazard. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

638D2—Clarion-Storden loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on knobs, ridgetops, and side slopes in the uplands. Slopes typically are short. Areas range from 2 to 30 acres in size and are irregular in shape. They are about 50 percent Clarion soil and 30 percent Storden soil. The Clarion soil is on the smoother ridgetops, in concave swales, and on the lower side slopes. The Storden soil is on the more sloping, convex knobs and the upper part of the side slopes. It can be readily identified because its surface layer is lighter colored than that of the Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, dark grayish brown, and very dark brown loam about 7 inches thick. It is mixed with streaks of brown subsoil material. The subsoil is loam about 11 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and yellowish brown, calcareous loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown in the lower part. Lime accumulations are throughout the soil.

Included with these soils in mapping are small areas of Salida soils in the more convex landscape positions. These included soils contain less organic matter than the Clarion soil. Also, they contain more sand and gravel than the Clarion and Storden soils and are droughty. They make up about 10 percent of the unit. Also included are small areas of Dickman and Nicollet soils, which make up about 10 percent of the unit. Dickman soils are sandy and droughty. They are in positions on the landscape similar to those of the Clarion and Storden soils. Nicollet soils are in the lower lying areas and are somewhat poorly drained.

The Clarion and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. Reaction typically is slightly acid or neutral in the surface layer of the Clarion soil and is moderately alkaline in the surface layer of the Storden soil. Both soils typically have a very low supply of available phosphorus and potassium below the surface layer. The excess lime in the surface layer of the Storden soil adversely affects crop response to fertilizer and herbicides. Tilth typically is good in both soils, but surface crusting is a problem after heavy rains.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain. They are suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are difficult because of the undulating topography and the short slopes. Only some areas can be farmed on the contour and terraced. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The residue or manure also helps to maintain the organic matter content in the surface layer.

Applying additional phosphorus can overcome the phosphorus deficiency in the Storden soil for a number of years.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

If these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings, further erosion is a hazard. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IIIe.

638E2—Clarion-Storden loams, 14 to 18 percent slopes, moderately eroded. These moderately steep, well drained soils are on knobs, ridgetops, and side slopes in the uplands. Slopes typically are short. Areas range from 2 to 30 acres in size and are irregular in shape. They are about 40 percent Clarion soil and 40 percent Storden soil. The Clarion soil is on the smoother ridgetops, in concave swales, and on the lower side slopes. The Storden soil is on the more sloping, convex knobs and the upper part of the side slopes. It can be readily identified because its surface layer is lighter colored than that of the Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, dark grayish brown, and very dark brown loam about 7 inches thick. It is mixed with streaks of brown subsoil material. The subsoil is loam about 10 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and yellowish brown, calcareous loam about 7 inches thick. The substratum to a depth of about 60 inches is calcareous loam. It is yellowish brown in the upper part and light olive brown in the lower part. Lime accumulations are throughout the soil.

Included with these soils in mapping are small areas of Salida soils in the more convex landscape positions. These included soils contain less organic matter than the Clarion soil. Also, they contain more sand and gravel and are more droughty than the Clarion and Storden soils. Also included are small areas of Dickman and Nicollet soils. Dickman soils are sandy and droughty. They are in positions on the landscape similar to those of the Clarion and Storden soils. Nicollet soils are in the lower lying areas and are somewhat poorly drained. Included soils make up about 20 percent of the unit.

The Clarion and Storden soils are moderately permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. Reaction typically is slightly acid or neutral in the surface layer of the Clarion soil and is moderately alkaline in the surface layer of the Storden soil. Both soils typically have a very low supply of available phosphorus and potassium below the surface layer. The excess lime in the surface layer of the Storden soil adversely affects crop response to fertilizer and herbicides. Tilth typically is good in both soils, but surface crusting is a problem after heavy rains.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain. They are suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves crop residue on the surface throughout the year and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are difficult because of the hilly topography and the short slopes. Only some areas can be farmed on the contour and terraced. Returning crop residue to the soils or regularly adding other organic material, such as livestock manure, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. The residue or manure also helps to maintain the organic matter content in the surface layer. Applying additional phosphorus can overcome the phosphorus deficiency in the Storden soil for a number of years.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

If these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings, further erosion is a severe hazard. It can be controlled, however, by a permanent plant cover or surface mulch.

The land capability classification is IVe.

639C2—Salida-Storden complex, 5 to 9 percent slopes, moderately eroded. These moderately sloping soils are on knobs, hilly valley trains, and glacial outwash plains. Areas generally are 2 to 10 acres in size and are irregular in shape. They are about 45 percent Salida soil and 35 percent Storden soil. The excessively drained Salida soil typically is on the high and more prominent knobs and ridges. The well drained Storden soil typically is in areas that surround or are adjacent to those knobs and ridges. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Salida soil is very dark grayish brown, calcareous gravelly sandy loam about 7 inches thick. The subsoil is brown, calcareous, loose gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is variegated brown and yellowish brown, calcareous gravelly sand. In some places the surface layer is not calcareous. In other places cobbles 3 to 6 inches in diameter are common on the surface.

Figure 20.—A cultivated area of Salida-Storden complex, 5 to 9 percent slopes, moderately eroded, on a ridge.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous loam. The upper part is yellowish brown, and the lower part is light olive brown. Lime accumulations are throughout the soil. In places the surface layer is gravelly loam.

Included with these soils in mapping are small areas of Clarion, Dickman, and Wadena soils. These included soils are not calcareous, are deeper to the substratum than the Salida or Storden soil, and contain less gravel in the surface layer and subsoil than the Salida soil. They are on the less prominent, lower lying parts of the landscape. They make up about 20 percent of the unit.

Permeability is very rapid in the Salida soil and moderate in the Storden soil. Surface runoff is slow on the Salida soil and rapid on the Storden soil. Available water capacity is very low in the Salida soil and high in the Storden soil. The content of organic matter in the surface layer of both soils is about 0.5 to 1.0 percent. Typically, reaction is mildly alkaline or moderately alkaline throughout the profile. The supply of available phosphorus and potassium generally is very low below the surface layer. Tilling these soils is somewhat difficult because of rocks and stones.

The large areas typically support grass for hay or pasture. The smaller areas, 2 to 4 acres in size, are commonly cultivated along with the more productive surrounding soils (fig. 20). The Salida and Storden soils are poorly suited to corn, soybeans, and small grain. They are droughty and are best suited to grasses. If these soils are not overgrazed, a cover of pasture plants or hay is effective in controlling erosion.

Managing these soils as areas of idle grassland or shrubs for wildlife is effective in controlling erosion. Although the Salida soil is poorly suited to trees, the Storden soil and the included soils are at least moderately suited to the trees or shrubs grown to enhance wildlife habitat.

The land capability classification is IIIe.

639D2—Salida-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on knobs, hilly valley trains, and glacial outwash plains. Areas generally are 2 to 10 acres in size and are irregular in shape. They are about 45 percent Salida soil and 35 percent Storden soil. The excessively drained Salida soil typically is on the high and more prominent knobs and ridges. The well drained Storden soil typically is in areas that surround or are adjacent to those knobs and ridges. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Salida soil is very dark grayish brown, calcareous gravelly sandy loam about 7 inches thick. The subsoil is brown, calcareous, loose gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is variegated brown and yellowish brown, calcareous gravelly sand. In some places the surface layer is not calcareous. In other places cobbles 3 to 6 inches in diameter are common on the surface. In some areas the slopes are 14 to 18 percent.

Typically, the surface layer of the Storden soil is mixed very dark grayish brown and yellowish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous loam. The upper part is yellowish brown, and the lower part is light olive brown. Lime accumulations are throughout the soil. In places the surface layer is gravelly loam.

Included with these soils in mapping are small areas of Clarion, Dickman, and Wadena soils. These included soils are not calcareous, are deeper to the substratum and darker than the Salida or Storden soil, and contain less gravel than the Salida soil. They are on the less prominent, lower lying parts of the landscape. They make up about 20 percent of the unit.

Permeability is very rapid in the Salida soil and moderate in the Storden soil. Surface runoff is slow on the Salida soil and rapid on the Storden soil. Available water capacity is very low in the Salida soil and high in the Storden soil. The content of organic matter in the surface layer of both soils is about 0.5 to 1.0 percent. Typically, reaction is mildly alkaline or moderately alkaline throughout the profile. The supply of available phosphorus and potassium is very low below the surface layer. Tilling these soils is somewhat difficult because of rocks and stones.

The large areas generally support grass for hay or pasture. The smaller areas, 2 to 3 acres in size, are commonly cultivated along with the more productive surrounding soils. The Salida and Storden soils are poorly suited to corn, soybeans, and small grain. They are droughty and are best suited to grasses. In areas where the pasture is not overgrazed, a cover of pasture plants or hay is effective in controlling erosion.

Managing these soils as areas of idle grassland for wildlife is effective in controlling erosion. Although the Salida soil is poorly suited to trees, the Storden soil and the included soils are at least moderately suited to the trees or shrubs grown to enhance wildlife habitat.

The land capability classification is IVe.

655—Crippin loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained, calcareous soil is on small, slightly convex rises in the uplands. Areas are 2 to 4 acres in size and are oval or irregular in shape.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is loam about 9 inches thick. The upper part is black, and the lower part is black and very dark grayish brown. The subsoil is loam about 16 inches thick. It is mixed very dark grayish brown, dark grayish brown, and black in the upper part and dark grayish brown and mottled in the lower part. The substratum to a depth of about 60 inches is grayish brown, mottled loam. In places the soil is not calcareous.

Included with this soil in mapping are some areas of Canisteo soils. These soils are poorly drained and are in the lower areas. They make up about 10 percent of the unit.

The Crippin soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. This layer typically is mildly alkaline. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. The soil is well suited to corn, soybeans, small grain, and grasses and legumes for hay and pasture. In some areas the seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content of the surface soil. Cultivating or grazing when the soil is wet causes surface compaction.

In areas where this soil is used for pasture or hay, overgrazing increases the erosion hazard. Grazing when the soil is too wet lowers productivity. Proper stocking rates help to keep the pasture and soil in a productive condition.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks and ornamental plantings. Generally, it is a slight limitation, and most of the species adapted to the climate of the county can be planted.

The land capability classification is I.

658—Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in low-lying areas on stream terraces and in outwash areas on uplands. Areas are irregularly shaped. They generally are 5 to 20 acres in size, but some are larger than 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 12 inches thick. The subsoil is about 8 inches thick. It is olive gray, mottled loam in the upper part and olive gray and gray, very friable, mottled, calcareous coarse loamy sand in the lower part. The substratum to a depth of about 60 inches is grayish brown and olive sand and gravel. In places the soil is not calcareous. In some areas the dark surface soil is more

than 24 inches thick. In other areas the depth to the gravelly substratum is less than 24 inches.

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

The Mayer soil is moderately permeable in the upper part and rapidly permeable in the lower part of the subsoil and in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is low or moderate. The content of organic matter is about 5 to 6 percent in the surface layer. The soil is mildly alkaline or moderately alkaline throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, small grain, and grasses and legumes. It not only is seasonally wet but also is droughty during some periods because of the gravelly substratum. Tile drains remove excess water. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content of the surface soil. The high content of lime in the soil adversely affects the availability of some of the plant nutrients. In large areas where soybeans are grown, the varieties that are suited to a high content of lime should be selected for planting.

In areas used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

659—Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in low lying areas on terraces and in outwash areas on uplands. Areas are irregularly shaped. They generally are 5 to 15 acres in size, but some are larger than 80 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 13 inches thick. The subsoil is about 13 inches thick. It is olive gray, mottled loam in the upper part and olive gray, mottled, calcareous coarse loamy sand in the lower part. The substratum to a depth of about 60 inches is grayish brown and olive sand and gravel. In places the soil is not calcareous. In some areas the dark surface soil is more than 24 inches thick. In other areas the depth to sand and gravel is more than 40 inches.

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

The Mayer soil is moderately permeable in the upper part and rapidly permeable in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 5 to 6 percent in the surface layer. The soil is mildly alkaline or moderately alkaline throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. If adequately drained, this soil is moderately suited to corn, soybeans, small grain, and grasses and legumes. It not only is seasonally wet but also is slightly droughty during some periods because of the gravelly substratum. Tile drains remove excess water. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, help to control wind erosion. The residue or manure also helps to maintain the organic matter content of the surface soil. The high content of lime in the soil adversely affects the availability of some of the plant nutrients. In large areas where soybeans are grown, the varieties that are suited to a high content of lime should be selected for planting.

In areas used for pasture, grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

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 well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

733—Calco silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on bottom land (fig. 21). It is subject to flooding. Areas are long and narrow or irregularly shaped. They typically are 40 to more than 100 acres in size, but some of the long and narrow ones are less than 20 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam. It is about 33 inches thick. The subsoil is dark grayish brown, mottled silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is light gray, mottled silty clay loam. In places the dark surface soil is less than 24 inches thick or is noncalcareous.

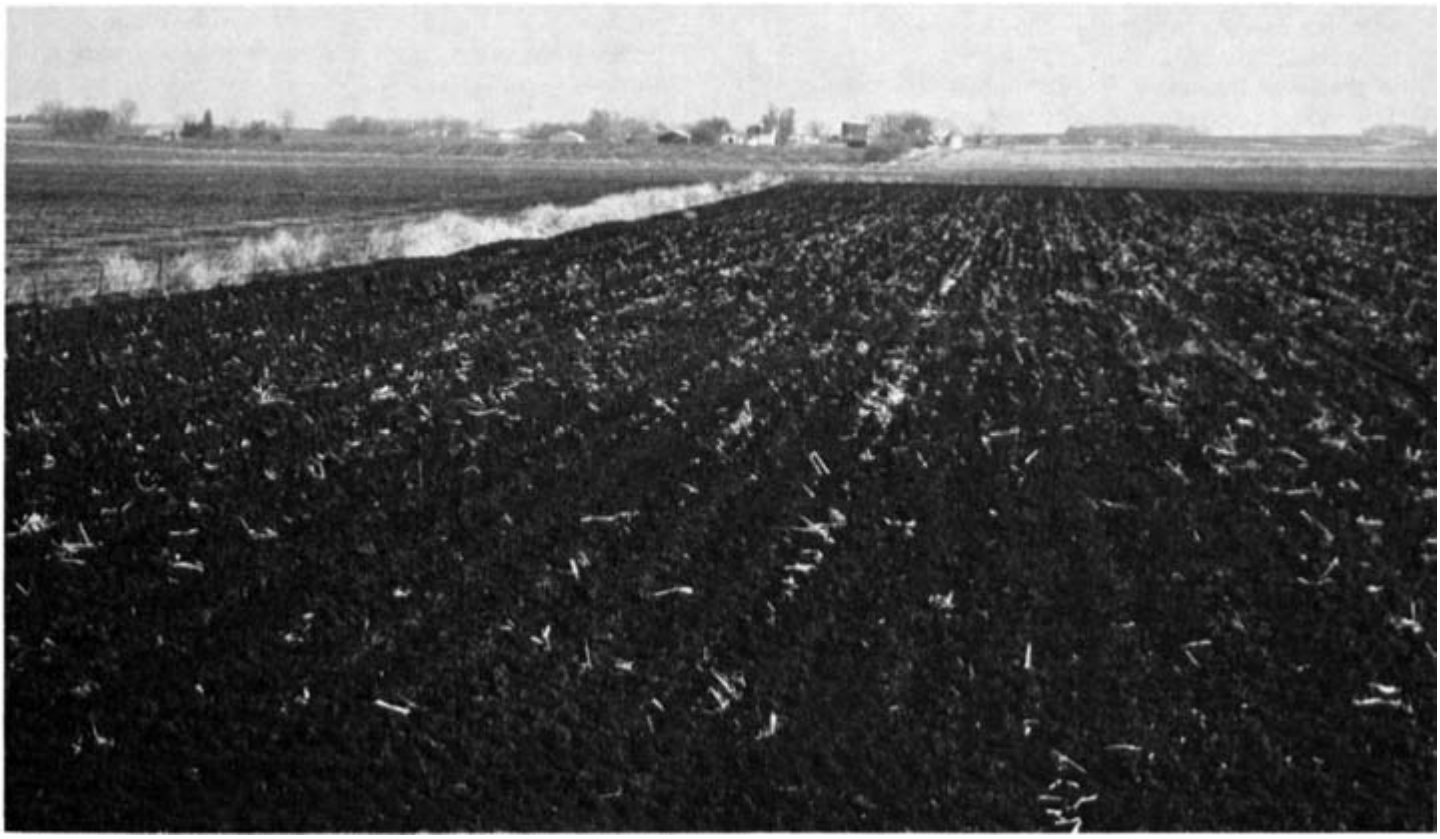

Figure 21.—An area of Calco silty clay loam, 0 to 2 percent slopes, on bottom land.

Included with this soil in mapping are small areas of Biscay and Mayer soils. These soils are in positions on the landscape similar to those of the Calco soil. They are underlain by sand and gravel within a depth of 40 inches. They make up about 5 percent of the unit.

The Calco soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer. The surface soil and subsoil are moderately alkaline. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, small grain, and grasses and legumes if it is adequately 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. Because of the excess lime, the soil structure tends to be weak and breaks down easily. Puddling results from the breakdown of the soil structure. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to control wind erosion and prevent surface crusting and increases the infiltration rate. The high content of lime in the soil increases the possibility of herbicide damage to crops and adversely affects the availability of plant nutrients. In some areas where soybeans are grown, applications of iron compounds are needed.

Some areas are used for pasture because they are isolated by a meandering stream, but most are accessible to farm machinery. Pastures can be renovated as needed. Weed control is important because weed seeds are carried in by floodwater. Overgrazing reduces the extent of the protective plant cover and increases the wind erosion hazard. Grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates, pasture rotation, and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

The wetness, the flooding, 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 well in a wet, calcareous soil should be selected for planting.

The land capability classification is IIw.

878—Ocheyedan loam, 0 to 2 percent slopes. This nearly level, well drained soil dominantly is on slightly convex to slightly concave slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on terraces are 2 to 10 acres in size and those on uplands 2 to 3 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown, black, and dark brown loam about 5 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown loam in the upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is light yellowish brown, mottled, calcareous silt loam. In some areas on uplands, the substratum is underlain by glacial till at a depth of about 40 inches.

Included with this soil in mapping are some areas of Fostoria soils. These soils are somewhat poorly drained and are in low areas. They make up about 10 percent of the unit.

Permeability is moderate in the Ocheyedan soil. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid. 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, small grain, and grasses and legumes. In some areas it is seasonally droughty because of a sandy substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing, however, causes surface compaction and increases the wind erosion hazard. Proper stocking rates help to keep the pasture and soil in good condition.

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

The land capability classification is I.

878B—Ocheyedan loam, 2 to 5 percent slopes. This gently sloping, well drained soil dominantly is on slightly convex or smooth slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on terraces are 2 to 15 acres in size and those on uplands 2 to 5 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown, black, and dark brown loam about 5 inches thick. The subsoil is about 22 inches thick. It is yellowish brown loam in the upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is light yellowish brown, mottled, calcareous silt loam. In some areas on uplands, the substratum is underlain by glacial till at a depth of about 40 inches.

Included with this soil in mapping are some areas of Dickman soils. These soils are more sandy than the Ocheyedan soil. They are in positions on the landscape similar to those of the Ocheyedan soil. Also included are some areas of Fostoria soils. These soils are somewhat poorly drained and are in low areas. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Ocheyedan soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The surface soil typically is slightly acid. 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. In some areas it is seasonally droughty because of a sandy substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

In some areas drought is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A surface mulch conserves moisture.

The land capability classification is IIe.

878B2—Ocheyedan loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil dominantly is on slightly convex slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on terraces are 2 to 15 acres in size and those on uplands 2 to 5 acres.

Typically, the surface layer is very dark brown loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown subsoil material. The subsoil is about 20 inches thick. It is yellowish brown loam in the

upper part and light olive brown silt loam in the lower part. The substratum to a depth of about 60 inches is light yellowish brown, mottled, calcareous silt loam. In some areas on uplands, the substratum is underlain by glacial till at a depth of about 36 inches.

Included with this soil in mapping are some areas of the more sandy Dickman soils. These soils are in positions on the landscape similar to those of the Ocheyedan soil. Also included are some areas of Wadena soils, which are underlain by sand and gravel at a depth of 24 to 40 inches. These soils generally are at the slightly higher elevations. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Ocheyedan soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer typically is slightly acid. 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, small grain, and grasses and legumes. In some areas it is seasonally droughty because of a sandy substratum. The surface layer of this eroded Ocheyedan soil has a lower organic matter content, is lower in natural fertility, and is more easily eroded than the surface layer of the uneroded Ocheyedan soils. As a result, more fertilizer and more intensive management are needed. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

In some areas drought is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A surface mulch conserves moisture.

The land capability classification is IIe.

878C2—Ocheyedan loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil dominantly is on convex slopes on the more sloping parts of terraces but in a few areas is on uplands near stream valleys. Typically, areas are 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. It is mixed with some dark yellowish brown subsoil material. The subsoil is about 18 inches thick. The upper part is dark yellowish brown loam, and the lower part is light olive brown silt loam. The substratum to a depth of about 60 inches is light yellowish brown, mottled silt loam. In some areas it is underlain by glacial till at a depth of about 34 inches. In some places the surface layer is uneroded and is underlain by a dark grayish brown subsurface layer that is about 3 inches thick. In other places the slopes are more than 9 percent.

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

Most areas are cultivated. Some are pastured. This soil is 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 in some areas because of a sandy substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material, such as livestock manure, improves fertility, conserves moisture, and helps to control erosion. The residue or manure also helps to maintain the organic matter content in the surface layer.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion. Proper stocking rates help to keep the pasture and soil in good condition.

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 in some areas. A permanent plant cover or surface mulch helps to control erosion and conserves moisture.

The land capability classification is IIIe.

