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Department of
Agriculture

Soil
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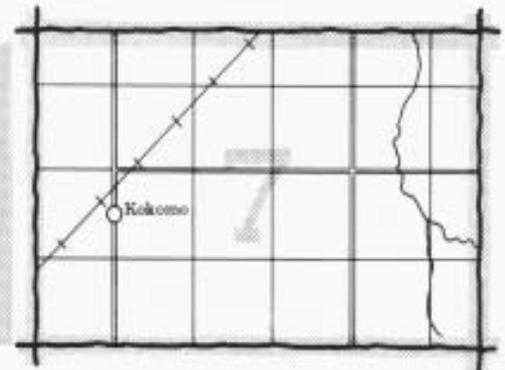
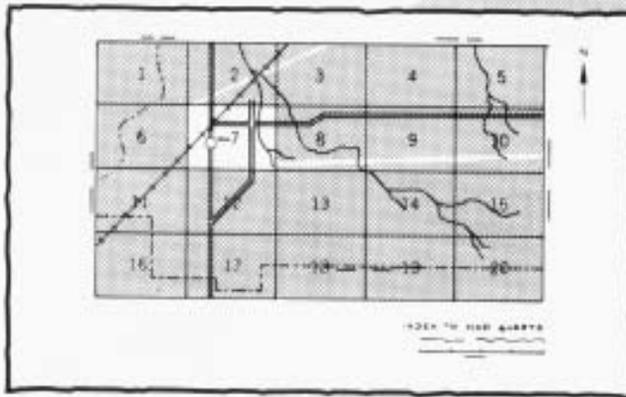
In cooperation with
Minnesota Agricultural
Experiment Station

Soil Survey of Jackson County, Minnesota



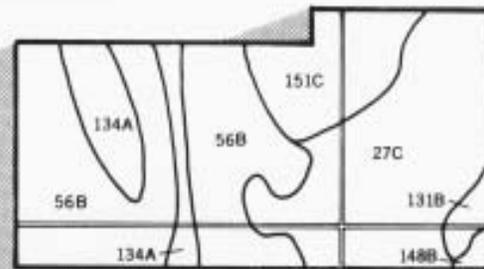