879—Fostoria loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil dominantly is on slightly concave or smooth slopes on terraces but in a few areas is on uplands. Areas are irregularly shaped. Generally, those on terraces are 2 to 15 acres in size and those on uplands are 2 to 3 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer also is black loam about 8 inches thick. The subsoil is about 26 inches thick. It is dark grayish brown, mottled clay loam in the upper part and grayish brown, mottled loam in the lower part. The substratum to a depth of about 60 inches is grayish brown and light brownish gray, mottled silt loam. In places the substratum is loamy fine sand or fine sand below a depth of 30 inches. In some areas on uplands, it is underlain by glacial till within a depth of 40 inches.

Included with this soil in mapping are some areas of Biscay and Ocheyedan soils. Biscay soils are poorly drained, are underlain by sand and gravel, and are in low areas. Ocheyedan soils are well drained and are in the higher areas. Included soils make up about 10 percent of the unit.

The Fostoria soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The surface soil is typically neutral. 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, small grain, and grasses and legumes. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Cultivating when the soil is too wet causes surface compaction. Wind erosion is a hazard if large areas of the soil are plowed in the fall. A conservation tillage system that leaves a protective amount of crop residue on the soil or regular additions of other organic material, such as livestock manure, help to control wind erosion and prevent surface crusting and increase the infiltration rate. The residue or manure also helps to maintain the organic matter content in the surface soil.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and increases the runoff rate. Proper stocking rates and controlled grazing during wet periods help to keep the pasture in good condition.

The seasonal high water table is a moderate limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. 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.

1048—Knoke mucky silty clay loam, ponded, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Areas range from 5 to more than 80 acres in size. They are irregularly shaped or are somewhat elliptical.

Typically, a few inches of partly decomposed plant residue is at the surface. The surface layer is black mucky silty clay loam about 6 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The subsoil is black silty clay loam about 21 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is gray, mottled silty clay loam.

This soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is ponded. Available water capacity is very high. The content of organic matter is about 15 percent in the surface layer. The soil typically is moderately alkaline throughout. The subsoil generally has a very low supply of available phosphorus and potassium.

This soil supports aquatic vegetation (fig. 22). It is suited to wetland wildlife habitat. The trees and shrubs planted in areas of wildlife habitat should be tolerant of an extremely wet soil.

Unless an extensive drainage system is installed, this soil is not suited to cultivated crops or to grasses and legumes for hay and pasture. Also, it is unsuited to most trees and shrubs.

The land capability classification is VIIw.

1135—Coland silty clay loam, channeled, 0 to 1 percent slopes. This nearly level, poorly drained soil is on bottom land and low terraces dissected by meandering streams and oxbows. It is subject to flooding. Areas generally range from 10 to 50 acres in size. They are long and narrow.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is about 36 inches thick. It is black silty clay loam and clay loam in the upper part and very dark gray, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is mixed light brownish gray and very dark gray, mottled clay loam. In some places the dark surface soil is only about 24 inches thick and overlies a dark gray and gray substratum. In other places the surface soil is lighter colored, more sandy overwash that is more than 8 inches thick.

Included with this soil in mapping are small areas of Biscay soils. These soils have sand within a depth of 40 inches. They generally are at the slightly higher elevations. They make up about 5 percent of the unit.

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

Most areas are pastured. This soil is not protected from flooding or is isolated by a meandering stream. As a result, it is not well suited to corn, soybeans, and small grain. Water-tolerant grasses and legumes are the best suited pasture plants. A cover of pasture plants or hay is helpful in areas that are too small or too dissected for crops. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and the soil in a productive condition.

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.

Figure 22.—An area of Knoke mucky silty clay loam, ponded, 0 to 1 percent slopes, in Dunbar Slough, which provides habitat for ducks and geese.

Only the species that can withstand the wetness and the flooding should be selected for planting.

The land capability classification is Vw.

1308—Wadena Variant loam, 0 to 2 percent slopes. This nearly level, well drained soil is on slightly convex to slightly concave slopes on terraces. Areas are irregularly shaped. Generally, they are 2 to 20 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 11 inches thick. The subsoil is about 22 inches thick. It is very dark grayish brown loam in the upper part, brown loam in the next part, and brown fine sandy loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown loamy fine sand and fine sand. In places it is sand and gravel.

Included with this soil in mapping are small areas of Spillville soils. These soils are somewhat poorly drained and are in the low areas. They have a dark surface soil that is thicker than that of the Wadena Variant soil. They make up about 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and rapid in the lower part. Surface runoff is medium. Available water capacity is moderate. The

content of organic matter is about 4 to 5 percent in the surface layer. The surface soil and the upper part of the subsoil typically are slightly acid or neutral. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, small grain, and grasses and legumes. It is seasonally droughty because of the sandy substratum. A conservation tillage system that leaves a protective amount of crop residue on the surface or regular additions of other organic material, such as livestock manure, improve fertility, conserve moisture, and help to control wind erosion. The residue or manure also helps to maintain the organic matter content of the surface layer.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, reduces the extent of the protective plant cover and increases the wind erosion hazard. Proper stocking rates help to keep the pasture and soil in good condition.

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

The land capability classification is IIs.

1585—Coland-Spillville complex, channeled, 0 to 2 percent slopes. These nearly level soils are in the larger valleys cut by meandering stream channels. They are subject to flooding. Areas generally are 10 to 50 acres in size and are long and narrow. They are about 70 percent Coland soil and 30 percent Spillville soil. The poorly drained Coland soil is in the lower areas near the channels, and the somewhat poorly drained Spillville soil is in the higher areas. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 36 inches thick. The substratum to a depth of about 60 inches is light brownish gray and very dark gray, mottled loam. In some areas the surface layer is covered by sandy loam or loamy sand overwash more than 8 inches thick.

Typically, the Spillville soil has a surface layer of black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 45 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some small areas the surface layer is covered by sandy loam or loamy sand overwash more than 8 inches thick. In other areas the dark surface soil is less than 36 inches thick. In places the surface layer is fine sandy loam.

These soils are moderately permeable. They have a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The surface layer and subsurface layer typically are slightly acid or neutral. Below the surface layer, the supply of available phosphorus generally is low and the supply of available potassium very low.

Most areas are used for pasture. Some are used for woodland. These soils generally are not cultivated. The use of farm machinery is impractical because a meandering stream dissects most areas. The soils are moderately suited to pasture. Grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

These soils are well suited to wildlife habitat. Wetness and flooding are the main limitations in the areas used for trees and shrubs. The species planted in areas of wildlife habitat or woodland should be those that can withstand the wetness.

The land capability classification is Vw.

1585B—Coland-Spillville complex, channeled, 2 to 5 percent slopes. These gently sloping soils are in long, narrow valleys cut by meandering stream channels. Areas generally are 10 to 50 acres in size and are long and narrow. They are about 60 percent Coland soil and 40 percent Spillville soil. The poorly drained Coland soil is in the lower areas near the channels. It is subject to flooding. The somewhat poorly drained Spillville soil is in the higher areas that are along the base of upland slopes. The two soils occur as areas so narrow or so small that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 36 inches thick. The substratum to a depth of about 60 inches is light brownish gray and very dark gray, mottled loam. In some areas the surface layer is covered by sandy loam or loamy sand overwash more than 8 inches thick.

Typically, the Spillville soil has a surface layer of black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 45 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled clay loam. In some small areas the surface layer is covered by sandy loam or loamy sand overwash more than 8 inches thick. In other areas the dark surface soil is less than 36 inches thick. In places the surface layer is fine sandy loam.

These soils are moderately permeable. They have a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The surface layer and subsurface layer typically are slightly acid or neutral. Below the surface layer, the supply of available phosphorus generally is low and the supply of available potassium very low.

Most areas are used for pasture. Some are used for woodland. These soils generally are not cultivated. The use of farm machinery is impractical because a

meandering stream dissects most areas. The soils are moderately suited to pasture. Grazing when the soil is too wet causes some surface compaction and puddling and lowers productivity. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

These soils are well suited to wildlife habitat. Wetness and flooding are the main limitations in the areas used for trees and shrubs. The species planted in areas of wildlife habitat or woodland should be those that can withstand the wetness.

The land capability classification is Vw.

2315—Fluvaquents-Coland complex, 0 to 3 percent slopes. These nearly level and gently undulating, poorly drained and somewhat poorly drained soils are on bottom land, generally along the larger streams. The soils are subject to flooding, which deposits new sediments on the surface. Areas are 10 to more than 100 acres in size. They are irregularly shaped. The landscape is characterized by large stream channels and by old meandering channels, low natural levees, sloughs, and small oxbows. Some areas are undulating. They are 15 to 50 feet across. Some have elevation differences of 1 to 3 feet, but others have elevation differences of as much as 6 to 7 feet.

This map unit is about 45 percent Fluvaquents (stratified sands and silts), 35 percent Coland soil, and 20 percent minor soils. The soils in this unit occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Fluvaquents are very dark grayish brown, grayish brown, and brown, stratified sediments. The texture of the sediments varies, including fine sand, loamy sand, sandy loam, silt loam, and silty clay loam to a depth of 60 inches.

Typically, the Coland soil has a black silty clay loam surface layer about 8 inches thick. The subsurface layer is clay loam about 36 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The substratum to a depth of about 60 inches is light brownish gray and very dark gray, mottled loam.

Included with these soils in mapping are Calco, Millington, and Spillville soils. The poorly drained Calco and Millington soils are in the slightly lower slack water areas, in old oxbows, and in small meandering channels. The somewhat poorly drained Spillville soils are in the slightly higher areas. Included soils have a higher organic matter content and a higher available water capacity than the Fluvaquents. They make up about 15 percent of the unit.

Permeability is moderate in the Coland soil. It varies in the Fluvaquents, depending on the texture of the soils. It is rapid in the most sandy soils and very slow in the most clayey soils. Surface runoff is medium to very slow. Available water capacity ranges from high to low. The Coland soil has a seasonal high water table. The other soils usually have a high water table during wet periods. The soils generally can be easily tilled in areas where they are protected from flooding. The organic matter content ranges from 1 to 6 percent. The surface layer is slightly acid to mildly alkaline. Below the surface layer, the supply of available phosphorus generally is very low or low and the supply of available potassium is very low.

Most areas are used as timbered pasture (fig. 23). Some areas support only water-tolerant plants. Some areas have been rough-leveled and are used for cultivated crops. These soils are poorly suited to corn, soybeans, and small grain unless they are protected from flooding. They are suited to grasses for pasture. The wetness caused by flooding or the high water table is a limitation. Proper stocking rates and controlled grazing during wet periods help to keep the pasture and soil in a more productive condition.

These soils are suited to wetland wildlife habitat. They are rather poorly suited to trees. The species planted should be those that are tolerant of flooding.

The land capability classification is Vw.

5010—Pits, gravel. These pits dominantly are on stream terraces but in some areas are on uplands. They generally are being mined, but some are inactive. They range from less than 1 acre to more than 40 acres in size and commonly are somewhat rectangular.

Typically, the soil material tends to be droughty during much of the growing season. In most areas it has a seasonal high water table. Also, the low-lying areas are ponded during wet periods. Stones and cobbles are commonly on the surface. Reaction 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 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.

5020—Pits and dumps. These pits and dumps are in areas where coal has been mined. The pits are open, trench-type excavations that are 20 feet or more deep. The dumps are piles of acid spoil material that is 15 to 30 feet high. The pits and dumps are nearly barren of vegetation. Water accumulates in some of the pits. Idle land between or adjacent to the pits and dumps is eventually vegetated by annual weeds, grasses, and trees after the mining has been completed. Areas are irregular in shape and commonly range from 5 to more than 20 acres in size.

The properties of the soil material and the slopes vary considerably from area to area. Generally, permeability is slow or very slow. Surface runoff ranges from medium to very rapid, depending upon the slopes. The soil material typically is extremely acid.

No land capability classification is assigned.

Figure 23.—Timbered pasture in an area of Fluvaquents-Coland complex, 0 to 3 percent slopes.

5040—Orthents, loamy. These well drained to somewhat poorly drained soils are in borrow areas, cut and fill areas, sanitary landfills, and dumps. Areas are about 2 to 20 acres in size. Some are square or rectangular, and some are irregularly shaped. Slopes range from 0 to 9 percent.

The soil material varies but in most areas is derived from loamy glacial till. In many areas it is compacted. Typically, it is moderately alkaline and calcareous, and the content of organic matter is less than 1 percent in the surface layer. In areas where topsoil has been replaced, however, reaction is neutral or slightly acid and the content of organic matter is 2 percent or more.

Some areas that have not been converted to urban uses could be used for corn and soybeans. Most areas, however, are better suited to hay or pasture. The more sloping areas are subject to erosion if they are cultivated.

Some areas are suitable as wildlife habitat or woodland. Special care is needed in selecting species for planting. Only the plants suited to the specific soil conditions at the site should be selected.

No land capability classification is assigned.

5041—Orthents, reclaimed, 2 to 9 percent slopes. These soils are on stream terraces and uplands. They formerly were gravel pits and some cut and fill areas,

which have been smoothed, filled, or leveled. In some areas the soils are highly compacted. Areas range from less than 1 to more than 5 acres in size and are commonly irregular in shape.

Typically, available water capacity is low, but it varies from area to area. As a result, some areas are quite droughty during much of the growing season but others are not. In most areas the soils have a seasonal high water table. In some areas stones and cobbles are common on the surface. Typically, the content of organic matter is about 1 to 2 percent. Reaction is moderately alkaline.

Most of these reclaimed pits are used for hay or cultivated crops, but some support trees. Large amounts of fertilizer commonly are needed if hay or cultivated crops are grown. 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.

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, must 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 cropland, 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 or is available for these uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. 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 usually 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 local offices of the Soil Conservation Service.

About 286,000 acres in Greene County, or about 78 percent of the total acreage, meets the requirements for prime farmland. Nearly all of the prime farmland is used for crops.

The map units in Greene County 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.

Some of the soils that have a seasonal high water table or are flooded qualify for prime farmland only in areas where these limitations have been overcome by drainage or flood-control measures. In table 5 the need for these measures is indicated in parentheses after the map unit name. Onsite evaluation is needed to determine whether or not these limitations have 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 woodland; 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.

Greene County has a total area of 364,096 acres. About 352,700 acres is farmland, according to the 1982 Iowa Agricultural Statistics. Of this total, 313,400 acres is used for crops, 7,600 acres for hay, and 22,600 acres for pasture. Corn and soybeans are the main crops, but some oats are also grown. Alfalfa or a grass-alfalfa mixture is the major hay crop. Most of the permanent pastures support bluegrass and are not used as cropland because the soils either are flooded too frequently or are too steep for cultivation. Some of the pasture is timbered.

The paragraphs that follow describe the main management concerns in the areas used for crops and pasture.

Soil erosion is the major problem on about 30 percent of the cropland and pasture in Greene County. The major soils that are subject to erosion are Clarion, Dickman, Hayden, Lester, Storden, and Wadena soils.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is mixed into the plow layer. Loss of the surface layer is especially damaging on soils that have low fertility in the subsoil, such as Clarion and Lester soils. Erosion also reduces productivity of soils that tend to be droughty, such as Dickman and Wadena soils. Second, erosion on farmland can result in pollution of streams by sediment. Control of erosion improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing the pollution of streams.

Erosion control provides a protective plant cover, reduces the runoff rate, and increases the rate of water infiltration. On livestock farms, where part of the acreage is pasture and hayland, including legumes and grasses in the cropping system not only provides nitrogen and improves tilth for the following crops but also reduces the risk of 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 can be combined or separate operations. Conservation tillage is effective only if the amount of crop residue left on the surface after planting is enough to control erosion.

Terraces and diversions reduce the length of slopes and the hazards of runoff and erosion. They are most practical on deep, well drained soils, such as Clarion or Lester soils, which have long, uniform slopes. Some sloping soils are poorly suited to terraces and diversions because slopes are short or irregular. In some areas Hayden, Lester, and Storden soils are poorly suited because they are too steep. Dickman, Estherville, Salida, and Wadena soils are underlain by sand and gravel and thus are poorly suited to terraces and diversions. On these soils cropping systems that provide substantial vegetative cover and a conservation tillage system that leaves residue on the surface are effective in controlling erosion.

Contour farming is an erosion-control practice that is sometimes used in this county. It is well suited to the more sloping Clarion and Lester soils in areas where slopes are smooth and uniform.

Wind erosion is a hazard on the sandy Dickman soils and on the soils that have a high content of lime, such as Calco, Canisteo, and Harps soils. Maintaining a vegetative cover or surface mulch minimizes wind erosion on these soils.

Soil drainage is a major management concern in Greene County. Poorly drained and somewhat poorly drained soils make up about 63 percent of the total acreage in the county.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and measures that provide protection from runoff from the slopes at the higher elevations is needed in some areas of somewhat poorly drained, poorly drained, and very poorly drained soils that are intensively row cropped. Drains should be more closely spaced in the moderately slowly permeable soils than in the more rapidly permeable soils.

Soil fertility is affected by the supply of available phosphorus and potassium in the subsoil, by reaction, and by the content of organic matter in the surface layer. The supply of available phosphorus and potassium is very low or low in most soils in Greene County. Some upland soils are acid in the surface layer. On these soils applications of ground limestone are needed to raise the pH level sufficiently for good growth of alfalfa and other crops that grow well only on nearly neutral soils. Applications of lime are not needed, however, on some soils that have a high pH level. Examples are Calco, Canisteo, Harps, Mayer, Knoke, and Storden soils.

In most medium textured, well drained upland soils that formed under grass vegetation, such as Clarion soils, the content of organic matter in the surface layer is about 4 percent. In the eroded soils, it is generally less than 2 percent. In the medium textured, well drained soils that formed under the influence of forest and grass vegetation, such as Lester soils, it is about 2 to 3 percent. In the moderately sandy Dickman soils, it is generally 1 or 2 percent. In the poorly drained upland soils, such as Canisteo and Webster soils, the content of organic matter in the surface layer is about 6 percent. In the mucky Knoke and Okoboji soils, which are very poorly drained, it is about 15 percent.

The soils that formed in alluvium on bottom land are commonly slightly acid or neutral in the surface layer but range from medium acid to mildly alkaline. The organic matter content ranges from about 4 or 5 percent in Spillville soils to 6 or 7 percent in Coland soils. The supply of available phosphorus and potassium in alluvial soils in Greene County is generally low or very low.

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

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are generally granular and porous and have a high content of organic matter.

Most of the upland soils in the county have a dark surface layer in which the content of organic matter is moderate or high. Generally, the structure of the surface layer is weak, and intense rainfall causes the formation of a crust on the surface. The crust is hard when dry. It reduces the rate of water infiltration and increases the runoff rate. Regularly adding crop residue and manure improves soil structure and helps prevent surface crusting.

Fall plowing generally is not practical on the soils in the county. It increases the hazard of wind erosion if the soils are not protected by cover crops, windbreaks, or snow. It also increases the runoff rate and the hazard of erosion early in spring, during the period when snow melts.

Pasture and hay are suited to the soils and climate in Greene County. Several kinds of legumes, cool-season grasses, and warm-season grasses are grown.

Alfalfa and red clover are the most commonly grown legumes. They are also grown as mixtures with orchardgrass, bromegrass, or timothy for hay and pasture.

Warm-season grasses adapted to the county are switchgrass, big bluestem, and indiangrass. These grasses grow well during the warm summer months, but a special management system for establishing and grazing the plants is needed. Good grazing management is needed to enhance production of all pasture species. On steeply sloping soils it is needed to prevent surface compaction and gully erosion. The management needed on established stands includes applications of fertilizer, control of weeds and brush, rotation or deferred grazing, proper stocking rates, and adequate livestock watering facilities. If cultivated crops are grown prior to seeding, soil losses can be reduced by a conservation tillage system that leaves crop residue on the surface, contour farming, and grassed waterways. 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 capability classification is also shown for each unit.

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.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in table 6.

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. 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 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. If grading is needed, the depth of the soil over bedrock should be considered.

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, wheatgrass, 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, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-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 reeds.

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 bobwhite quail, 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, 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, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, 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 the depth to bedrock or 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, depth to bedrock, large stones, 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. Depth to bedrock, 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, depth to bedrock, 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, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock 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 or fractured bedrock 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, depth to bedrock, 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 and bedrock 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, depth to bedrock, 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, rock fragments, and bedrock.

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, stones, or soluble salts, 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 or stones, 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 fractured bedrock or other 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 of 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. 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. Depth to bedrock and the content of large stones affect 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 bedrock or to other 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; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as a high content of calcium carbonate. 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, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind 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, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, 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.

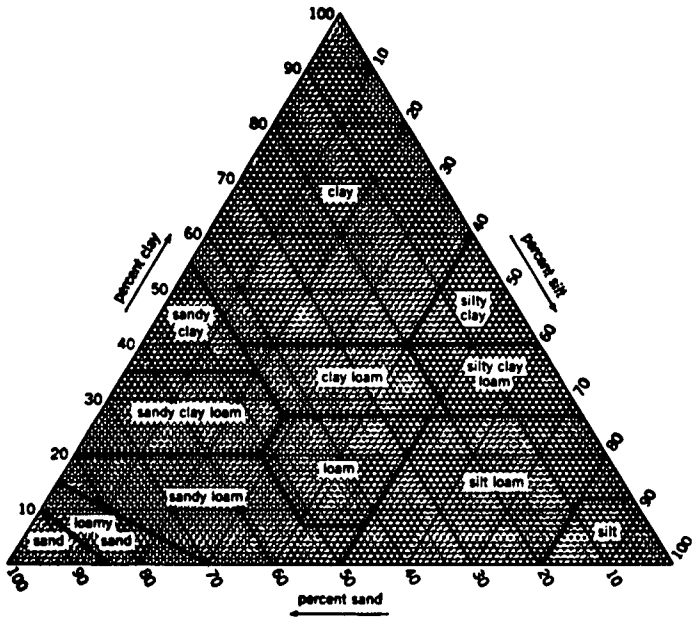

Figure 24.—Percentages of clay, silt, and sand in the basic USDA textural classes.

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 (fig. 24). "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, SP-SM.

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 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 wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. 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 wind erosion 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 wind erosion 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 wind erosion 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 wind erosion are used.
5. Loamy soils that are less than 18 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 wind erosion are used.
6. Loamy soils that are 18 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 wind erosion.

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.

In table 16, some soils are assigned to two hydrologic groups. 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, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal 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.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

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 (*14*). 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 have 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. The soil is compared with similar soils and with nearby soils of other 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* (*13*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*14*). 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."

Biscay Series

The Biscay series consists of poorly drained soils on outwash plains and stream terraces. These soils formed in loamy glacial outwash sediments underlain by calcareous sand and gravel. The native vegetation was prairie grasses. Permeability is moderate in the upper part of the profile and rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

Biscay soils are similar to Mayer and Webster soils and are commonly adjacent to Coland, Cylinder, and Mayer soils. Coland soils are slightly lower on the landscape than the Biscay soils. They are cumulic.

Coland and Webster soils contain more silt and clay and less sand and gravel in the substratum than the Biscay soils. Mayer soils are calcareous throughout the solum. They are in positions on the landscape similar to those of the Biscay soils. Cylinder soils are somewhat poorly drained and are slightly higher on the landscape than the Biscay soils.

Typical pedon of Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 160 feet east and 1,210 feet north of the southwest corner of sec. 19, T. 84 N., R. 30 W.

Ap—0 to 8 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

A—8 to 13 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

AB—13 to 22 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; thin discontinuous very dark grayish brown (2.5Y 3/2) and black (10YR 2/1) coatings on faces of peds; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; friable; neutral; clear irregular boundary.

Bg—22 to 35 inches; dark gray (5Y 4/1) and olive gray (5Y 5/2) loam; thin discontinuous very dark gray (10YR 3/1) and black (10YR 2/1) coatings on faces of peds; common fine faint light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; neutral; clear irregular boundary.

2Cg1—35 to 43 inches; dark grayish brown (2.5Y 4/2) loamy coarse sand; about 6 percent gravel; few fine distinct brown (7.5YR 5/4) mottles; weak fine subangular blocky structure; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg2—43 to 49 inches; olive gray (5Y 5/2) coarse sand; about 10 percent gravel; very weak fine subangular blocky structure; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg3—49 to 60 inches; olive gray (5Y 4/2) coarse and medium sand; about 20 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 mollic epipedon ranges from 16 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 or 1. It is loam or clay loam in which the content of clay is about 24 to 29 percent. It is slightly acid to mildly alkaline. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 to 3. It is neutral or mildly alkaline. The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is sand, loamy coarse sand, or loamy sand. In most pedons the content of gravel in this horizon varies.

Calco Series

The Calco series consists of poorly drained, moderately permeable soils on flood plains and low terraces. These soils formed in silty, calcareous alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Calco soils are similar to Canisteo, Coland, and Knoke soils and are commonly adjacent to Canisteo and Coland soils. Canisteo soils are higher on the landscape than the Calco soils. Also, their mollic epipedon is thinner. Coland soils contain more sand than the Calco soils and are not calcareous. Knoke soils contain more clay than the Calco soils.

Typical pedon of Calco silty clay loam, 0 to 2 percent slopes, in an area of cropland; 50 feet east and 1,000 feet south of the northwest corner of sec. 7, T. 83 N., R. 32 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; common very fine fragments of snail shells; strong effervescence; mildly alkaline; clear smooth boundary.

A1—8 to 20 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; friable; common very fine fragments of snail shells; strong effervescence; mildly alkaline; gradual wavy boundary.

A2—20 to 29 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium and fine subangular blocky structure; firm; few very fine fragments of snail shells; strong effervescence; mildly alkaline; gradual wavy boundary.

A3—29 to 41 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few medium distinct dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; firm; few fine fragments of snail shells; strong effervescence; mildly alkaline; clear wavy boundary.

Bg—41 to 50 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few medium distinct strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), and gray (10YR 5/1) mottles; moderate medium and fine subangular blocky structure; firm; few dark concretions (manganese oxide); strong effervescence; mildly alkaline; clear wavy boundary.

Cg—50 to 60 inches; light gray (5Y 6/1) silty clay loam (about 29 percent clay); common fine distinct

yellowish brown (10YR 5/4 and 5/6) mottles; massive; some vertical cleavage; friable; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. The mollic epipedon ranges from 30 to 50 inches in thickness. The number of snail shell fragments scattered throughout the profile ranges from few to many.

The maximum clay content in the A and B horizons ranges from 30 to 35 percent. The Bg horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 to 5. The Cg horizon is commonly clay loam or silty clay loam, but the range includes loam.

Calcousta Series

The Calcousta series consists of very poorly drained, moderately permeable, calcareous soils. These soils formed in silty lacustrine sediments in depressions on glacial till plains. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Calcousta soils are similar to Wacousta soils and are commonly adjacent to Canisteo, Harps, and Okoboji soils. Okoboji soils are cumulic. They have a higher content of clay than the Calcousta soils. They are in positions on the landscape similar to those of the Calcousta soils. Harps soils have a calcic horizon. Canisteo and Harps soils are poorly drained and are in the slightly higher areas. Wacousta soils have a noncalcareous surface layer.

Typical pedon of Calcousta silty clay loam, 0 to 1 percent slopes, in an area of cropland; 90 feet north and 2,550 feet east of the southwest corner of sec. 7, T. 84 N., R. 31 W.

Ap—0 to 11 inches; black (N 2/0) silty clay loam (about 30 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; abrupt wavy boundary.

Bg1—11 to 17 inches; gray (5Y 5/1) silty clay loam (about 34 percent clay); weak fine subangular blocky structure; friable; few dark gray (5Y 4/1) coatings on faces of peds; common reddish brown (5YR 4/4) root channels; violent effervescence; mildly alkaline; gradual smooth boundary.

Bg2—17 to 24 inches; light gray (5Y 6/1) silty clay loam (about 34 percent clay); weak fine subangular blocky structure; friable; olive gray (5Y 5/2) coatings on faces of peds; common reddish brown (5YR 4/4) root channels; violent effervescence; mildly alkaline; clear smooth boundary.

2Cg1—24 to 34 inches; gray (5Y 5/1 and 6/1) loam; many coarse distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 5 percent gravel; violent effervescence; mildly alkaline; clear smooth boundary.

2Cg2—34 to 49 inches; gray (5Y 5/1 and 6/1) loam; many coarse distinct light olive brown (2.5Y 5/4) mottles; massive; friable; violent effervescence; moderately alkaline; clear smooth boundary.

2Cg3—49 to 60 inches; gray (5Y 5/1) silt loam; many coarse distinct light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/4) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 16 to 28 inches. The thickness of the mollic epipedon ranges from 10 to 16 inches.

The A horizon is black (N 2/0 or 10YR 2/1). It is silty clay loam, mucky silty clay loam, or mucky silt loam. The B horizon has value of 4 to 6. The C horizon is loam, silt loam, or very fine sandy loam.

Canisteo Series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils on uplands. These soils formed in glacial sediments and glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Canisteo soils are similar to Harps and Webster soils and are commonly adjacent to Harps, Knoke, Okoboji, and Webster soils. Harps soils have a calcic horizon. They are in the slightly higher areas. Webster soils are noncalcareous in the solum. They are in positions on the landscape similar to those of the Canisteo soils. Knoke and Okoboji soils are cumulic. They are in the lower, more definite depressions.

Typical pedon of Canisteo clay loam, 0 to 2 percent slopes, in an area of cropland; 270 feet west and 1,500 feet north of the southeast corner of sec. 33, T. 83 N., R. 30 W.

Ap—0 to 8 inches; black (N 2/0) clay loam (about 32 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few very fine snail shell fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A—8 to 13 inches; black (10YR 2/1) clay loam (about 28 percent clay), very dark gray (10YR 3/1) and dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few very fine snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

AB—13 to 19 inches; very dark gray (10YR 3/1) clay loam (about 28 percent clay), gray (10YR 5/1) and dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few very fine snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg1—19 to 23 inches; dark gray (10YR 4/1) clay loam (about 28 percent clay); common very dark gray

(10YR 3/1) coatings on faces of peds; few fine faint brown (10YR 4/3) mottles; weak medium subangular blocky structure; friable; few fine snail shell fragments and lime accumulations; strong effervescence; mildly alkaline; clear smooth boundary.

Bg2—23 to 30 inches; grayish brown (2.5Y 5/2) clay loam (about 27 percent clay); discontinuous thin dark gray (10YR 4/1) coatings on faces of peds; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; common fine pebbles and lime accumulations; strong effervescence; mildly alkaline; clear smooth boundary.

Cg1—30 to 48 inches; light brownish gray (2.5Y 6/2) loam; few medium faint light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/4) mottles; massive; friable; few dark oxides and lime accumulations; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg2—48 to 60 inches; light brownish gray (2.5Y 6/2) loam; many medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; few dark concretions (manganese oxide); few lime accumulations; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 26 to 48 inches. The thickness of the mollic epipedon ranges from 15 to 23 inches.

The A horizon has value of 2 or 3 and chroma of 0 or 1. It is clay loam, loam, or silty clay loam. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2. It generally is clay loam, but the range includes silty clay loam and loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2. It ranges from loam to fine sandy loam or clay loam.

Clarion Series

The Clarion series consists of well drained, moderately permeable soils on convex upland slopes. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 18 percent.

Clarion soils are similar to Ocheyedan and Terril soils and are commonly adjacent to Nicollet and Storden soils. Ocheyedan soils formed in loamy glacial sediments. Terril soils formed in alluvium. Their mollic epipedon is thicker than that of the Clarion soils. Nicollet soils are somewhat poorly drained and are in the lower areas. Storden soils do not have a B horizon, are calcareous throughout, and generally are on the steeper, more convex slopes.

Typical pedon of Clarion loam, 2 to 5 percent slopes, in an area of cropland; 625 feet west and 2,300 feet south of the northeast corner of sec. 25, T. 85 N., R. 32 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; slightly acid; clear smooth boundary.

AB—9 to 14 inches; mixed black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam, dark gray (10YR 4/1) and grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1—14 to 22 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) coatings on faces of peds; neutral; clear smooth boundary.

Bw2—22 to 28 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; few pebbles; neutral; clear smooth boundary.

C1—28 to 40 inches; yellowish brown (10YR 5/4) loam; common fine faint light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) mottles; massive; friable; common pebbles; common lime accumulations; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—40 to 57 inches; yellowish brown (10YR 5/4) loam; common fine distinct light brownish gray (2.5Y 6/2) and many fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few pebbles; common lime accumulations; strong effervescence; moderately alkaline; clear smooth boundary.

C3—57 to 60 inches; yellowish brown (10YR 5/4) loam; many fine distinct light brownish gray (10YR 6/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) mottles; massive; friable; few pebbles; common lime accumulations; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 46 inches. The mollic epipedon ranges from 10 to 20 inches in thickness in the uneroded areas and from 7 to 10 inches in thickness in the eroded areas.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is dominantly loam, but the range includes sandy loam, silt loam, and clay loam. The Ap horizon is slightly acid or neutral. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. The B horizon is loam or clay loam. The C horizon has hue of dominantly 10YR but in some pedons has hue of 2.5Y. It is loam or sandy loam.

Coland Series

The Coland series consists of poorly drained, moderately permeable soils on flood plains and in drainageways. These soils formed in loamy and silty alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Coland soils are similar to Calco and Millington soils and are commonly adjacent to those soils. Calco and Millington soils are calcareous. They are in positions on the landscape similar to those of the Coland soils.

Typical pedon of Coland silty clay loam, 0 to 2 percent slopes, in an area of cropland; 65 feet south and 258 feet east of the northwest corner of sec. 14, T. 82 N., R. 31 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (about 18 percent sand), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A1—8 to 20 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A2—20 to 28 inches; black (N 2/0) clay loam (about 28 percent clay), very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—28 to 36 inches; black (10YR 2/1) clay loam (about 28 percent clay), dark gray (10YR 4/1) dry; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine prismatic structure parting to weak medium subangular blocky; friable; neutral; gradual wavy boundary.

AC—36 to 44 inches; very dark gray (10YR 3/1) clay loam (about 28 percent clay), gray (10YR 5/1) dry; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual wavy boundary.

Cg—44 to 60 inches; mixed light brownish gray (2.5Y 6/2) and very dark gray (N 3/0) loam; few fine prominent strong brown (7.5YR 5/6) and few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; neutral.

The thickness of the solum and the thickness of the mollic epipedon range from 36 to 48 inches. The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 or 1. It is neutral to medium acid. It is dominantly clay loam, but the range includes silty clay loam and loam. The AC horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 2 to 4 and chroma of 0 or 1. The C horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 2 to 5 and chroma of 0 to 2. It is clay loam or loam.

Cordova Series

The Cordova series consists of poorly drained, moderately slowly permeable soils in low areas on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Cordova soils are similar to Dundas and Webster soils and are commonly adjacent to Lester and Le Sueur soils. Dundas soils do not have a mollic epipedon. The well drained Lester and somewhat poorly drained Le Sueur soils are in the slightly higher, more sloping areas. Webster soils do not have an argillic horizon.

Typical pedon of Cordova loam, 0 to 2 percent slopes, in an area of cropland; 220 feet north and 1,500 feet east of the southwest corner of sec. 6, T. 82 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 26 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A—8 to 14 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; thin dark organic coatings and fillings in root channels; slightly acid; clear smooth boundary.

AB—14 to 19 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) and dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; thin dark organic coatings and fillings in voids; slightly acid; clear smooth boundary.

Btg1—19 to 25 inches; olive gray (5Y 4/2) clay loam; few fine faint olive gray (5Y 5/2) mottles; moderate fine and medium subangular blocky structure; firm; discontinuous dark grayish brown (2.5Y 4/2) clay films; thin very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

Btg2—25 to 32 inches; olive gray (5Y 5/2) clay loam; common fine faint olive gray (5Y 4/2) mottles; weak medium and fine subangular blocky structure; firm; discontinuous dark grayish brown (2.5Y 4/2) clay films; thin very dark gray (10YR 3/1) organic coatings on faces of peds; few dark concretions (manganese oxide); slightly acid; clear wavy boundary.

Btg3—32 to 38 inches; olive gray (5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; firm; thin discontinuous dark grayish brown (2.5Y 4/2) clay films; common dark concretions (manganese oxide); few fine lime accumulations; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—38 to 60 inches; olive gray (5Y 5/2) loam; common fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few dark concretions (manganese oxide); common lime accumulations; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon ranges from 10 to 23 inches in thickness.

The A horizon is loam, silty clay loam, or clay loam. The Bt horizon has hue of 5Y or 2.5Y and chroma of 2 or hue of 10YR and chroma of 1. It is loam, clay loam, or silty clay loam. The C horizon has hue of 5Y or 2.5Y. It is loam or clay loam.

Crippin Series

The Crippin series consists of somewhat poorly drained, moderately permeable soils on slightly convex upland slopes. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Crippin soils are similar to Guckeen and Nicollet soils and are commonly adjacent to Canisteo and Okoboji soils. Guckeen and Nicollet soils are noncalcareous in the surface layer. The poorly drained Canisteo and very poorly drained Okoboji soils are in the lower areas. Okoboji soils are cumulic.

Typical pedon of Crippin loam, 1 to 3 percent slopes, in an area of cropland; 175 feet south and 2,112 feet east of the northwest corner of sec. 14, T. 85 N., R. 29 W.

Ap—0 to 7 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A1—7 to 12 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A2—12 to 16 inches; mixed black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam, mixed dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slight effervescence; mildly alkaline; clear smooth boundary.

BA—16 to 20 inches; mixed very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and black (10YR 2/1) loam, mixed grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

Bw—20 to 26 inches; dark grayish brown (10YR 4/2) and black (10YR 2/1) loam; common fine faint yellowish brown (10YR 5/4) mottles; weak fine and medium subangular blocky structure; strong effervescence; mildly alkaline; clear smooth boundary.

BC—26 to 32 inches; dark grayish brown (10YR 4/2) loam; common fine faint yellowish brown (10YR 5/4 and 5/6) mottles; weak medium subangular blocky structure; friable; few soft lime accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

C—32 to 60 inches; grayish brown (2.5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; few dark concretions (manganese oxide); common soft lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 36 inches. The mollic epipedon ranges from 12 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 0 to 2. The B horizon is loam or clay loam. It has hue of 10YR or 2.5Y. The Bw and BC horizons have value of 4 or 5.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils on outwash plains and stream terraces. These soils formed in loamy glacial outwash or alluvium underlain by calcareous sand and gravel. The native vegetation was prairie grasses. Permeability is moderate in the upper part of the profile and very rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

Cylinder soils are similar to Fostoria and Nicollet soils and are commonly adjacent to Biscay and Wadena soils. Fostoria soils are finer textured in the substratum than the Cylinder soils. Nicollet soils are underlain by glacial till. Biscay soils are poorly drained and are in the lower areas. Wadena soils are well drained and are in the higher areas.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in an area of cropland; 1,440 feet west and 510 feet north of the southeast corner of sec. 7, T. 84 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few pebbles; slightly acid; clear smooth boundary.

A—10 to 17 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; few pebbles; slightly acid; clear smooth boundary.

AB—17 to 22 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; friable; few pebbles; neutral; gradual wavy boundary.

Bw1—22 to 27 inches; dark grayish brown (2.5Y 4/2) loam; few fine faint dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; thin very dark grayish brown (10YR 3/2) coatings on faces of peds; few pebbles; neutral; clear wavy boundary.

Bw2—27 to 33 inches; grayish brown (2.5Y 5/2) loam; common faint yellowish brown (10YR 5/4) mottles; weak fine and medium subangular blocky structure; friable; few dark concretions (manganese oxide); few pebbles; neutral; gradual wavy boundary.
2BC—33 to 39 inches; mixed grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) loamy sand; few fine distinct yellowish brown (10YR 5/6) and few fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very friable; few dark concretions (manganese oxide); common pebbles; neutral; clear wavy boundary.
2C—39 to 60 inches; variegated brown (10YR 5/3) and light brownish gray (2.5Y 6/2) sand and gravel; single grained; loose; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The mollic epipedon ranges from 14 to 22 inches in thickness.

The A horizon is loam or clay loam. It ranges from medium acid to neutral. The B horizon has hue of 10YR or 2.5Y and value of 4 or 5. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8. The upper few inches of this horizon is leached in some pedons.

Dickman Series

The Dickman series consists of well drained soils on convex ridgetops and side slopes in the uplands. These soils formed in loamy material and in the underlying sandy sediments. The native vegetation was prairie grasses. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 2 to 9 percent.

Dickman soils are similar to Estherville soils and are commonly adjacent to Clarion and Storden soils. Estherville soils contain more gravel than the Dickman soils. Clarion and Storden soils contain less sand and more silt and clay than the Dickman soils. Clarion soils are commonly in the less convex sloping areas. Storden soils are calcareous. They are in the more convex sloping areas.

Typical pedon of Dickman fine sandy loam, 2 to 5 percent slopes, in an area of cropland; 90 feet east and 380 feet south of the northwest corner of sec. 28, T. 82 N., R. 32 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) fine sandy loam (about 8 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; medium acid; clear smooth boundary.
AB—8 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.
Bw1—14 to 19 inches; brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; loose; slightly acid; clear smooth boundary.
Bw2—19 to 41 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; loose; about 3 percent gravel; slightly acid; gradual wavy boundary.
Bw3—41 to 49 inches; brown (10YR 4/3) sand; single grained; loose; slightly acid; clear wavy boundary.
C—49 to 60 inches; variegated brown (10YR 5/3) and light yellowish brown (10YR 6/4) sand; about 15 percent gravel; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is slightly acid or medium acid. The B horizon is dark brown (10YR 3/3) or brown (10YR 4/3) in the upper part and brown (10YR 4/3) to yellowish brown (10YR 5/4) in the lower part. The C horizon has hue of 7.5YR to 2.5Y, value of 5 or 6, and chroma of 3 or 4.

Dundas Series

The Dundas series consists of poorly drained, moderately slowly permeable soils in low areas on uplands. These soils formed in glacial till. The native vegetation was mixed deciduous forest and prairie grasses. Slopes range from 0 to 2 percent.

Dundas soils are similar to Cordova soils and are commonly adjacent to Le Sueur and Lester soils. Cordova soils have a mollic epipedon. The somewhat poorly drained Le Sueur and well drained Lester soils are in the higher, more sloping areas.

Typical pedon of Dundas silt loam, 0 to 2 percent slopes, in an area of cropland; 600 feet south and 310 feet east of the northwest corner of sec. 26, T. 84 N., R. 32 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
E—7 to 13 inches; dark gray (10YR 4/1) and gray (10YR 5/1) silt loam, light gray (10YR 7/1 and 6/1) dry; weak fine and medium subangular blocky structure parting to weak thin platy; friable; medium acid; abrupt smooth boundary.
Btg1—13 to 19 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine and medium distinct light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark gray (10YR 3/1) clay films; common light gray (10YR

6/1) silt coatings on some faces of peds; strongly acid; clear smooth boundary.

Btg2—19 to 25 inches; grayish brown (2.5Y 5/3) clay loam; common fine and medium distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark gray (10YR 3/1) clay films; strongly acid; clear smooth boundary.

Btg3—25 to 34 inches; grayish brown (2.5Y 5/2) clay loam; common fine faint light olive brown (2.5Y 5/4) and common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; firm; thin discontinuous very dark gray (10YR 3/1) clay films; common black (10YR 2/1) fillings in root channels; strongly acid; gradual smooth boundary.

BCg—34 to 47 inches; light brownish gray (2.5Y 6/2) clay loam; common fine and medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak coarse subangular blocky structure; firm; common black (10YR 2/1) fillings in root channels; few fine dark concretions (manganese oxide); slightly acid; clear smooth boundary.

Cg—47 to 60 inches; light olive gray (5Y 6/2) loam; common fine and medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; common fine black (10YR 2/1) fillings in root channels; common dark concretions (manganese oxide); common fine lime accumulations; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 36 to 48 inches. The A or Ap horizon ranges from 5 to 9 inches in thickness. It is black (10YR 2/1) or very dark gray (10YR 3/1). It is silt loam, loam, or silty clay loam. The E horizon is 2 to 8 inches thick. The B horizon has hue of 2.5Y or 5Y and value of 4 or 5. The lower part of the B horizon and the C horizon are clay loam or loam.

Estherville Series

The Estherville series consists of somewhat excessively drained soils on terraces, in valleys, and on moraines. These soils formed in loamy glacial outwash and in the underlying sandy and gravelly sediments. The native vegetation was prairie grasses. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 16 percent.

Estherville soils are similar to Dickman and Salida soils and are commonly adjacent to Cylinder and Wadena soils. Dickman soils are well drained. They contain less gravel than the Estherville soils. The solum of Cylinder and Wadena soils is thicker than that of the Estherville soils. Cylinder soils are somewhat poorly drained, are nearly level, and are lower on the landscape than the Estherville soils. Wadena soils are in positions on the landscape similar to those of the Estherville soils but generally are in the less convex sloping areas. Salida soils are excessively drained.

Typical pedon of Estherville sandy loam, 2 to 5 percent slopes, in an area of cropland; 840 feet west and 1,210 feet south of the northeast corner of sec. 20, T. 83 N., R. 30 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) sandy loam (about 14 percent clay), dark grayish brown (10YR 4/2) and brown (10YR 5/3) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; about 5 percent gravel; neutral; abrupt wavy boundary.

A—7 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; very friable; about 5 percent gravel; neutral; clear wavy boundary.

Bw—10 to 15 inches; brown (10YR 4/3 and 7.5YR 4/4) loam; weak medium and fine subangular blocky structure; friable; about 10 percent gravel; neutral; clear wavy boundary.

2BC—15 to 20 inches; dark yellowish brown (10YR 3/4) and brown (10YR 4/3) loamy sand and gravel; single grained; loose; about 20 percent gravel; neutral; clear wavy boundary.

2C1—20 to 28 inches; multicolored sand and gravel; single grained; loose; about 35 percent gravel; strong effervescence; mildly alkaline; gradual wavy boundary.

2C2—28 to 48 inches; multicolored sand and gravel; single grained; loose; about 30 percent gravel; strong effervescence; mildly alkaline; gradual wavy boundary.

2C3—48 to 60 inches; multicolored dark grayish brown (10YR 4/2), yellowish brown (10YR 5/4), and light gray (10YR 7/2) sand and gravel; single grained; loose; about 50 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 15 to 24 inches. The mollic epipedon ranges from 9 to 20 inches in thickness.

The A horizon has hue of 10YR and value of 2 or 3. It is sandy loam or loam. The content of gravel in this horizon ranges from 2 to 15 percent. The Bw horizon has value of 4 or 5. It is loam or sandy loam in which the content of gravel is less than 15 percent. In some pedons the 2BC horizon is gravelly loamy sand or gravelly sandy loam.

Fostoria Series

The Fostoria series consists of somewhat poorly drained, moderately permeable soils. These soils formed in loamy outwash sediments on stream terraces or in

loamy sediments on glacial till plains in the uplands. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Fostoria soils are similar to Cylinder and Nicollet soils and are commonly adjacent to Ocheyedan and Webster soils. Cylinder soils are underlain by sand and gravel. Nicollet soils formed in glacial till. Ocheyedan soils are well drained and generally are in the slightly higher, more convex sloping areas on terraces. Webster soils are poorly drained and are in the lower areas on uplands.

Typical pedon of Fostoria loam, 0 to 2 percent slopes, in an area of cropland; 1,400 feet east and 1,650 feet south of the northwest corner of sec. 31, T. 82 N., R. 29 W.

Ap—0 to 8 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; neutral; clear smooth boundary.

A—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine and medium granular; friable; neutral; clear smooth boundary.

Bw1—16 to 23 inches; dark grayish brown (10YR 4/2) clay loam (about 28 percent clay), grayish brown (10YR 5/2) dry; few fine faint yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; many very dark grayish brown (10YR 3/2) and some black (10YR 2/1) coatings on faces of peds; some black (10YR 2/1) root channels; neutral; gradual smooth boundary.

Bw2—23 to 35 inches; dark grayish brown (2.5Y 4/2) clay loam (about 28 percent clay); common fine faint olive brown (2.5Y 4/4) and yellowish brown (10YR 5/4) mottles; weak medium and fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; neutral; gradual wavy boundary.

BC—35 to 42 inches; grayish brown (2.5Y 5/2) loam; common medium distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; few fine dark concretions (manganese oxide); neutral; gradual wavy boundary.

2C1—42 to 51 inches; grayish brown (2.5Y 5/2) silt loam; common fine and medium distinct yellowish brown (10YR 5/6) and olive brown (2.5Y 4/4) mottles; massive; friable; few fine dark concretions (manganese oxide); slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—51 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common coarse distinct yellowish brown (10YR 5/6) and olive brown (2.5Y 4/4) mottles; massive; friable; few fine dark concretions (manganese oxide); slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 48 inches. The mollic epipedon ranges from 12 to 22 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 to 2. It is loam, silt loam, or clay loam. It is neutral or slightly acid. The B horizon is clay loam, loam, or silt loam. The 2C horizon has hue of 10YR or 2.5Y and value of 4 to 6. It is silt loam to fine sandy loam.

Guckeen Series

The Guckeen series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. These soils formed in glacial or lacustrine sediments over loamy glacial till or sediments that have a lower content of clay. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Guckeen soils are similar to Nicollet soils and are commonly adjacent to Clarion and Marna soils. Nicollet soils have a lower clay content than the Guckeen soils. Clarion soils are well drained and are in the higher, more convex sloping areas. Marna soils are poorly drained and are in the slightly lower, less sloping areas.

Typical pedon of Guckeen silty clay loam, 1 to 3 percent slopes; 40 feet east and 1,956 feet north of the southwest corner of sec. 15, T. 85 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A—9 to 14 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

AB—14 to 18 inches; very dark grayish brown (2.5Y 3/2) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; thin discontinuous very dark gray (10YR 3/1) coatings on faces of peds; slightly acid; gradual smooth boundary.

Bw1—18 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine and medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; slightly acid; gradual wavy boundary.

Bw2—27 to 39 inches; grayish brown (2.5Y 5/2) silty clay; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine and medium prismatic structure parting to moderate medium subangular blocky; firm; common dark concretions (manganese oxide); neutral; gradual wavy boundary.

BC—39 to 44 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct yellowish brown (10YR 5/6) and few fine prominent brown (7.5YR 4/4)

mottles; moderate medium prismatic structure; friable; thin dark grayish brown (2.5Y 4/2) coatings on faces of peds; common dark concretions (manganese oxide); mildly alkaline; gradual wavy boundary.

2C—44 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common fine and medium distinct yellowish brown (10YR 5/6) and few fine prominent brown (7.5YR 4/4) mottles; massive; friable; common dark concretions (manganese oxide); common lime accumulations; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 44 inches. The mollic epipedon ranges from 14 to 18 inches in thickness.

The A horizon is black (N 2/0) or has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It is silty clay, silty clay loam, or clay loam. The upper part of the B horizon has hue of 2.5Y or 10YR. It is silty clay, silty clay loam, or clay. The lower part is clay loam or loam. The C horizon has hue of 2.5Y or 5Y.

Harps Series

The Harps series consists of poorly drained, moderately permeable, highly calcareous soils along the edges of upland depressions and on slight rises and in swales. These soils formed in glacial till or glacial till sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Harps soils are similar to Canisteo soils and are commonly adjacent to Canisteo, Knoke, and Okoboji soils. Canisteo and Knoke soils are less calcareous than the Harps soils. Canisteo soils are in positions on the landscape similar to those of the Harps soils but are in the smoother areas. Knoke and Okoboji soils have a cumulic A horizon and a clayey B horizon. They are in depressions.

Typical pedon of Harps loam, 0 to 2 percent slopes, in an area of cropland; 450 feet south and 225 feet east of the northwest corner of sec. 6, T. 84 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine snail shell fragments; violent effervescence; mildly alkaline; clear smooth boundary.

Ak1—8 to 13 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; common fine snail shell fragments; violent effervescence; mildly alkaline; gradual smooth boundary.

Ak2—13 to 17 inches; mixed black (10YR 2/1) and dark gray (10YR 4/1) loam; weak fine subangular blocky structure parting to weak fine granular; friable; common fine shell fragments; violent effervescence; mildly alkaline; gradual smooth boundary.

BAkg—17 to 25 inches; gray (2.5Y 5/1) loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

Bkg—25 to 33 inches; light olive gray (5Y 6/2) loam; common medium and fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few pebbles; common lime accumulations; violent effervescence; moderately alkaline; clear smooth boundary.

BCkg—33 to 42 inches; light olive gray (5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common pebbles; few lime accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—42 to 60 inches; light olive gray (5Y 6/2) loam; many large prominent yellowish red (5YR 4/6) and yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (manganese oxide); few pebbles; common lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon is black (10YR 2/1) or very dark gray (N 3/0). It is loam or clay loam. The B horizon is loam, clay loam, or sandy clay loam. The C horizon is dominantly loam or sandy clay loam, but in some pedons it has thin strata of coarser textured material.

Hayden Series

The Hayden series consists of well drained, moderately permeable soils on uplands. These soils formed in calcareous glacial till on moraines. The native vegetation was deciduous trees. Slopes range from 25 to 40 percent.

Hayden soils are similar to Lester soils and are commonly adjacent to Lester and Storden soils. Lester soils generally are in the smoother, less sloping areas. Their A horizon is thicker than that of the Hayden soils, and the E horizon is thinner. Storden soils do not have a B horizon and are calcareous. They generally are in the steeper, more convex sloping areas.

Typical pedon of Hayden loam, 25 to 40 percent slopes, in an area of timber; 400 feet east and 200 feet north of the southwest corner of sec. 36, T. 83 N., R. 30 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loam (about 21 percent clay), gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

E—3 to 7 inches; dark grayish brown (10YR 4/2) loam (about 20 percent clay); weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.
BE—7 to 11 inches; yellowish brown (10YR 5/4) loam (about 26 percent clay); moderate medium and fine subangular blocky structure; friable; thin discontinuous light gray (10YR 6/1) dry silt coatings on faces of peds; strongly acid; clear wavy boundary.
Bt1—11 to 18 inches; yellowish brown (10YR 5/4) clay loam (about 28 percent clay); moderate medium subangular blocky structure; firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films; thin patchy light gray (10YR 6/1) dry silt coatings on faces of peds; medium acid; clear wavy boundary.
Bt2—18 to 23 inches; yellowish brown (10YR 5/4) clay loam (about 28 percent clay); weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films; slightly acid; clear wavy boundary.
Bt3—23 to 27 inches; yellowish brown (10YR 5/4) clay loam (about 28 percent clay); few fine distinct yellowish brown (10YR 5/8) and brown (7.5YR 4/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous dark yellowish brown (10YR 3/4) clay films; neutral; clear wavy boundary.
BC—27 to 32 inches; light olive brown (2.5Y 5/4) loam; few fine distinct brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; some thin dark yellowish brown (10YR 3/4) organic stains on vertical cleavage planes; common lime accumulations; strong effervescence; mildly alkaline; clear wavy boundary.
C1—32 to 52 inches; light olive brown (2.5Y 5/4) loam; few medium prominent yellowish red (5YR 4/6) and few medium distinct brown (7.5YR 4/4) mottles; massive; friable; common lime accumulations; strong effervescence; moderately alkaline; gradual wavy boundary.
C2—52 to 60 inches; light olive brown (2.5Y 5/4) loam; few medium distinct brown (7.5YR 4/4) mottles; massive; friable; few dark concretions (manganese oxide); few lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 44 inches. The A horizon is 2 to 4 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has value of 4 or 5 and chroma of 3 or 4. In the lower part this horizon has hue of 10YR or 2.5Y.

Knoke Series

The Knoke series consists of very poorly drained, calcareous, moderately slowly permeable soils in upland depressions. These soils formed in silty glacial sediments. The native vegetation was grasses, sedges, and reeds. Slopes are 0 to 1 percent.

Knoke soils are similar to Okoboji soils and are commonly adjacent to Canisteo and Harps soils. Okoboji soils are not calcareous in the surface layer. Canisteo and Harps soils are not cumulic and are in the fine-loamy family. Canisteo soils are in the slightly higher areas. Harps soils are on the rims of depressions.

Typical pedon of Knoke silty clay loam, 0 to 1 percent slopes, in an area of cropland; 100 feet south and 1,660 feet west of the northeast corner of sec. 24, T. 85 N., R. 32 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine snail shell fragments; strong effervescence; mildly alkaline; clear smooth boundary.
A1—8 to 12 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; few fine snail shell fragments; strong effervescence; mildly alkaline; clear smooth boundary.
A2—12 to 19 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate fine and medium granular; friable; common snail shell fragments; strong effervescence; mildly alkaline; clear smooth boundary.
A3—19 to 26 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak medium granular; friable; few snail shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.
A4—26 to 34 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; firm; slight effervescence; mildly alkaline; clear smooth boundary.
Bg—34 to 41 inches; black (2.5Y 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual wavy boundary.
BCg—41 to 50 inches; very dark gray (5Y 3/1) silty clay loam, gray (5Y 5/1) dry; black (2.5Y 2/1) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) mottles; weak fine and medium subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual wavy boundary.
Cg—50 to 60 inches; mixed gray (5Y 5/1) and light olive gray (5Y 6/2) silty clay loam; common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The mollic epipedon ranges from 30 to 54 inches in thickness.

The A horizon is black (N 2/0) or very dark gray (10YR 3/1). Where the surface layer is mucky silty clay loam or mucky silt loam, the mucky material extends to a depth of 6 to 25 inches. The upper part of the B horizon has value of 2 or 3 and chroma of 0 or 1. The lower part is neutral in hue or has hue of 2.5Y or 5Y.

Le Sueur Series

The Le Sueur series consists of somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loamy glacial till. The native vegetation was mixed grasses and deciduous trees. Slopes are 1 to 3 percent.

Le Sueur soils are similar to Lester and Moingona soils and are commonly adjacent to Cordova, Dundas, and Lester soils. Lester soils are well drained and are in the higher, more convex sloping areas. Moingona soils formed in alluvial and colluvial sediments on foot slopes and fans. Cordova and Dundas soils are poorly drained and in the lower, less sloping areas.

Typical pedon of Le Sueur loam, 1 to 3 percent slopes, in an area of cropland; 50 feet west and 480 feet south of the northeast corner of sec. 32, T. 82 N., R. 29 W.

Ap—0 to 7 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; weak medium granular structure; friable; medium acid; clear smooth boundary.

A—7 to 11 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam, dark gray (10YR 4/1) and grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

BE—11 to 22 inches; dark grayish brown (2.5Y 4/2) loam; weak medium and fine subangular blocky structure; friable; few thin gray (10YR 5/1) porous silt coatings on faces of peds; thin discontinuous black (10YR 2/1) coatings on faces of peds; medium acid; clear smooth boundary.

Bt1—22 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) and few fine faint olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; firm; thin discontinuous dark clay films and organic stains; dark root channels; slightly acid; clear smooth boundary.

Bt2—30 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine distinct yellowish brown (10YR 5/6) and few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; firm; thin discontinuous dark clay films and organic stains; dark root channels; slightly acid; clear smooth boundary.

BC—36 to 49 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/4 and 5/6) and brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; thin discontinuous dark clay films and organic stains; dark root channels; few dark concretions (manganese oxide); slightly acid; gradual smooth boundary.

Cg—49 to 60 inches; gray (5Y 5/1) loam; common medium distinct light olive brown (2.5Y 5/6) and dark yellowish brown (10YR 4/4) mottles; massive; friable; few dark concretions (manganese oxide); strong effervescence; moderately alkaline.

The thickness of the solum ranges from 28 to 55 inches. The mollic epipedon ranges from 10 to 18 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, silty clay loam, clay loam, or silt loam. It is medium acid to neutral. The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 to 5, 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 B horizon is clay loam or silty clay loam. It is strongly acid to slightly acid. The C horizon has hue of 2.5Y or 5Y. It is mildly alkaline or moderately alkaline.

Lester Series

The Lester series consists of well drained, moderately permeable soils on uplands. These soils formed in glacial till. The native vegetation was mixed grasses and deciduous trees. Slopes range from 2 to 40 percent.

Lester soils are similar to Clarion and Hayden soils and are commonly adjacent to Le Sueur and Storden soils. The A horizon of Clarion soils is thicker than that of the Lester soils. The A horizon of Hayden soils is thinner than that of the Lester soils, and the E horizon is more prominent. Le Sueur soils are somewhat poorly drained and are in the lower, less sloping areas. Storden soils are calcareous, do not have a B horizon, and are in the steeper, more convex sloping areas.

Typical pedon of Lester loam, 2 to 5 percent slopes, in an area of cropland; 1,000 feet east and 125 feet north of the southwest corner of sec. 29, T. 82 N., R. 29 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam (about 20 percent clay), grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

E—7 to 9 inches; mixed very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) loam (about 20 percent clay), grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; weak

medium subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—9 to 14 inches; brown (10YR 4/3) clay loam (about 27 percent clay); moderate fine and medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films; medium acid; clear smooth boundary.

Bt2—14 to 20 inches; brown (10YR 4/3) clay loam (about 28 percent clay); weak fine prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous dark grayish brown (10YR 4/2) clay films; few pebbles; medium acid; gradual smooth boundary.

Bt3—20 to 27 inches; dark yellowish brown (10YR 4/4) clay loam (about 28 percent clay); moderate medium subangular blocky structure; firm; thin discontinuous brown (10YR 4/3) and very dark grayish brown (10YR 3/2) clay films; slightly acid; gradual wavy boundary.

C1—27 to 40 inches; light olive brown (2.5Y 5/4) loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few dark organic stains in old root channels; common lime accumulations; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; many soft lime accumulations; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 44 inches. The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or sandy loam. The E horizon has chroma of 1 or 2. It is loam, silt loam, or sandy loam. The A and E horizons are medium acid or slightly acid. The upper part of the B horizon has chroma of 3 or 4, and the lower part has hue of 10YR or 2.5Y and value of 4 or 5. Some pedons have silt coatings on peds in the upper part of the B horizon. This horizon is clay loam or loam. It is strongly acid to slightly acid in the upper part and medium acid to neutral in the lower part. The C horizon has value of 4 to 6 and chroma of 3 to 6.

Marna Series

The Marna series consists of poorly drained, slowly permeable soils on uplands. These soils formed in glacial or lacustrine sediments overlying loamy glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Marna soils are similar to Guckeen and Webster soils and are commonly adjacent to Canisteo and Guckeen soils. Canisteo soils are calcareous. They are in positions on the landscape similar to those of the Marna soils. Guckeen soils are somewhat poorly drained and are in the slightly higher, more convex sloping areas. Webster soils contain less clay in the solum than the Marna soils.

Typical pedon of Marna silty clay loam, 0 to 2 percent slopes; 1,637 feet north and 45 feet east of the southwest corner of sec. 15, T. 85 N., R. 29 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A—9 to 19 inches; black (N 2/0) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine and medium granular; friable; neutral; clear smooth boundary.

AB—19 to 22 inches; very dark gray (5Y 3/1) clay (about 21 percent sand), very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; black (N 2/0) coatings on faces of peds; neutral; clear smooth boundary.

Bg1—22 to 30 inches; olive gray (5Y 5/2) clay (about 32 percent sand); few fine prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; thin nearly continuous clay films on faces of peds; common dark concretions (manganese oxide); neutral; gradual smooth boundary.

2Bg2—30 to 37 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; firm; thin patchy clay films on faces of peds; common dark concretions (manganese oxide); neutral; clear wavy boundary.

2Cg1—37 to 54 inches; light brownish gray (2.5Y 6/2) loam; common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; common dark concretions (manganese oxide); common lime accumulations; strong effervescence; moderately alkaline; gradual wavy boundary.

2Cg2—54 to 60 inches; olive gray (5Y 5/2) loam; many medium prominent yellowish brown (10YR 5/6) and brown (7.5YR 4/4) mottles; massive; friable; common dark concretions (manganese oxide); common lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches, and the thickness of the moderately fine textured sediments ranges from 24 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches. The A and B horizons are silty clay loam or clay in which the content of clay is 35 to 55 percent.

Mayer Series

The Mayer series consists of poorly drained, calcareous soils on outwash plains and stream terraces. These soils formed in loamy glacial outwash or alluvium underlain by calcareous sand and gravel. The native vegetation was prairie grasses. Permeability is moderate in the upper part of the profile and rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

Mayer soils are similar to Biscay soils and are commonly adjacent to Biscay and Cylinder soils. Biscay and Cylinder soils are noncalcareous. Biscay soils are in positions on the landscape similar to those of the Mayer soils. Cylinder soils are somewhat poorly drained and are in the slightly higher areas.

Typical pedon of Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 494 feet east and 490 feet north of the southwest corner of sec. 24, T. 84 N., R. 31 W.

Ap—0 to 8 inches; black (N 2/0) loam (about 25 percent clay), very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; few very fine snail shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

A—8 to 15 inches; black (N 2/0) loam (about 25 percent clay), very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; few fine snail shell fragments; slight effervescence; moderately alkaline; clear smooth boundary.

AB—15 to 21 inches; very dark grayish brown (2.5Y 3/2) loam (about 23 percent clay), dark grayish brown (2.5Y 4/2) dry; thin discontinuous very dark gray (N 3/0) coatings on faces of peds; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak fine and medium subangular blocky structure; friable; few fine snail shell fragments; slight effervescence; moderately alkaline; clear smooth boundary.

Bg1—21 to 27 inches; olive gray (5Y 4/2) loam (about 20 percent clay); thin discontinuous very dark gray (5Y 3/1) coatings on faces of peds; few fine faint olive brown (2.5Y 4/4) mottles; weak fine and medium subangular blocky structure; friable; slight effervescence; moderately alkaline; clear wavy boundary.

Bg2—27 to 34 inches; olive gray (5Y 5/2) loam (about 15 percent clay); few small dark gray (10YR 4/1) organic stains; few fine faint light olive brown (2.5Y 5/4) and few fine distinct dark yellowish brown (10YR 4/6) mottles; weak fine and medium subangular blocky structure; friable; slight effervescence; moderately alkaline; clear smooth boundary.

2BC—34 to 39 inches; olive gray (5Y 5/2) loamy coarse sand (about 9 percent clay); common fine faint olive (5Y 5/4) mottles; weak fine subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.

2Cg1—39 to 47 inches; olive (5Y 5/3) sand and gravel; single grained; loose; slight effervescence; moderately alkaline; gradual smooth boundary.

2Cg2—47 to 60 inches; grayish brown (2.5Y 5/2) sand and gravel; single grained; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. Effervescence is slight to strong throughout the pedon.

The A horizon is black (10YR 2/1 or N 2/0) or very dark gray (10YR 3/1 or N 3/0). It is loam or clay loam. It has snail shell fragments in some pedons. It is mildly alkaline or moderately alkaline. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. The C horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 2 or 3. It is sand, loamy coarse sand, or loamy sand. In most pedons the content of gravel varies in this horizon.

Millington Series

The Millington series consists of poorly drained, moderately permeable soils on flood plains. These soils formed in alluvial sediments. The native vegetation was marsh and prairie grasses. Slopes range from 0 to 2 percent.

Millington soils are similar to Calco and Coland soils and are commonly adjacent to Calco, Coland, and Spillville soils and to Fluvaquents. Calco and Coland soils are not stratified. Coland soils are not calcareous. Calco and Coland soils and Fluvaquents are in positions on the landscape similar to those of the Millington soils. Fluvaquents vary more in drainage and in fertility than the Millington soils. Spillville soils are somewhat poorly drained and are in the slightly higher areas.

Typical pedon of Millington loam, 0 to 2 percent slopes, in an area of pasture; 1,400 feet east and 2,440 feet north of the southwest corner of sec. 23, T. 84 N., R. 32 W.

A1—0 to 7 inches; black (10YR 2/1) loam (about 22 percent clay), dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; common roots; common fine pores; slight effervescence; moderately alkaline; gradual smooth boundary.

A2—7 to 22 inches; very dark gray (10YR 3/1) loam (about 20 percent clay), dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; thin continuous black (10YR 2/1) coatings on faces of peds; common roots; common fine pores; slight effervescence; mildly alkaline; gradual smooth boundary.

Bw1—22 to 33 inches; very dark gray (10YR 3/1) loam (about 22 percent clay), dark gray (10YR 4/1) with light gray (10YR 6/1) pockets when dry; common fine distinct brown (7.5YR 4/4) mottles; weak medium and fine subangular blocky structure; friable; thin discontinuous black (10YR 2/1) coatings on faces of peds; common roots; common fine pores; slight effervescence; mildly alkaline; abrupt irregular boundary.

C1—33 to 39 inches; stratified dark grayish brown (10YR 4/2) sand (about 4 percent clay) and very dark grayish brown (10YR 3/2) loam; common fine distinct brown (10YR 4/3) mottles; very weak fine subangular blocky structure; very friable; slight effervescence; moderately alkaline; clear smooth boundary.

C2—39 to 48 inches; black (N 2/0) loam (about 20 percent clay); thin gray (10YR 5/1) strata; common fine distinct brown (7.5YR 4/4) and few fine prominent dark reddish brown (2.5YR 3/4) mottles; massive; friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C3—48 to 54 inches; grayish brown (10YR 5/2) sand; some gravel at a depth of 48 to 50 inches; common fine distinct dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6) mottles; single grained; loose; slight effervescence; moderately alkaline; clear smooth boundary.

C4—54 to 60 inches; stratified light brownish gray (10YR 6/2) loamy fine sand and dark grayish brown (10YR 4/2) sandy loam; common medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; massive; very friable; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches. Some pedons have fragments of snail shells. In some pedons the mollic colors extend only into the upper part of the B horizon.

The A horizon has chroma of 1 or 2. It is commonly loam, but the range includes silt loam, silty clay loam, and clay loam. The B horizon generally has the same textures as the A horizon, but the range includes sandy loam.

Moingona Series

The Moingona series consists of moderately well drained, moderately permeable soils. These soils formed in alluvial and colluvial sediments on foot slopes, alluvial fans, and terraces. The native vegetation was mixed prairie grasses and deciduous trees. Slopes range from 0 to 7 percent.

Moingona soils are similar to Le Sueur soils and are commonly adjacent to Spillville, Storden, and Wadena soils. Le Sueur soils formed in glacial till. Spillville soils are somewhat poorly drained and are in the lower areas. Storden soils do not have a subsoil, formed in glacial till, and are in the higher areas. Wadena soils are underlain by sand and gravel and generally are in the lower areas.

Typical pedon of Moingona loam, 2 to 7 percent slopes, in an area of pasture; 1,000 feet north and 2,560 feet west of the southeast corner of sec. 5, T. 83 N., R. 31 W.

A1—0 to 11 inches; black (10YR 2/1) loam (about 23 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A2—11 to 15 inches; very dark grayish brown (10YR 3/2) loam (about 19 percent clay), dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure parting to weak fine granular; friable; thin discontinuous grayish brown (10YR 5/2) dry silt coatings on faces of peds; slightly acid; clear smooth boundary.

BA—15 to 23 inches; dark grayish brown (10YR 4/2) loam (about 19 percent clay); weak medium subangular blocky structure; friable; thin discontinuous clay films; thin discontinuous grayish brown (10YR 5/2) dry silt coatings on faces of peds; neutral; clear smooth boundary.

Bt1—23 to 32 inches; brown (10YR 4/3) loam (about 23 percent clay); few fine faint yellowish brown (10YR 5/4) mottles; moderate medium and fine subangular blocky structure; friable; thin continuous clay films on vertical faces of peds; few thin light gray (10YR 6/1) dry silt or fine sand coatings on faces of peds; neutral; clear smooth boundary.

Bt2—32 to 39 inches; brown (10YR 4/3) loam (about 25 percent clay); few fine faint yellowish brown (10YR 5/4 and 5/6) mottles; weak fine prismatic structure parting to moderate medium subangular blocky; firm; neutral; clear smooth boundary.

Bt3—39 to 57 inches; brown (10YR 4/3) loam (about 27 percent clay); few fine faint yellowish brown (10YR 5/4 and 5/6) mottles; weak fine and medium subangular blocky structure; firm; few dark concretions (manganese oxide); neutral; clear smooth boundary.

BC—57 to 60 inches; brown (10YR 4/3) sandy loam (about 19 percent clay); weak fine and medium subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) coatings on faces of peds; few dark concretions (manganese oxide); neutral.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon ranges from 10 to 22 inches in thickness.

The Ap or A horizon is loam or sandy loam. Some pedons have an E horizon. The Bt horizon has value of 4 or 5 and chroma of 3 or 4. The content of clay in this horizon generally ranges from 21 to 30 percent but may

be as much as 35 percent in some subhorizons. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It typically is loam, sandy loam, or clay loam. In some pedons a 2C horizon of gravelly sandy loam or clay loam glacial till is below a depth of 50 inches.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils. These soils formed in loamy glacial till on uplands. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Nicollet soils are similar to Crippin, Fostoria, and Guckeen soils and are commonly adjacent to Clarion and Webster soils. Crippin soils are calcareous. Fostoria soils formed in outwash sediments. Guckeen soils have a higher content of clay in the solum than the Nicollet soils. Clarion soils are well drained and are in the higher, more convex sloping areas. Webster soils are poorly drained and are in the lower, less sloping areas.

Typical pedon of Nicollet loam, 1 to 3 percent slopes, in an area of cropland; 60 feet west and 2,535 feet south of the northeast corner of sec. 15, T. 82 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A—8 to 15 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

BA—15 to 20 inches; dark grayish brown (10YR 4/2) clay loam; weak fine and medium subangular blocky structure; friable; thin dark organic coatings on faces of peds; few pebbles; slightly acid; gradual smooth boundary.

Bw1—20 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; few pebbles; neutral; gradual smooth boundary.

Bw2—25 to 29 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few pebbles; neutral; clear wavy boundary.

Cg1—29 to 36 inches; light brownish gray (2.5Y 6/2) loam; many medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; massive; friable; few pebbles; many lime accumulations; strong effervescence; mildly alkaline; clear wavy boundary.

Cg2—36 to 60 inches; light brownish gray (2.5Y 6/2) loam; many medium distinct yellowish brown (10YR 5/6 and 5/4) mottles; massive; friable; few dark concretions (manganese oxide); many lime accumulations; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 48 inches. The mollic epipedon ranges from 10 to 21 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. It is medium acid to neutral. The upper part of the B 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 B horizon is clay loam or loam.

Ocheyedan Series

The Ocheyedan series consists of well drained, moderately permeable soils. These soils formed in loamy and silty glacial sediments on stream terraces and uplands. The native vegetation was prairie grasses. Slopes range from 0 to 9 percent.

Ocheyedan soils are similar to Clarion and Wadena soils and are commonly adjacent to Biscay, Fostoria, and Mayer soils. Clarion soils formed in glacial till. Wadena soils are coarser textured in the C horizon than the Ocheyedan soils. The poorly drained Biscay and Mayer and somewhat poorly drained Fostoria soils are in the lower, less sloping areas. Mayer soils are calcareous.

Typical pedon of Ocheyedan loam, 2 to 5 percent slopes, in an area of cropland; 180 feet north and 850 feet west of the southeast corner of sec. 20, T. 82 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A—8 to 13 inches; mixed very dark grayish brown (10YR 3/2), black (10YR 2/1), and dark brown (10YR 3/3) loam, dark grayish brown (10YR 4/2) and brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

BA—13 to 18 inches; dark yellowish brown (10YR 4/4) loam; weak medium and fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) and black (10YR 2/1) coatings on faces of peds; neutral; clear smooth boundary.

Bw1—18 to 26 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; thin discontinuous brown (10YR 4/3) coatings on faces of peds; neutral; clear smooth boundary.

2Bw2—26 to 35 inches; light olive brown (2.5Y 5/4) silt loam; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

2C1—35 to 42 inches; light yellowish brown (2.5Y 6/4) silt loam; few fine distinct yellowish brown (10YR 5/6) and few fine prominent brown (7.5YR 4/4) mottles; massive; friable; common lime

accumulations and few dark concretions (iron and manganese oxides); strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—42 to 60 inches; light yellowish brown (2.5Y 6/4) silt loam; few fine prominent brown (7.5YR 4/4) and few medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few fine lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The mollic epipedon ranges from 10 to 23 inches in thickness.

The A horizon is neutral to medium acid. The B horizon has chroma of 3 or 4. It is loam, sandy loam, or sandy clay loam. The 2B and 2C horizons are silt loam or sandy loam.

Okoboji Series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils on uplands. These soils formed in silty alluvium in upland depressions. The native vegetation was grasses, sedges, and reeds. Slopes are 0 to 1 percent.

Okoboji soils are similar to Knoke soils and are commonly adjacent to Canisteo, Harps, and Webster soils. Canisteo, Harps, and Knoke soils are calcareous. Canisteo, Harps, and Webster soils are not cumulic. They have a lower content of clay in the B horizon than the Okoboji soils. Also, they are slightly higher on the landscape.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes, in an area of cropland; 333 feet west and 18 feet north of the southeast corner of sec. 19, T. 84 N., R. 31 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A1—9 to 23 inches; black (N 2/0) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A2—23 to 31 inches; black (10YR 2/1) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium and fine subangular blocky structure; firm; neutral; clear smooth boundary.

A3—31 to 37 inches; very dark gray (10YR 3/1) silty clay loam (about 40 percent clay), gray (10YR 5/1) dry; very few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; mildly alkaline; clear smooth boundary.

Bg—37 to 43 inches; dark gray (5Y 4/1) silty clay (about 41 percent clay); common fine distinct light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; very dark gray (10YR 3/1) coatings on faces of peds; few snail shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

BCg—43 to 55 inches; mixed gray (5Y 5/1) and light gray (5Y 6/1) silty clay loam (about 34 percent clay); common fine distinct light olive brown (2.5Y 5/4) and few fine prominent brown (7.5YR 4/4) mottles; weak fine prismatic structure parting to weak fine and medium subangular blocky; firm; few black (10YR 2/1) organic stains; very dark gray (10YR 3/1) fillings in cracks; few dark concretions (manganese oxide); common lime accumulations and snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—55 to 60 inches; gray (5Y 5/1) silty clay loam; few fine distinct light olive brown (2.5Y 5/4) and brown (7.5Y 4/4) mottles; massive; friable; few dark concretions (manganese oxide); strong effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon ranges from 24 to 48 inches in thickness. The content of clay in the 10- to 40-inch control section ranges from 35 to 40 percent.

The A horizon is black (N 2/0 or 10YR 2/1). It is silty clay loam, mucky silty clay loam, or mucky silt loam. The mucky layers are 7 to 20 inches thick. The upper part of the A horizon is slightly acid to mildly alkaline. The content of clay in the Bg horizon ranges from 35 to 45 percent. The lower part of this horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2.

Salida Series

The Salida series consists of excessively drained, very rapidly permeable soils. These soils formed in glacial outwash on plains and moraines or in valley trains. The native vegetation was prairie grasses. Slopes range from 5 to 14 percent.

Salida soils are similar to Estherville soils and are commonly adjacent to Clarion and Storden soils. Estherville soils are somewhat excessively drained. Their solum is thicker than that of the Salida soils. Clarion and Storden soils are well drained. They are finer textured than the Salida soils. Clarion soils are in the less convex sloping areas. Storden soils are in positions on the landscape similar to those of the Salida soils.

Typical pedon of Salida gravelly sandy loam, in a cultivated area of Salida-Storden complex, 9 to 14

percent slopes, moderately eroded; 792 feet south and 400 feet west of the northeast corner of sec. 7, T. 84 N., R. 32 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam, grayish brown (10YR 5/2) dry; weak medium granular structure; friable; few cobbles as much as 4 inches in diameter; about 27 percent gravel; slight effervescence; mildly alkaline; clear smooth boundary.
Bw—7 to 13 inches; brown (10YR 4/3) gravelly loamy coarse sand; single grained; loose; about 24 percent gravel; strong effervescence; mildly alkaline; clear irregular boundary.
C—13 to 60 inches; variegated brown (10YR 4/3 and 5/3), dark yellowish brown (10YR 4/4), and yellowish brown (10YR 5/4 and 5/6) gravelly coarse sand; loose; few cobbles as much as 5 inches in diameter; about 28 to 34 percent gravel; strong effervescence; moderately alkaline.

The solum ranges from 7 to 16 inches in thickness. It is generally calcareous to the surface, but the depth to carbonates ranges from 0 to 15 inches. The mollic epipedon is 7 to 9 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is gravelly loamy sand or gravelly sandy loam.

Spillville Series

The Spillville series consists of somewhat poorly drained, moderately permeable soils on foot slopes, fans, low terraces, and flood plains. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Spillville soils are similar to Terril soils and are commonly adjacent to Coland and Terril soils. Terril soils are moderately well drained and are in the slightly higher areas. Coland soils are poorly drained and are in the lower areas.

Typical pedon of Spillville loam, 0 to 2 percent slopes, in an area of cropland; 620 feet west and 39 feet south of the northeast corner of sec. 31, T. 82 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.
A1—8 to 20 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
A2—20 to 36 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.
A3—36 to 53 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.
C—53 to 60 inches; dark grayish brown (10YR 4/2) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; common fine dark concretions (manganese oxide); neutral.

The thickness of the solum and the thickness of the mollic epipedon range from 30 to 56 inches. The A horizon commonly is slightly acid but is neutral in some pedons. It generally is black (10YR 2/1) or very dark brown (10YR 2/2). It has value of 2 to 3 and chroma of 1 or 2 in the lower part. It is commonly loam, but the range includes silt loam. Below a depth of 36 inches, the texture is loam, sandy loam, or clay loam.

Storden Series

The Storden series consists of well drained, moderately permeable soils on convex side slopes, ridges, and knobs on glacial moraines. These soils formed in calcareous, loamy glacial till. The native vegetation was prairie grasses. Slopes range from 5 to 40 percent.

Storden soils are commonly adjacent to Clarion, Lester, and Salida soils. Clarion and Lester soils have an A horizon that is thicker than that of the Storden soils and have a noncalcareous B horizon. They are generally on the less convex and less steep slopes. Salida soils have a mollic epipedon. They are underlain by sand and gravel. They are on the higher knobs and are generally surrounded by the Storden soils.

Typical pedon of Storden loam, 18 to 25 percent slopes, in an area of hayland; 96 feet south and 1,850 feet west of the northeast corner of sec. 10, T. 84 N., R. 31 W.

Ap—0 to 7 inches; mixed very dark grayish brown (10YR 3/2) and brown (10YR 4/3 and 5/3) loam, dark gray (10YR 4/1) and light brownish gray (2.5Y 6/2) dry; weak medium and fine granular structure; friable; few pebbles and lime accumulations; strong effervescence; moderately alkaline; abrupt smooth boundary.
C1—7 to 16 inches; yellowish brown (10YR 5/4) loam; very weak medium subangular blocky structure; friable; few lime accumulations and pebbles; violent effervescence; moderately alkaline; gradual smooth boundary.
C2—16 to 30 inches; yellowish brown (10YR 5/4) loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; massive; friable; many lime accumulations; few dark concretions (iron oxide); violent effervescence; moderately alkaline; gradual smooth boundary.

C3—30 to 38 inches; light olive brown (2.5Y 5/4) loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few lime accumulations; few dark concretions (iron oxide); violent effervescence; moderately alkaline; gradual smooth boundary.
C4—38 to 60 inches; yellowish brown (10YR 5/4) loam; common fine distinct yellowish brown (10YR 5/8) and light gray (10YR 6/1) mottles; massive; friable; few dark concretions (iron oxide); violent effervescence; moderately alkaline.

The thickness of the solum is commonly the same as the thickness of the A horizon. The calcium carbonate equivalent ranges from 5 to 20 percent. The content of coarse fragments in the control section ranges, by volume, from 2 to 10 percent. The content of clay ranges from 18 to 25 percent, and the content of fine sand or coarser sand ranges from 20 to 40 percent.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in local alluvium derived from glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Terril soils are similar to Spillville soils and are commonly adjacent to Clarion, Lester, and Storden soils. The adjacent soils are not cumulic. They generally are upslope from the Terril soils. Spillville soils are somewhat poorly drained and are lower on the landscape than the Terril soils. Also, they have lower chroma below the mollic epipedon.

Typical pedon of Terril loam, 2 to 5 percent slopes, in an area of cropland; 1,075 feet south and 60 feet west of the northeast corner of sec. 5, T. 83 N., R. 31 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.
A1—8 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.
A2—14 to 22 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; thin discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
A3—22 to 29 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; thin discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
BA—29 to 37 inches; dark brown (10YR 3/3) loam; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bw—37 to 43 inches; brown (10YR 4/3) clay loam; weak medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.
BC—43 to 60 inches; dark yellowish brown (10YR 4/4) loam; weak medium and fine subangular blocky structure; friable; few pebbles; neutral.

The thickness of the solum ranges from 44 to more than 60 inches. The A horizon ranges from 24 to 36 inches in thickness. It generally is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) in the lower part. In some pedons where the surface horizon is recent overwash, it is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The B horizon has value of 3 and chroma of 2 or 3 in the upper part but within a depth of 40 inches commonly has value of 4 and chroma of 3 or 4. It is commonly loam or clay loam.

Wacousta Series

The Wacousta series consists of very poorly drained, moderately permeable soils in upland depressions on glacial till plains. These soils formed in silty lacustrine sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Wacousta soils are similar to Calcousta soils and are commonly adjacent to Canisteo, Harps, and Okoboji soils. Calcousta soils are calcareous in the upper part of the solum. Okoboji soils are cumulic, have a higher content of clay than the Wacousta soils, and are in similar positions on the landscape. Canisteo and Harps soils are poorly drained, are calcareous in the upper part of the solum, and are in the slightly higher areas.

Typical pedon of Wacousta silty clay loam, 0 to 1 percent slopes, in an area of cropland; 1,200 feet east and 150 feet south of the northwest corner of sec. 13, T. 84 N., R. 32 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; abrupt smooth boundary.
A—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; mildly alkaline; abrupt smooth boundary.
Bg—14 to 16 inches; mixed olive gray (5Y 5/2) and dark gray (10YR 4/1) silty clay loam; few fine distinct light yellowish brown (2.5Y 6/4) mottles; weak fine subangular blocky structure; friable; common fine

lime accumulations; strong effervescence; mildly alkaline; abrupt smooth boundary.
Cg1—16 to 26 inches; mixed olive gray (5Y 5/2) and light olive gray (5Y 6/2) silty clay loam; few medium prominent yellowish brown (10YR 5/6) mottles; massive; vertical cleavage; friable; strong effervescence; moderately alkaline; clear smooth boundary.
Cg2—26 to 34 inches; gray (5Y 6/1) silty clay loam (about 29 percent clay); common medium prominent olive (5Y 5/6) and dark reddish brown (5YR 3/3) mottles; massive; friable; few dark concretions (manganese oxide); strong effervescence; moderately alkaline; clear smooth boundary.
Cg3—34 to 43 inches; light olive gray (5Y 6/2) silty clay loam (about 29 percent clay); few fine prominent yellowish brown (10YR 5/6) and few fine faint olive (5Y 5/4) mottles; massive; friable; strong effervescence; moderately alkaline; clear smooth boundary.
Cg4—43 to 53 inches; olive gray (5Y 5/2) silt loam; common medium prominent yellowish brown (10YR 5/6) and few fine prominent brown (7.5YR 4/4) mottles; massive; friable; few organic stains; common lime accumulations; strong effervescence; moderately alkaline; clear smooth boundary.
Cg5—53 to 58 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) very fine sandy loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; clear smooth boundary.
Cg6—58 to 60 inches; gray (5Y 5/1 and 6/1) loam; common coarse prominent yellowish brown (10YR 5/6) and brown (10YR 4/3) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 22 inches. The depth to carbonates ranges from 12 to 20 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches.

The A horizon is silty clay loam, mucky silty clay loam, or silt loam. The content of clay in the control section ranges from 24 to 35 percent.

Wadena Series

The Wadena series consists of well drained soils on terraces and uplands. These soils formed in loamy outwash sediments overlying sand and gravel. The native vegetation was prairie grasses. Permeability is moderate in the solum and very rapid in the substratum. Slopes range from 0 to 9 percent.

Wadena soils are similar to Ocheyedan and Wadena Variant soils and are commonly adjacent to Cylinder and Estherville soils. Cylinder soils are in the slightly lower areas and are somewhat poorly drained. Estherville soils contain less clay than the Wadena soils, have more gravel and a thinner solum, and are in the more convex sloping areas. Ocheyedan soils are finer textured in the substratum than the Wadena soils. Wadena Variant soils have finer sand in the substratum than the Wadena soils.

Typical pedon of Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in an area of cropland; 1,500 feet south and 2,140 feet east of the northwest corner of sec. 5, T. 84 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; friable; neutral; clear smooth boundary.
AB—8 to 16 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.
Bw1—16 to 20 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.
Bw2—20 to 26 inches; brown (10YR 4/3) loam; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw3—26 to 30 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.
2BC—30 to 36 inches; dark yellowish brown (10YR 4/4 and 3/4) gravelly loamy sand; weak fine subangular blocky structure; friable; about 15 percent gravel; neutral; clear smooth boundary.
2C1—36 to 41 inches; yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) gravelly coarse sand; single grained; loose; about 30 percent gravel; strong effervescence; mildly alkaline; clear smooth boundary.
2C2—41 to 49 inches; brown (10YR 5/3) sand; single grained; loose; about 5 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.
2C3—49 to 60 inches; pale brown (10YR 6/3), brown (10YR 5/3), and yellowish brown (10YR 5/4) sand and gravel; single grained; loose; about 25 percent gravel; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 40 inches. The depth to carbonates ranges from 30 to 50 inches. The mollic epipedon ranges from 12 to 20 inches in thickness. In the loamy mantle, the content of clay is about 18 to 30 percent and the content of fine sand and coarser particles is 25 to 40 percent.

The A horizon is neutral or slightly acid. The B horizon has hue of 10YR or 7.5YR. In the upper part it is loam or sandy clay loam. The 2B horizon is loamy sand or sandy loam in which the content of gravel varies. The 2C horizon has hue of 10YR or 7.5YR.

Wadena Variant

The Wadena Variant consists of well drained soils on terraces. These soils formed in loamy outwash sediments. The native vegetation was prairie grasses. Permeability is moderate in the solum and rapid in the substratum. Slopes range from 0 to 2 percent.

Wadena Variant soils are similar to Ocheyedan, Terril, and Wadena soils and are commonly adjacent to Cylinder and Wadena soils. Ocheyedan soils contain more silt in the substratum than the Wadena Variant soils. Terril soils are finer textured in the substratum than the Wadena Variant soils. Wadena soils contain more gravel and coarser sand than the Wadena Variant soils. Also, they have a thinner solum. They are in the more convex sloping areas. Cylinder soils are somewhat poorly drained and are in the slightly lower areas.

Typical pedon of Wadena Variant loam, 0 to 2 percent slopes, in an area of cropland; 340 feet north and 580 feet east of the southwest corner of sec. 36, T. 83 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A—8 to 19 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

Bw1—19 to 26 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Bw2—26 to 36 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

BC—36 to 41 inches; brown (10YR 4/3) fine sandy loam; very weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.

C1—41 to 51 inches; brown (10YR 5/3) loamy fine sand; single grained; loose; neutral; gradual wavy boundary.

C2—51 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; neutral.

The thickness of the solum is typically about 41 inches but ranges from 36 to 56 inches. The thickness of the mollic epipedon is typically about 26 inches but ranges from 19 to 33 inches. Reaction is neutral to medium acid throughout the profile.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). It is typically loam, but the range includes sandy loam. The B horizon is brown (10YR 4/3), very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), or dark yellowish brown (10YR 4/4). It is typically loam, but the range includes fine sandy loam, very fine sandy loam, sandy clay loam, and clay loam. The C horizon is brown (10YR 5/3) or yellowish brown (10YR 5/4). It is typically loamy fine sand and fine sand, but the range includes very fine sandy loam and loam.

Webster Series

The Webster series consists of poorly drained, moderately permeable soils in plane or slightly concave areas on uplands. These soils formed in loamy glacial till or sediments derived from till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Webster soils are similar to Canisteo and Marna soils and are commonly adjacent to Canisteo, Nicollet, and Okoboji soils. Canisteo soils are calcareous throughout. Canisteo and Marna soils are in positions on the landscape similar to those of the Webster soils. Marna soils contain more clay in the solum than the Webster soils. Nicollet soils are somewhat poorly drained and are in the slightly higher, more sloping areas. Okoboji soils are very poorly drained and are in depressions.

Typical pedon of Webster clay loam, 0 to 2 percent slopes, in an area of cropland; 900 feet north and 1,100 feet west of the southeast corner of sec. 10, T. 84 N., R. 31 W.

Ap—0 to 8 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A—8 to 15 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

BA—15 to 20 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; weak fine and very fine subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

Bg1—20 to 26 inches; dark gray (5Y 4/1) clay loam; few fine faint olive gray (5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; common dark organic coatings; mildly alkaline; gradual smooth boundary.

Bg2—26 to 30 inches; olive gray (5Y 5/2) clay loam; few fine distinct yellowish brown (10YR 5/6) and few fine faint olive (5Y 5/3) mottles; very weak medium subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

Cg1—30 to 52 inches; olive gray (5Y 5/2) loam; few fine prominent yellowish brown (10YR 5/6) and few fine faint olive (5Y 5/3) mottles; massive; friable; few pebbles; few fine dark concretions (manganese oxide); common lime accumulations; violent

effervescence; moderately alkaline; gradual smooth boundary.

Cg2—52 to 60 inches; olive gray (5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/8) and few fine faint light gray (5Y 7/2) mottles; massive; friable; few pebbles; common dark concretions (manganese oxide); common lime accumulations; violent effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 36 inches. The mollic epipedon ranges from 16 to 23 inches in thickness.

The A horizon is clay loam, silty clay loam, or loam. The lower part of the B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The B horizon is clay loam, loam, or silty clay loam in which the content of sand is moderate. The C horizon has hue of 2.5Y or 5Y and value of 5 or 6. It is loam, sandy loam, or clay loam.

Formation of the Soils

This section describes the factors that affect soil formation in Greene County. It also describes the processes of soil formation.

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 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. Human activities also affect soil formation.

Climate and vegetation are the active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Some time is always needed for horizon differentiation. Generally, a long time is needed for the development of distinct horizons. The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

The soils in Greene County formed in glacial till, alluvium, glacial outwash, glacial sediments, and lacustrine sediments. These parent materials are defined in the glossary.

Glacial till is the most extensive parent material in the county. Only Wisconsin-age glacial material is exposed, but three glaciers have deposited material in Greene County—the Nebraskan, the Kansan, and the Wisconsin. The Wisconsin glacial till is the most recently deposited. The Nebraskan is the oldest.

The county was covered by the Des Moines Lobe of the Wisconsin Glaciation. The till is friable loam or clay loam and was deposited by the Cary substage of the Wisconsin Glaciation (*7, 9*). Evidence of the geologic youth of the Cary substage is the poorly developed surface drainage system and numerous closed depressions.

The first glacial till to be deposited, the Nebraskan, was covered thousands of years later by Kansan glacial till. The Kansan till was buried thousands of years later by Wisconsin-age loess, about 17,000 years ago (*8*). Finally, this loess was buried by the Wisconsin-age glacial till. The maximum ice advance of the Des Moines Lobe in Greene County was probably about 14,000 years ago (*8*).

Soils that formed in glacial till in Greene County are Clarion, Cordova, Crippin, Dundas, Hayden, Lester, Le Sueur, Nicollet, and Storden soils. Several other soils formed in glacial sediments and glacial till. These are Canisteo, Harps, and Webster soils. Guckeen and Marna soils formed in glacial or lacustrine sediments overlying glacial till.

Soils that formed in alluvium include Calco, Coland, Millington, Moingona, Spillville, and Terril soils. Several soils formed in glacial outwash overlying sand and gravel sediments. These include Biscay, Cylinder, Estherville, Mayer, and Wadena soils. Knoke and Okoboji soils formed in local alluvial sediments in the uplands, and Calcousta and Wacousta soils formed in lacustrine sediments. Fostoria and Ocheyedan soils formed in loamy outwash sediments, and Salida soils formed in coarse textured outwash sediments. Dickman soils formed in a loamy mantle and in the underlying sandy sediments.

Climate

The soils in Greene County, according to recent evidence, formed under a variety of climatic conditions. In the post-Cary glaciation period, from about 13,000 to 10,500 years ago, the climate was cool and the vegetation was dominantly conifers. During the period from 10,500 to 8,000 years ago, a warming trend occurred and the vegetation changed from conifers to mixed forest, dominantly hardwoods. Beginning about 8,000 years ago, the climate became warmer and drier and herbaceous prairie vegetation became dominant. About 3,000 years ago, a change from a relatively dry to a more moist climate began (*6, 15*). The present climate is midcontinental and subhumid.

A nearly uniform climate prevails throughout the county, although there is some variation in rainfall. The general climate has had an important overall influence

on the characteristics of the soils but has not caused major differences among them. The influence of the general climate, however, is modified by local conditions in or near the forming soil. For example, the microclimate on south-facing slopes is warmer and less humid than that in nearby areas. The microclimate on north- and east-facing slopes tends to be cooler and more moist than that on south-facing slopes. In low-lying or depressional areas, poorly drained or very poorly drained soils are wetter and colder than most soils around them. These local conditions account for some of the differences among the soils in the county.

Changes in temperature activate the weathering of the parent material by water and air. As the parent material weathers, changes caused by both physical and chemical actions take place. Rainfall affects the amount of leaching in the soil and the kinds of plants on the soil. Temperature and other climatic factors affect soil formation through their effect on the plant and animal life on and in the soil.

Plant and Animal Life

Many kinds of living organisms affect soil formation. Burrowing animals, worms, crayfish, and micro-organisms, for example, influence soil properties. Differences in the kind of vegetation, however, commonly cause the most marked differences among soils (*6, 16*).

The soils of Greene County were influenced by prairie grasses and trees. Tall prairie grasses were the dominant vegetation when the county was settled, but trees were near most of the major streams and their major tributaries (*3*).

Because grasses have many roots and tops that have decayed, the soils that formed under prairie vegetation typically have a thicker, darker surface ıayer than the soils that formed under trees. The organic matter in the soils that formed under trees is derived principally from fallen leaves and is deposited mainly on the surface. These soils generally are more acid than the soils that formed under grasses. Also, more of the bases and clay minerals have moved downward in their profiles.

Clarion and Nicollet soils are typical of soils that formed in glacial till under prairie vegetation. Very poorly drained soils, such as Knoke and Okoboji, formed under a native vegetation of sedges, cattails, and other water-tolerant plants.

Dundas and Lester soils are among the soils in the county that formed in glacial till under mixed prairie and forest vegetation. In areas that have not been cultivated, these soils have a thin A horizon, an E horizon that is distinctly lighter colored than the A horizon when dry, and a B horizon that has a stronger structure and shows more evidence of the accumulation of silicate clay than is apparent in the soils that formed under prairie grasses.

Dundas and Lester soils have properties that are intermediate between those of soils that formed entirely under trees, such as Hayden soils, and those of soils that formed entirely under grasses, such as Clarion soils. Dundas and Lester soils probably formed under prairie grasses, and then later trees grew in the area. The morphology of these soils reflects the influence of both trees and grasses.

Relief

Relief is an important factor in soil formation because of its effect on drainage, runoff, the depth to the water table, and erosion. Slopes range from level to very steep in Greene County. A difference in relief is the main reason for the differing properties among some of the soils in the county.

Slope affects the thickness and color of the A horizon and the thickness of the solum through its effect on erosion and the amount of water that runs off and percolates through the soil. For example, the thickness and color of the A horizon of Storden, Clarion, and Nicollet soils, which formed in similar parent material, are related to slope. The thickness of the A horizon increases and the color darkens as the slope decreases. Generally, Storden soils are strongly sloping to steep, Clarion soils are gently sloping or moderately sloping, and Nicollet soils are very gently sloping. The solum of the Storden soils is thinner than that of the Clarion and Nicollet soils. Also, carbonates are closer to the surface.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. In well drained soils the subsoil generally is brown because iron compounds are well distributed and are oxidized. In poorly drained or very poorly drained, poorly aerated soils, however, the subsoil is generally grayish and mottled. The poorly drained Canisteo and Webster and very poorly drained Okoboji soils, which are level or nearly level, are examples. The well drained Clarion and Lester soils, which are steeper than the Canisteo, Okoboji, and Webster soils, have a brownish B horizon. Nicollet soils have profile characteristics of somewhat poorly drained soils. Their subsoil, for example, is grayish brown.

The water that percolates through soils removes clay from the A horizon, and much of this clay accumulates in the B horizon. Generally, more water percolates through nearly level or depressional soils than through the soils in the more sloping areas where some of the water runs off the surface. As a result, the content of clay in the B horizon generally is higher in the nearly level or depressional soils.

Time

Time enables relief, climate, and plant and animal life to change the parent material. If these factors continue to operate for a long period, very similar kinds of soils form in widely different kinds of parent material. Soil formation, however, generally is interrupted by geologic events that expose new parent material. In Greene

County, new parent material has been added to the uplands at least four times. Throughout the entire county, the bedrock was first covered by glacial drift from two different glaciers. Then loess was deposited, and another glacier subsequently deposited the present surface material (*8*).

According to radiocarbon dates, loess deposition began about 30,000 years ago and continued to about 14,000 years ago (*8*). These dates indicate that the base of the Cary glacial drift in the southern part of the Des Moines Lobe was deposited about 14,000 years ago. Thus, all of the soils that formed in this drift material are as young or younger than 14,000 years old.

The sediment stripped from the side slopes accumulated as local alluvium. The age of soils on the side slopes is determined by dating the alluvial fill at the base of slopes, which in some stream valleys in western Iowa is less than 1,800 years old. Some of the soils that formed in alluvium in Greene County are Coland, Calco, Spillville, and Terril soils.

Human Activities

Important changes took place when Greene County was settled. Breaking the prairie sod and clearing the timber removed and changed the protective plant cover. Changes caused by erosion generally are the most significant. As the soil was cultivated, the runoff rate increased and the rate at which water moved into the soil decreased. As a result, accelerated erosion removed part or all of the original surface layer from many of the more sloping soils. In some areas shallow to deep gullies formed.

Erosion and cultivation also changed the structure and consistence of the surface layer in some soils and lowered the content of organic matter and the level of fertility. In severely eroded areas the plow layer commonly includes the upper part of the subsoil, which is less friable and finer textured than the original surface layer. Even in areas that are not subject to erosion, compaction by heavy machinery reduces the thickness of the surface layer and changes the structure. The granular structure characteristic of virgin grassland breaks down when the soils are intensively cultivated.

Some management measures decrease the susceptibility to erosion, increase soil productivity, and reclaim areas not suitable for crops or pasture. For example, large areas on bottom land are suitable for cultivation because flooding and deposition are controlled by diversion terraces at the base of slopes, by drainage ditches, and by other measures. In some areas erosion and runoff are controlled by terraces and other measures. Many soils are more productive than they were in their virgin state because applications of commercial fertilizer and lime have overcome deficiencies in plant nutrients.

Erosion is one of the main causes of a decrease in the content of organic matter in soils (*11*). Though they cannot increase the content to the level that was characteristic of the native grassland, measures that control erosion can keep the content at a level that is needed when crops are grown.

Processes of Horizon Differentiation

Horizon differentiation is the result of four basic processes. These are additions, removals, transfers, and transformations (*10*). Each of these affects many substances in the soils, such as organic matter, soluble salts, carbonates, sesquioxides, and silicate clay minerals. The changes brought about by these processes help to determine the ultimate nature of the soil profile.

The accumulation of organic matter is an early phase in the formation of most soils. The content of organic matter ranges from high to very low in the A horizon of the soils in Greene County. It is high in the thick A horizon of Webster soils and low in soils that have a thin A horizon. In some soils it is low because erosion has removed part of the A horizon.

The removal of substances from parts of the profile is important in the differentiation of soil horizons in Greene County. Many of the soils have been leached of calcium carbonates in the upper part of the profile, and some have been so strongly leached that they are strongly acid in the surface layer and subsoil. Exceptions are Calco, Canisteo, Harps, Mayer, and Storden soils, which are generally calcareous throughout.

Transfers of substances from one horizon to another are evident in some of the soils in Greene County. Phosphorus, for example, is removed from the subsoil by plant roots and transferred to the parts of the plant growing above the ground. It is then returned to the surface layer in the plant residue.

The translocation of clay is an important process in horizon differentiation. The clay, composed primarily of silicate clay minerals in this county, is carried downward in suspension in percolating water from the A horizon. It accumulates in the B horizon as fillings in pores and root channels and as clay films on the faces of peds.

Transformations are physical and chemical. The weathering of soil particles to smaller sizes is an example of a transformation. The reduction of iron is another example. This process is called gleying. It occurs when the soil is saturated for long periods. The soil contains enough organic matter for biological activity to take place during the periods of saturation. Gleying is evidenced by ferrous iron and gray colors in the soil. It is a characteristic of poorly drained soils, such as Webster soils. Reductive extractable iron, or free iron, generally is not so evident in somewhat poorly drained soils, such as Nicollet soils. Another kind of transformation is the weathering of the primary apatite mineral in the parent material to secondary phosphorus compounds.

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Glossary

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

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

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.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

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.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

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.

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

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 60 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

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

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

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material

through eluviation are eluvial; those that have received material are illuvial.

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.

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

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

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 melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

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.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

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.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

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.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Lenses. Layers of soil material that differ in texture or color from the horizon in which they occur.

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.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

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).

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

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

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

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.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

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.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant 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.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

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.

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 (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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.

Strata. Thin layers of soil or parent material that differ in color or texture, or both, from adjacent layers.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

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 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. Includes all subdivisions of these horizons.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

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.

Till plain. An extensive flat to undulating area underlain by glacial till.

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.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-79 at Jefferson, 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----	27.6	8.3	18.0	53	-20	0	0.87	0.28	1.35	3	7.2
February---	34.2	14.5	24.4	60	-19	0	1.04	.30	1.63	3	7.2
March------	44.0	24.3	34.2	76	-4	31	2.26	.96	3.36	5	8.8
April------	62.3	38.2	50.3	87	18	109	3.42	1.92	4.75	7	1.5
May--------	73.6	49.8	61.7	91	29	373	4.07	2.29	5.64	8	.0
June-------	82.2	59.5	70.9	97	42	627	4.61	2.57	6.40	7	.0
July-------	86.2	63.5	74.9	99	49	772	3.61	1.40	5.46	6	.0
August-----	84.0	61.2	72.6	98	46	701	4.24	1.88	6.24	7	.0
September--	76.4	51.8	64.1	94	32	423	3.10	1.18	4.70	5	.0
October----	66.0	41.2	53.6	89	19	188	2.19	.54	3.49	4	.1
November---	47.7	27.6	37.7	73	2	12	1.46	.27	2.38	3	2.4
December---	34.2	15.8	25.0	62	-15	0	.90	.33	1.37	3	6.4
Yearly:											
Average--	59.9	38.0	49.0	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	-22	---	---	---	---	---	---
Total----	---	---	---	---	---	3,236	31.77	25.90	37.40	61	33.6

* 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° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-79 at Jefferson, 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--	April 27	May 2	May 15
2 years in 10 later than--	April 20	April 27	May 10
5 years in 10 later than--	April 7	April 17	April 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 16	October 6	September 23
2 years in 10 earlier than--	October 20	October 10	September 28
5 years in 10 earlier than--	October 29	October 19	October 7

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-79 at Jefferson, 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	182	166	141
8 years in 10	190	172	147
5 years in 10	205	184	159
2 years in 10	220	196	170
1 year in 10	228	202	176

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	3,325	0.9
6	Okoboji silty clay loam, 0 to 1 percent slopes	14,080	3.9
27B	Terril loam, 2 to 5 percent slopes	670	0.2
27C	Terril loam, 5 to 9 percent slopes	585	0.2
28B	Dickman fine sandy loam, 2 to 5 percent slopes	625	0.2
28C2	Dickman fine sandy loam, 5 to 9 percent slopes, moderately eroded	290	0.1
34	Estherville sandy loam, 0 to 2 percent slopes	465	0.1
34B	Estherville sandy loam, 2 to 5 percent slopes	1,000	0.3
34C2	Estherville sandy loam, 5 to 9 percent slopes, moderately eroded	405	0.1
34D2	Estherville sandy loam, 9 to 16 percent slopes, moderately eroded	200	0.1
48	Knoke mucky silt loam, 0 to 1 percent slopes	1,000	0.3
55	Nicollet loam, 1 to 3 percent slopes	66,785	18.2
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	600	0.2
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	580	0.2
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded	635	0.2
62F	Storden loam, 18 to 25 percent slopes	410	0.1
62G	Storden loam, 25 to 40 percent slopes	565	0.2
90	Okoboji mucky silt loam, 0 to 1 percent slopes	1,340	0.4
95	Harps loam, 0 to 2 percent slopes	3,350	0.9
107	Webster clay loam, 0 to 2 percent slopes	55,775	15.2
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,030	0.3
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	1,145	0.3
108C2	Wadena loam, 24 to 32 inches to sand and gravel, 5 to 9 percent slopes, moderately eroded	415	0.1
135	Coland silty clay loam, 0 to 2 percent slopes	6,825	1.9
138B	Clarion loam, 2 to 5 percent slopes	37,155	10.1
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded	23,095	6.3
138C	Clarion loam, 5 to 9 percent slopes	1,535	0.4
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	18,100	5.0
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	1,060	0.3
168G	Hayden loam, 25 to 40 percent slopes	350	0.1
202	Cylinder loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	920	0.3
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,010	0.3
236B	Lester loam, 2 to 5 percent slopes	4,860	1.3
236B2	Lester loam, 2 to 5 percent slopes, moderately eroded	465	0.1
236C	Lester loam, 5 to 9 percent slopes	1,060	0.3
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	1,510	0.4
236D	Lester loam, 9 to 14 percent slopes	345	0.1
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded	285	0.1
236E	Lester loam, 14 to 18 percent slopes	250	0.1
236F	Lester loam, 18 to 25 percent slopes	440	0.1
256D2	Lester-Storden loams, 9 to 14 percent slopes, moderately eroded	460	0.1
256E2	Lester-Storden loams, 14 to 18 percent slopes, moderately eroded	290	0.1
256F	Lester-Storden loams, 18 to 25 percent slopes	1,090	0.3
256G	Lester-Storden loams, 25 to 40 percent slopes	4,385	1.2
258	Biscay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	260	0.1
259	Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,105	0.3
307	Dundas silt loam, 0 to 2 percent slopes	425	0.1
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,170	0.3
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	790	0.2
325	Le Sueur loam, 1 to 3 percent slopes	2,035	0.6
383	Marna silty clay loam, 0 to 2 percent slopes	2,320	0.6
385	Guckeen silty clay loam, 1 to 3 percent slopes	860	0.2
386	Cordova loam, 0 to 2 percent slopes	1,050	0.3
458	Millington loam, 0 to 2 percent slopes	320	0.1
485	Spillville loam, 0 to 2 percent slopes	1,365	0.4
485B	Spillville loam, 2 to 5 percent slopes	1,125	0.3
506	Wacousta silty clay loam, 0 to 1 percent slopes	430	0.1
507	Canisteo clay loam, 0 to 2 percent slopes	55,645	15.2
508	Calcousta silty clay loam, 0 to 1 percent slopes	640	0.2
566	Moingona loam, 0 to 2 percent slopes	230	0.1
566C	Moingona loam, 2 to 7 percent slopes	385	0.1
585B	Coland-Spillville complex, 1 to 5 percent slopes	6,420	1.8
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded	4,535	1.2
638D2	Clarion-Storden loams, 9 to 14 percent slopes, moderately eroded	1,665	0.5
638E2	Clarion-Storden loams, 14 to 18 percent slopes, moderately eroded	640	0.2
639C2	Salida-Storden complex, 5 to 9 percent slopes, moderately eroded	730	0.2
639D2	Salida-Storden complex, 9 to 14 percent slopes, moderately eroded	310	0.1
655	Crippin loam, 1 to 3 percent slopes	475	0.1
658	Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	310	0.1
659	Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,010	0.3
733	Calco silty clay loam, 0 to 2 percent slopes	2,500	0.7

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
878	Ocheyedan loam, 0 to 2 percent slopes	390	0.1
878B	Ocheyedan loam, 2 to 5 percent slopes	1,130	0.3
878B2	Ocheyedan loam, 2 to 5 percent slopes, moderately eroded	460	0.1
878C2	Ocheyedan loam, 5 to 9 percent slopes, moderately eroded	605	0.2
879	Fostoria loam, 0 to 2 percent slopes	920	0.3
1048	Knoke mucky silty clay loam, ponded, 0 to 1 percent slopes	285	0.1
1135	Coland silty clay loam, channeled, 0 to 1 percent slopes	1,690	0.5
1308	Wadena Variant loam, 0 to 2 percent slopes	470	0.1
1585	Coland-Spillville complex, channeled, 0 to 2 percent slopes	445	0.1
1585B	Coland-Spillville complex, channeled, 2 to 5 percent slopes	465	0.1
2315	Fluvaquents-Coland complex, 0 to 3 percent slopes	5,870	1.6
5010	Pits, gravel	470	0.1
5020	Pits and dumps	80	*
5040	Orthents, loamy	385	0.1
5041	Orthents, reclaimed, 2 to 9 percent slopes	270	0.1
	Water	646	0.2
	Total	364,096	100.0

* Less than 0.1 percent.

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
55	Nicollet loam, 1 to 3 percent slopes
95	Harps loam, 0 to 2 percent slopes (where drained)
107	Webster 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
135	Coland silty clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion loam, 2 to 5 percent slopes
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded
202	Cylinder loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236B2	Lester loam, 2 to 5 percent slopes, moderately eroded
258	Biscay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes (where drained)
259	Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
307	Dundas silt loam, 0 to 2 percent slopes (where drained)
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
325	Le Sueur loam, 1 to 3 percent slopes
383	Marna silty clay loam, 0 to 2 percent slopes (where drained)
385	Guckeen silty clay loam, 1 to 3 percent slopes
386	Cordova loam, 0 to 2 percent slopes (where drained)
458	Millington loam, 0 to 2 percent slopes (where drained and protected from flooding)
485	Spillville loam, 0 to 2 percent slopes
485B	Spillville loam, 2 to 5 percent slopes
507	Canisteo clay loam, 0 to 2 percent slopes (where drained)
566	Moingona loam, 0 to 2 percent slopes
566C	Moingona loam, 2 to 7 percent slopes
585B	Coland-Spillville complex, 1 to 5 percent slopes (where drained)
655	Crippin loam, 1 to 3 percent slopes
658	Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes (where drained)
659	Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
733	Calco silty clay loam, 0 to 2 percent slopes (where drained)
878	Ocheyedan loam, 0 to 2 percent slopes
878B	Ocheyedan loam, 2 to 5 percent slopes
878B2	Ocheyedan loam, 2 to 5 percent slopes, moderately eroded
879	Fostoria loam, 0 to 2 percent slopes
1308	Wadena 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	82	31	65	3.3	3.3	4.3	5.5
6---------- Okoboji	IIIw	84	32	67	3.4	3.3	4.3	7.3
27B---------- Terril	IIe	118	45	94	5.0	4.2	7.0	8.3
27C---------- Terril	IIIe	113	43	91	4.8	4.2	6.7	8.0
28B---------- Dickman	IIIe	50	20	45	2.5	1.2	2.5	3.7
28C2---------- Dickman	IVe	45	18	40	2.2	1.2	2.5	3.4
34---------- Estherville	IIIs	50	17	40	2.0	2.0	3.0	3.0
34B---------- Estherville	IIIe	45	15	35	2.0	2.0	3.0	2.5
34C2---------- Estherville	IIIe	27	9	29	1.4	1.2	2.5	2.0
34D2---------- Estherville	IVe	---	---	---	1.4	1.2	2.5	2.0
48---------- Knoke	IIIw	82	31	65	3.3	3.3	4.3	5.5
55---------- Nicollet	I	113	39	84	4.3	4.2	6.5	7.1
62C2---------- Storden	IIIe	92	35	74	3.9	3.6	5.6	6.5
62D2---------- Storden	IIIe	83	32	66	3.5	3.3	5.2	5.8
62E2---------- Storden	IVe	68	26	54	2.9	2.3	3.3	4.8
62F---------- Storden	VIe	---	---	---	2.5	1.5	3.5	3.7
62G---------- Storden	VIIe	---	---	---	---	1.5	---	---
90---------- Okoboji	IIIw	84	32	67	3.4	3.3	4.3	7.3
95---------- Harps	IIw	95	36	76	4.0	3.3	5.0	6.6
107---------- Webster	IIw	110	42	88	4.4	4.2	6.6	7.3
108---------- Wadena	IIs	72	27	60	2.7	2.7	4.3	4.8
108B---------- Wadena	IIe	70	27	60	2.8	2.7	4.3	4.7

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*
108C2---------- Wadena	IIIe	62	24	53	2.5	2.3	3.7	4.2
135---------- Coland	IIw	110	42	83	4.6	4.1	6.0	7.6
138B---------- Clarion	IIe	110	42	88	4.6	4.2	6.7	7.6
138B2---------- Clarion	IIe	107	41	86	4.5	3.8	6.3	7.5
138C---------- Clarion	IIIe	105	40	84	4.4	3.8	6.3	7.3
138C2---------- Clarion	IIIe	102	39	82	4.3	3.8	6.2	7.1
138D2---------- Clarion	IIIe	93	35	74	3.9	3.7	5.5	6.5
168G---------- Hayden	VIIe	---	---	---	---	1.5	---	---
202---------- Cylinder	IIs	88	33	70	3.7	3.3	5.3	6.1
203---------- Cylinder	IIs	103	39	82	4.3	3.8	6.2	7.1
236B---------- Lester	IIe	105	35	80	4.5	3.5	6.0	6.5
236B2---------- Lester	IIe	100	33	75	4.5	3.5	6.0	6.5
236C---------- Lester	IIIe	95	33	75	4.5	3.5	6.0	6.5
236C2---------- Lester	IIIe	90	31	70	4.3	3.3	5.5	6.3
236D---------- Lester	IIIe	95	33	75	4.5	3.5	5.8	6.5
236D2---------- Lester	IIIe	90	31	70	4.3	3.3	5.5	6.3
236E---------- Lester	IVe	75	30	65	4.0	3.0	5.0	6.0
236F---------- Lester	VIe	---	---	---	3.0	3.0	5.0	4.5
256D2---------- Lester-Storden	IIIe	83	28	62	3.9	3.0	5.0	5.7
256E2---------- Lester-Storden	IVe	63	---	51	3.4	2.7	4.8	5.1
256F---------- Lester-Storden	VIe	---	---	---	2.8	2.4	3.5	4.1
256G---------- Lester-Storden	VIIe	---	---	---	---	1.6	---	---
258---------- Biscay	IIw	90	34	72	3.6	3.6	5.4	6.0
259---------- Biscay	IIw	100	38	80	4.0	3.8	5.9	6.6

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*
307---------- Dundas	IIw	85	30	65	3.5	3.8	5.5	5.0
308---------- Wadena	IIs	92	35	74	3.7	3.7	5.0	6.2
308B---------- Wadena	IIe	90	34	72	3.6	3.7	5.0	6.0
325---------- Le Sueur	I	112	43	90	4.7	4.1	6.0	7.8
383---------- Marna	IIw	96	36	75	4.0	4.2	6.6	6.0
385---------- Guckeen	I	104	40	85	4.0	3.7	5.0	6.7
386---------- Cordova	IIw	104	40	75	4.0	4.2	6.6	6.0
458---------- Millington	IIw	86	33	70	3.3	3.3	5.0	5.5
485---------- Spillville	IIw	122	46	98	5.1	4.2	7.3	8.6
485B---------- Spillville	IIe	120	45	96	5.0	4.1	7.2	8.5
506---------- Wacousta	IIIw	100	38	80	4.0	2.0	7.0	8.0
507---------- Canisteo	IIw	105	36	75	3.5	3.0	5.0	5.2
508---------- Calcousta	IIIw	75	29	62	4.0	2.0	4.0	4.0
566---------- Moingona	I	115	43	92	4.8	4.1	5.8	8.0
566C---------- Moingona	IIe	110	42	88	4.6	4.1	5.5	7.6
585B---------- Coland-Spillville	IIw	98	37	78	4.0	3.6	5.5	6.6
638C2---------- Clarion-Storden	IIIe	88	31	71	4.0	3.4	5.0	6.3
638D2---------- Clarion-Storden	IIIe	80	27	64	3.6	3.3	5.0	5.8
638E2---------- Clarion-Storden	IVe	64	---	48	3.1	2.6	4.8	4.9
639C2---------- Salida-Storden	IIIe	50	17	42	2.7	2.0	4.0	4.0
639D2---------- Salida-Storden	IVe	40	13	25	2.5	1.8	3.6	3.6
655---------- Crippin	I	113	39	84	4.3	4.2	6.5	7.1
658---------- Mayer	IIw	80	25	63	3.2	3.0	4.8	5.3

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*
659---------- Mayer	IIw	91	29	69	3.5	3.2	5.0	5.8
733---------- Calco	IIw	99	38	84	4.2	4.2	5.3	7.0
878---------- Ocheyedan	I	86	33	69	3.6	3.3	5.2	6.0
878B---------- Ocheyedan	IIe	84	32	67	3.5	3.3	5.3	5.8
878B2---------- Ocheyedan	IIe	81	31	65	3.4	3.1	5.1	5.7
878C2---------- Ocheyedan	IIIe	76	29	61	3.2	2.7	4.5	5.3
879---------- Fostoria	I	96	36	77	4.0	3.7	5.8	6.6
1048---------- Knoke	VIIw	---	---	---	---	---	---	---
1135---------- Coland	Vw	---	---	---	---	2.5	---	---
1308---------- Wadena Variant	IIs	85	32	68	3.6	3.6	5.3	5.8
1585---------- Coland-Spillville	Vw	---	---	---	4.8	3.4	6.3	7.9
1585B---------- Coland-Spillville	Vw	---	---	---	---	3.1	---	---
2315---------- Fluvaquents-Coland	Vw	---	---	---	---	---	---	---
5010**. Pits								
5020**. Pits and dumps								
5040**, 5041**. 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	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
27B, 27C---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
28B, 28C2--------- Dickman	Siberian peashrub	Eastern redcedar, Tatarian honeysuckle, lilac.	Green ash, honeylocust, red pine, jack pine, Austrian pine, Russian-olive.	Eastern white pine, Siberian elm.	---
34, 34B, 34C2, 34D2---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
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, 62F, 62G--------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
90---------- Okoboji	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	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.

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
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, 108C2-- 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.	---
168G---------- Hayden	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian-olive, Amur maple, northern white-cedar, blue spruce.	Eastern white pine, green ash.	---
202, 203---------- Cylinder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, northern white-cedar, Amur maple, white spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
236B, 236B2, 236C, 236C2, 236D, 236D2, 236E, 236F---------- Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
256D2*, 256E2*, 256F*, 256G*: Lester----------	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---

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
258, 259---------- Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
307---------- Dundas	---	Tatarian honeysuckle, lilac, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Eastern cottonwood, 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.	---	---
325---------- Le Sueur	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
383---------- Marna	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
385---------- Guckeen	---	Siberian peashrub, Tatarian honeysuckle, lilac, eastern redcedar.	Northern white-cedar, white spruce, Austrian pine, hackberry, Russian-olive, bur oak.	Eastern white pine, green ash.	---
386---------- Cordova	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, hackberry, tall purple willow, Amur maple.	Green ash, golden willow.	Eastern cottonwood, silver maple.
458---------- Millington	---	Northern white-cedar, lilac, Siberian peashrub.	Hackberry, white spruce, eastern redcedar.	Honeylocust, green ash.	Eastern cottonwood.
485, 485B---------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
506---------- Wacousta	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
507---------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, 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
508---------- Calcousta	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
566, 566C---------- Moingona	---	Redosier dogwood, gray dogwood, lilac, Siberian peashrub.	Amur maple, blue spruce, Russian-olive, northern white-cedar, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
585B*: 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.
Spillville-------	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
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------	---
639C2*, 639D2*: Salida.					
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.
658, 659---------- Mayer	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	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
733---------- Calco	---	Lilac, Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
878, 878B, 878B2, 878C2---------- Ocheyedan	---	Redosier dogwood, Siberian peashrub, gray dogwood, lilac.	Northern white-cedar, hackberry, Russian-olive, Amur maple, blue spruce.	Eastern white pine, ponderosa pine, green ash.	---
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.
1048. Knoke					
1135---------- 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.
1308---------- Wadena Variant	---	Siberian peashrub, Siberian crabapple, lilac, Tatarian honeysuckle.	Eastern redcedar, Amur maple, northern white-cedar, white spruce.	Scotch pine, green ash, eastern white pine.	Silver maple.
1585*: 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.
Spillville-------	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
1585B*: 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.
Spillville-------	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	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
2315*: Fluvaquents.					
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.
5010*. Pits					
5020*. Pits and dumps					
5040*, 5041*. 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.
27C Terril	Slight	Slight	Severe: slope.	Slight	Slight.
28B Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
28C2 Dickman	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
34 Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
34B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
34C2 Estherville	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
34D2 Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
48 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	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, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
62G Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
90 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
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	Moderate: small stones.	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
108B---------- Wadena	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Slight.
108C2---------- Wadena	Slight----------	Slight----------	Severe: 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.
168G---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
202, 203---------- Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
236B, 236B2---------- Lester	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
236C, 236C2---------- Lester	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
236D, 236D2---------- Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
236E, 236F---------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
256D2*:					
Lester----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
Storden----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
256E2*, 256F*:					
Lester----------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
256G*:					
Lester----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
258, 259---------- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
307---------- Dundas	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

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
308---- Wadena	Slight----	Slight----	Moderate: small stones.	Slight----	Slight.
308B---- Wadena	Slight----	Slight----	Moderate: slope, small stones.	Slight----	Slight.
325---- Le Sueur	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight----	Slight.
383---- Marna	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
385---- Guckeen	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----	Slight.
386---- Cordova	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
458---- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
485---- Spillville	Severe: flooding.	Slight----	Moderate: flooding.	Slight----	Moderate: flooding.
485B---- Spillville	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
506---- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
507---- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
508---- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
566---- Moingona	Slight----	Slight----	Slight----	Slight----	Slight.
566C---- Moingona	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
585B*: Coland----	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Spillville----	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
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.

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
638D2*: 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.
639C2*: Salida	Moderate: small stones.	Moderate: small stones.	Severe: slope, small stones.	Slight	Severe: droughty.
Storden	Slight	Slight	Severe: slope.	Slight	Slight.
639D2*: Salida	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Slight	Severe: droughty.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
655 Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
658, 659 Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
733 Calco	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
878 Ocheyedan	Slight	Slight	Slight	Slight	Slight.
878B, 878B2 Ocheyedan	Slight	Slight	Moderate: slope.	Slight	Slight.
878C2 Ocheyedan	Slight	Slight	Severe: slope.	Slight	Slight.
879 Fostoria	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
1048 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1135 Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1308 Wadena Variant	Slight	Slight	Slight	Slight	Slight.
1585*: Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.

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
1585*: Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
1585B*: Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
Spillville	Slight	Slight	Moderate: slope.	Slight	Slight.
2315*: Fluvaquents.					
Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
5010*. Pits					
5020*. Pits and dumps					
5040*, 5041*. 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.
27C---------- Terril	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
28B, 28C2---------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
34, 34B, 34C2------ Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
34D2---------- Estherville	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
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.
62F, 62G---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
90---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
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---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
108C2---------- Wadena	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
135---------- Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
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.
168G---------- Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
202, 203---------- Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.

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
236B, 236B2--------- Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236C, 236C2, 236D, 236D2, 236E-------- Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236F---------- Lester	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
256D2*, 256E2*: Lester----------	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.
256F*, 256G*: Lester----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Storden----------	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
258, 259---------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
307---------- Dundas	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
308, 308B---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
325---------- Le Sueur	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
383---------- Marna	Fair	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
385---------- Guckeen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
386---------- Cordova	Fair	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
458---------- Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
485---------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
485B---------- Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
506---------- Wacousta	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
507---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
508---------- Calcousta	Fair	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
566, 566C---------- Moingona	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.

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
585B*:										
Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Spillville	Good	Good	Good	Good	Good	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.
639C2*, 639D2*:										
Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	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.
658, 659--Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
733--Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
878, 878B, 878B2--Ocheyedan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
878C2--Ocheyedan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
879--Fostoria	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
1048--Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
1135--Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1308--Wadena Variant	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1585*:										
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
1585B*:										
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very 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
2315*: Fluvaquents.										
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
5010*. Pits										
5020*. Pits and dumps										
5040*, 5041*. 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.
27C---------- Terril	Slight---------	Slight---------	Slight---------	Moderate: slope.	Severe: low strength.	Slight.
28B---------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
28C2--------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
34, 34B------ Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
34C2--------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
34D2--------- Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
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, 62F, 62G---- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
90---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
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---- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.

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
108C2---------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
135---------- Coland	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.
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.
168G---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
202, 203---------- Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
236B, 236B2------- Lester	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
236C, 236C2------- Lester	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
236D, 236D2------- Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
236E, 236F-------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
256D2*: Lester----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Storden----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
256E2*, 256F*, 256G*: Lester----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Storden---------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
258, 259---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
307---------- Dundas	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
308, 308B--------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	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
325---------- Le Sueur	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
383---------- Marna	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
385---------- Guckeen	Moderate: too clayey, dense layer, wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
386---------- Cordova	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
458---------- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
485---------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
485B---------- Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
506---------- Wacousta	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
566---------- Moingona	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.
566C---------- Moingona	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
585B*: Coland----------	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.
Spillville-------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
638C2*: Clarion----------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
Storden----------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	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
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.
639C2*:						
Salida	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
639D2*:						
Salida	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
655 Crippin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
658, 659 Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
733 Calco	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.
878, 878B, 878B2 Ocheyedan	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
878C2 Ocheyedan	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
879 Fostoria	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
1048 Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
1135 Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
1308 Wadena Variant	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	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
1585*:						
Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
1585B*:						
Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
2315*: Fluvaquents.						
Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
5010*. Pits						
5020*. Pits and dumps						
5040*, 5041*. 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.	Severe: ponding.	Poor: ponding.
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
27B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
27C Terril	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28B Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
28C2 Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
34, 34B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
34C2, 34D2 Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
48 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
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, 62F, 62G Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
90 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
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 Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

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
108C2---------- Wadena	Severe: poor filter.	Severe: seepage, slope.	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.
168G---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
202, 203---------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
236B, 236B2---------- Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
236C, 236C2---------- Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
236D, 236D2---------- Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
236E, 236F---------- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
256D2*: Lester----------	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Storden----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
256E2*, 256F*, 256G*: Lester----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
258, 259---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
307---------- Dundas	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, 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
308, 308B---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
325---------- Le Sueur	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
383---------- Marna	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
385---------- Guckeen	Severe: wetness, percs slowly.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
386---------- Cordova	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
458---------- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
485---------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
485B---------- Spillville	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.
506---------- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
566---------- Moingona	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight----------	Fair: too clayey.
566C---------- Moingona	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
585B*: Coland----------	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Spillville---------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.
638C2*: Clarion----------	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.
Storden----------	Slight----------	Severe: slope.	Slight----------	Slight----------	Good.

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
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.
639C2*:					
Salida	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Slight	Severe: slope.	Slight	Slight	Good.
639D2*:					
Salida	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
655 Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
658, 659 Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
733 Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
878 Ocheyedan	Slight	Moderate: seepage.	Slight	Slight	Good.
878B, 878B2 Ocheyedan	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
878C2 Ocheyedan	Slight	Severe: slope.	Slight	Slight	Good.
879 Fostoria	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
1048 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1135 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
1308 Wadena Variant	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Slight	Fair: thin layer.

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
1585*:					
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
1585B*:					
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Spillville	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.
2315*:					
Fluvaquents.					
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
5010*.					
Pits					
5020*.					
Pits and dumps					
5040*, 5041*.					
Orthents					

* 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, 27C Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
28B, 28C2 Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
34, 34B, 34C2, 34D2 Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
48 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
55 Nicollet	Fair: wetness.	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, 62F Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
62G Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
90 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
95 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
107 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
108, 108B, 108C2 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.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
138D2---------- Clarion	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
168G---------- Hayden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
202, 203---------- Cylinder	Fair: wetness.	Probable----------	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
236B, 236B2, 236C, 236C2---------- Lester	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236D, 236D2---------- Lester	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
236E, 236F---------- Lester	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
256D2*: Lester----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Storden----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
256E2*, 256F*: Lester----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Storden----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
256G*: Lester----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Storden----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
258, 259---------- Biscay	Fair: wetness.	Probable----------	Probable----------	Fair: area reclaim, thin layer.
307---------- Dundas	Fair: wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
308, 308B---------- Wadena	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
325---------- Le Sueur	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
383---------- Marna	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
385---------- Guckeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too clayey.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
386---------- Cordova	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
458---------- Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
485, 485B---------- Spillville	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
506---------- Wacousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
507---------- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
508---------- Calcousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
566, 566C---------- Moingona	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
585B*:				
Coland----------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Spillville----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
638C2*:				
Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
638D2*:				
Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: 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.
639C2*:				
Salida----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim, too sandy.
Storden----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
639D2*:				
Salida----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim, too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
639D2*: Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
655 Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
658, 659 Mayer	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
733 Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
878, 878B, 878B2, 878C2 Ocheyedan	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
879 Fostoria	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1048 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1308 Wadena Variant	Good	Probable	Improbable: too sandy.	Good.
1585*, 1585B*: Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
2315*: Fluvaquents.				
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
5010*. Pits				
5020*. Pits and dumps				
5040*, 5041*. 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, 27C---------- Terril	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
28B, 28C2--------- Dickman	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
34, 34B, 34C2----- Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
34D2---------- Estherville	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
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, 62F, 62G---------- Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
90---------- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
95---------- Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
107---------- Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
108, 108B, 108C2-- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
135---------- Coland	Moderate: 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.
168G---------- Hayden	Severe: slope.	Slight----------	Severe: no water.	Deep to water	Slope----------	Slope.

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
202, 203---------- Cylinder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Favorable.
236B, 236B2, 236C, 236C2---------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
236D, 236D2, 236E, 236F---------- Lester	Severe: slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
256D2*, 256E2*, 256F*, 256G*: Lester----------	Severe: slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Storden---------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
258, 259---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
307---------- Dundas	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
308, 308B--------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
325---------- Le Sueur	Moderate: seepage.	Moderate: wetness.	Severe: no water.	Frost action---	Wetness--------	Favorable.
383---------- Marna	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.
385---------- Guckeen	Slight---------	Moderate: piping, wetness.	Severe: slow refill.	Deep to water	Erodes easily	Erodes easily, rooting depth.
386---------- Cordova	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
458---------- Millington	Moderate: seepage.	Severe: piping, wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
485---------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
485B---------- Spillville	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
506---------- Wacousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
507---------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
508---------- Calcousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, 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
566---------- Moingona	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Rooting depth.
566C---------- Moingona	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Rooting depth.
585B*:						
Coland----------	Moderate: seepage, slope.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action, slope.	Wetness--------	Wetness.
Spillville-------	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
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.
Storden----------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
639C2*:						
Salida----------	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy------	Droughty.
Storden----------	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
639D2*:						
Salida----------	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
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.
658, 659---------- Mayer	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
733---------- Calco	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
878---------- Ocheyedan	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
878B, 878B2, 878C2---------- Ocheyedan	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.

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
879---------- Fostoria	Moderate: seepage.	Moderate: wetness, piping.	Moderate: deep to water, slow refill.	Frost action---	Wetness, erodes easily.	Erodes easily.
1048---------- Knoke	Slight---------	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
1135---------- Coland	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
1308---------- Wadena Variant	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
1585*: Coland----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
Spillville-------	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
1585B*: Coland----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
Spillville-------	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
2315*: Fluvaquents.						
Coland----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
5010*. Pits						
5020*. Pits and dumps						
5040*, 5041*. 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		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
4----------	0-26	Silty clay loam	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
Knoke	26-50	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	50-60	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----------	0-31	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
Okoboji	31-43	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	43-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	41-55	20-30
27B, 27C----------	0-37	Loam----------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	11-20
Terril	37-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	11-20
28B, 28C2----------	0-14	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
Dickman	14-41	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
	41-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
34, 34B, 34C2, 34D2----------	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
Estherville	10-20	Loam, coarse sandy loam, loamy sand and gravel.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	20-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
48----------	0-10	Mucky silt loam	OH, MH	A-7	0	100	100	95-100	90-95	60-90	11-30
Knoke	10-25	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	25-60	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----------	0-15	Loam----------	ML, CL	A-6, A-7	0	95-100	90-100	85-98	55-85	35-50	11-25
Nicollet	15-29	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
	29-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
62C2, 62D2, 62E2, 62F, 62G----------	0-7	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
Storden	7-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
90----------	0-17	Mucky silt loam	OH, MH	A-7	0	100	100	95-100	90-95	60-95	11-30
Okoboji	17-25	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	25-48	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	48-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	41-55	20-30

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
95----------	0-17	Loam----------	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
Harps	17-42	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
	42-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	11-25
107----------	0-15	Clay loam--------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
Webster	15-30	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
	30-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	11-20
108, 108B, 108C2-	0-16	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
Wadena	16-30	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
	30-60	Stratified gravelly coarse sand to gravelly loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
135----------	0-20	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Coland	20-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	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
138B, 138B2, 138C, 138C2, 138D2----------	0-14	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
Clarion	14-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	28-60	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
168G----------	0-11	Loam----------	CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
Hayden	11-27	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	27-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
202----------	0-18	Loam----------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	11-25
Cylinder	18-28	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	11-20
	28-60	Gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
203----------	0-22	Loam----------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	11-25
Cylinder	22-39	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	11-20
	39-60	Gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
236B, 236B2, 236C, 236C2, 236D, 236D2, 236E, 236F------	0-9	Loam----------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
Lester	9-27	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	27-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
256D2*, 256E2*, 256F*, 256G*:											
Lester---------	0-9	Loam----------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	9-27	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	27-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
Storden--------	0-7	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

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	
258---------- Biscay	0-20	Loam----------	CL	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	11-25
	20-28	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	11-20
	28-36	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	36-60	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
259---------- Biscay	0-22	Loam----------	CL	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	11-25
	22-35	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	11-20
	35-43	Gravelly loam, loamy coarse sand, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	43-60	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
307---------- Dundas	0-13	Silt loam--------	ML, CL	A-6, A-4	0	100	95-98	85-97	60-80	30-40	6-16
	13-47	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-2	97-100	90-98	85-97	50-90	35-60	15-30
	47-60	Clay loam, loam, fine sandy loam.	CL, SC	A-6	0-2	95-100	90-98	80-95	35-70	30-40	11-20
308, 308B-------- Wadena	0-14	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	14-34	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
	34-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
325---------- Le Sueur	0-22	Loam----------	CL, CL-ML	A-6, A-4	0	95-100	95-100	90-100	70-85	20-40	5-15
	22-49	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	95-100	95-100	85-100	60-80	35-50	15-25
	49-60	Loam----------	CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	55-75	20-40	5-20
383---------- Marna	0-30	Silty clay loam, clay.	MH, ML	A-7	0	98-100	90-100	90-100	85-95	45-65	15-30
	30-37	Clay, silty clay, silty clay loam.	CH, MH	A-7	0	98-100	90-100	90-100	85-95	50-80	20-45
	37-60	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-98	75-95	60-80	35-50	15-25
385---------- Guckeen	0-9	Silty clay loam	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	41-60	15-25
	9-39	Silty clay, silty clay loam, clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	41-65	15-30
	39-60	Clay loam, loam	CL	A-6, A-7	0	90-100	90-98	85-95	60-75	30-50	11-25
386---------- Cordova	0-19	Clay loam, loam	OL, ML, MH, OH	A-6, A-7	0	95-100	95-100	90-100	70-85	38-60	12-25
	19-32	Silty clay loam, clay loam.	CL	A-7	0	90-100	90-100	85-95	65-90	41-50	20-30
	32-60	Clay loam, loam	CL	A-6	0-5	90-100	90-100	80-95	55-70	30-40	12-20
458---------- Millington	0-33	Loam----------	ML, CL, OL	A-6, A-7, A-4	0	90-100	90-100	80-100	70-95	30-45	8-17
	33-39	Loam, silty clay loam, clay loam.	CL, ML	A-7, A-6	0	95-100	90-100	80-100	70-95	28-50	11-22
	39-60	Stratified loamy fine sand to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	80-100	80-100	80-100	60-95	20-45	5-20

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	
485, 485B-------- Spillville	0-53	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	53-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
506---------- Wacousta	0-26	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	41-65	20-40
	26-53	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	41-60	20-35
	53-60	Silty clay loam, very fine sandy loam, loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15
507---------- Canisteo	0-13	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	41-50	15-20
	13-30	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	30-60	Clay loam, loam, fine sandy loam.	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
508---------- Calcousta	0-11	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	41-65	20-40
	11-24	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	41-60	20-35
	24-60	Silty clay loam, silt loam, loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15
566, 566C-------- Moingona	0-23	Loam----------	CL	A-4, A-6	0-2	95-100	95-100	80-90	50-65	25-40	8-15
	23-32	Sandy clay loam, loam, clay loam.	CL	A-6	0-2	95-100	95-100	80-90	50-60	25-40	11-20
	32-60	Loam, clay loam, sandy loam.	CL, SC	A-4, A-6	0-2	95-100	95-100	75-90	40-55	25-40	8-15
585B*: Coland----------	0-20	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	20-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	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
Spillville------	0-53	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	53-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
638C2*, 638D2*, 638E2*: Clarion--------	0-14	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	28-60	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--------	0-7	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
639C2*, 639D2*: Salida----------	0-7	Gravelly sandy loam.	SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	7-13	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GW	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	13-60	Gravelly coarse sand, very gravelly sand.	SP, SW, GP, GW	A-1	0-5	20-70	10-60	5-30	0-5	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
639C2*, 639D2*:											
Storden	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
655	0-20	Loam	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	11-20
Crippin	20-32	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	11-20
	32-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	11-20
658	0-20	Loam	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
Mayer	20-28	Loam, sandy clay loam, loamy coarse sand.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	28-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
659	0-21	Loam	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
Mayer	21-39	Loam, sandy clay loam, loamy coarse sand.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	39-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
733	0-20	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	41-60	15-30
Calco	20-41	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	41-60	15-30
	41-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	11-20
878, 878B, 878B2, 878C2	0-13	Loam	CL	A-6	0	100	100	75-90	65-80	30-40	11-15
Ocheyedan	13-26	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
	26-60	Sandy loam, sandy clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	100	100	85-95	50-90	25-40	5-15
879	0-42	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-95	25-40	5-15
Fostoria	42-60	Silt loam, loam, sandy loam.	CL	A-6	0-5	100	100	75-100	55-95	30-40	11-20
1048	0-6	Mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
Knoke	6-32	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	32-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
1135	0-20	Silty clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Coland	20-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	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
1308	0-41	Loam	ML	A-4	0	100	95-100	75-95	50-65	20-40	2-10
Wadena Variant	41-60	Loamy fine sand, fine sand.	SM	A-2	0	100	95-100	65-80	20-35	---	NP
1585*, 1585B*:											
Coland	0-20	Silty clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	20-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	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

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

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	
1585*, 1585B*:											
Spillville------	0-53	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	53-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
2315*:											
Fluvaquents.											
Coland----------	0-20	Silty clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	20-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	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
5010*.											
Pits											
5020*.											
Pits and dumps											
5040*, 5041*.											
Orthents											

* 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/cm³	In/hr	In/in	pH				
4	0-26	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High	0.37	5	7
Knoke	26-50	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High	0.37		
	50-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37		
6	0-31	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High	0.37	5	4
Okoboji	31-43	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37		
	43-60	20-35	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28		
27B, 27C	0-37	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	5	6
Terril	37-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low	0.32		
28B, 28C2	0-14	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low	0.20	3	3
Dickman	14-41	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low	0.20		
	41-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low	0.15		
34, 34B, 34C2, 34D2	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3
Estherville	10-20	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20		
	20-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10		
48	0-10	20-26	1.10-1.20	0.6-2.0	0.24-0.26	7.4-8.4	Moderate	0.28	5	6
Knoke	10-25	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High	0.37		
	25-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37		
55	0-15	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	0.24	5	6
Nicollet	15-29	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate	0.32		
	29-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.32		
62C2, 62D2, 62E2, 62F, 62G	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L
Storden	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
90	0-17	20-26	1.20-1.25	0.6-2.0	0.24-0.26	6.1-7.8	High	0.37	5	6
Okoboji	17-25	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37		
	25-48	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37		
	48-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28		
95	0-17	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L
Harps	17-42	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32		
	42-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32		
107	0-15	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate	0.24	5	6
Webster	15-30	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate	0.32		
	30-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32		
108, 108B, 108C2	0-16	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	4	5
Wadena	16-30	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low	0.32		
	30-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10		
135	0-20	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28	5	7
Coland	20-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High	0.28		
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low	0.28		
138B, 138B2, 138C, 138C2, 138D2	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6
Clarion	14-28	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37		
	28-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
168G	0-11	10-26	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32	5	6
Hayden	11-27	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate	0.32		
	27-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low	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/cm³	In/hr	In/in	pH				
202----------	0-18	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
Cylinder	18-28	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	28-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
203----------	0-22	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
Cylinder	22-39	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	39-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
236B, 236B2, 236C, 236C2, 236D, 236D2, 236E, 236F------	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6
Lester	9-27	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28		
	27-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37		
256D2*, 256E2*, 256F*, 256G*:										
Lester---------	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6
	9-27	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28		
	27-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37		
Storden--------	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
258----------	0-20	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
Biscay	20-28	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	28-36	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low----------	0.28		
	36-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
259----------	0-22	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
Biscay	22-35	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	35-43	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low----------	0.28		
	43-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
307----------	0-13	10-27	1.40-1.60	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.28	5	6
Dundas	13-47	20-35	1.50-1.65	0.2-0.6	0.15-0.19	5.1-7.3	Moderate-----	0.28		
	47-60	15-30	1.60-1.75	0.6-2.0	0.14-0.19	7.4-8.4	Moderate-----	0.28		
308, 308B---------	0-14	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
Wadena	14-34	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	34-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10		
325----------	0-22	20-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.24	5	6
Le Sueur	22-49	24-35	1.30-1.45	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.32		
	49-60	20-27	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32		
383----------	0-30	30-50	1.20-1.30	0.06-0.2	0.18-0.22	6.1-7.3	High---------	0.28	5	4
Marna	30-37	35-60	1.25-1.40	0.06-0.2	0.13-0.16	6.1-7.3	High---------	0.28		
	37-60	24-35	1.45-1.70	0.2-2.0	0.14-0.19	6.6-8.4	Moderate-----	0.28		
385----------	0-9	35-50	1.20-1.30	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.28	3	7
Guckeen	9-39	35-50	1.25-1.35	0.06-0.6	0.13-0.16	5.6-7.3	Moderate-----	0.28		
	39-60	24-40	1.35-1.85	0.2-0.6	0.15-0.17	6.6-8.4	Moderate-----	0.37		
386----------	0-19	15-30	1.25-1.45	0.2-2.0	0.18-0.22	6.1-7.3	Moderate-----	0.28	5	6
Cordova	19-32	28-35	1.35-1.50	0.2-0.6	0.15-0.19	5.1-6.5	Moderate-----	0.28		
	32-60	18-30	1.45-1.70	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28		
458----------	0-33	20-27	1.40-1.60	0.6-2.0	0.20-0.24	7.4-8.4	Low----------	0.28	5	5
Millington	33-39	18-35	1.40-1.60	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.28		
	39-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	Moderate-----	0.28		
485, 485B---------	0-53	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
Spillville	53-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
506----------	0-26	27-35	1.20-1.25	0.6-2.0	0.21-0.23	6.1-7.8	High---------	0.28	5	7
Wacousta	26-53	24-35	1.25-1.30	0.6-2.0	0.18-0.20	6.6-7.8	High---------	0.43		
	53-60	18-30	1.30-1.40	0.6-2.0	0.20-0.22	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/cm³	In/hr	In/in	pH				
507----------	0-13	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	4L
Canisteo	13-30	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32		
	30-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32		
508----------	0-11	27-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	7
Calcousta	11-24	24-32	1.30-1.40	0.6-2.0	0.18-0.20	7.4-8.4	High---------	0.43		
	24-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.43		
566, 566C----------	0-23	18-20	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	5
Moingona	23-32	21-30	1.45-1.65	0.6-2.0	0.16-0.18	5.6-7.3	Low----------	0.28		
	32-57	15-30	1.65-1.75	0.6-2.0	0.16-0.18	5.6-8.4	Low----------	0.28		
585B*:										
Coland----------	0-20	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	20-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
Spillville------	0-53	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	53-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
638C2*, 638D2*, 638E2*:										
Clarion--------	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6
	14-28	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	28-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
Storden--------	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
639C2*, 639D2*:										
Salida----------	0-7	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low----------	0.10	3	8
	7-13	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
	13-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
Storden---------	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
655----------	0-20	22-28	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.28	5	6
Crippin	20-32	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
	32-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low----------	0.37		
658----------	0-20	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	4	4L
Mayer	20-28	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low----------	0.28		
	28-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15		
659----------	0-21	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	4	4L
Mayer	21-39	9-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low----------	0.28		
	39-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15		
733----------	0-20	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	7
Calco	20-41	30-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28		
	41-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
878, 878B, 878B2, 878C2----------	0-13	24-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	6
Ocheyedan	13-26	14-24	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
	26-60	12-24	1.45-1.70	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.32		
879----------	0-42	25-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
Fostoria	42-60	16-26	1.40-1.75	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43		
1048----------	0-6	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High---------	0.37	5	7
Knoke	6-32	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High---------	0.37		
	32-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37		
1135----------	0-20	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
Coland	20-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		

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/cm³	In/hr	In/in	pH				
1308----------	0-41	18-25	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
Wadena Variant	41-60	1-10	1.55-1.65	6.0-20	0.04-0.08	6.1-7.3	Low----------	0.15		
1585*, 1585B*:										
Coland----------	0-20	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	20-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
Spillville------	0-53	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	53-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
2315*:										
Fluvaquents.										
Coland----------	0-20	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7
	20-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28		
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
5010*.										
Pits										
5020*.										
Pits and dumps										
5040*, 5041*.										
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 "rare," "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, 27C---------- Terril	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
28B, 28C2--------- Dickman	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
34, 34B, 34C2, 34D2---------- Estherville	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
48---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
55---------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Nov-Jul	High-----	High-----	Low.
62C2, 62D2, 62E2, 62F, 62G--------- Storden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
90---------- Okoboji	B/D	None--------	---	---	+1-1.0	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, 108C2-- 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.
168G---------- Hayden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
202, 203---------- Cylinder	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	Moderate	Low.
236B, 236B2, 236C, 236C2, 236D, 236D2, 236E, 236F---------- Lester	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
256D2*, 256E2*, 256F*, 256G*: Lester----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
Storden---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	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					
258, 259---------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	Moderate	Low.
307---------- Dundas	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
308, 308B---------- Wadena	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
325---------- Le Sueur	B	None--------	---	---	2.0-4.0	Perched	Nov-Jul	High-----	High-----	Low.
383---------- Marna	D	None--------	---	---	1.0-2.5	Apparent	Nov-Jul	High-----	High-----	Low.
385---------- Guckeen	C	None--------	---	---	3.5-5.0	Apparent	Nov-Jul	High-----	High-----	Low.
386---------- Cordova	C/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
458---------- Millington	B/D	Frequent----	Brief-----	Apr-Jun	0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
485---------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
485B---------- Spillville	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
506---------- Wacousta	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
507---------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
508---------- Calcousta	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
566, 566C---------- Moingona	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
585B*:										
Coland----------	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Spillville-------	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
638C2*, 638D2*, 638E2*:										
Clarion---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Storden---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
639C2*, 639D2*:										
Salida----------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
655---------- Crippin	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
658, 659---------- Mayer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
733---------- Calco	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	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					
878, 878B, 878B2, 878C2---------- Ocheyedan	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
879---------- Fostoria	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
1048---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
1135---------- Coland	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
1308---------- Wadena Variant	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
1585*:										
Coland----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Spillville-------	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
1585B*:										
Coland----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Spillville-------	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
2315*: Fluvaquents.										
Coland----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
5010*. Pits										
5020*. Pits and dumps										
5040*, 5041*. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Calcousta	Fine-silty, mixed (calcareous), 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
Cordova	Fine-loamy, mixed, mesic Typic Argiaquolls
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
Dundas	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fluvaquents	Mixed, mesic Fluvaquents
Fostoria	Fine-loamy, mixed, mesic Aquic Hapludolls
Guckeen	Fine, montmorillonitic, mesic Aquic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Le Sueur	Fine-loamy, mixed, mesic Aquic Argiudolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Marna	Fine, montmorillonitic, mesic Typic Haplaquolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Moingona	Fine-loamy, mixed, mesic Typic Argiudolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Ocheyedan	Fine-loamy, mixed, mesic Typic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Typic Udorthents
Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Wacousta	Fine-silty, mixed, mesic Typic Haplaquolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Wadena Variant	Fine-loamy, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls

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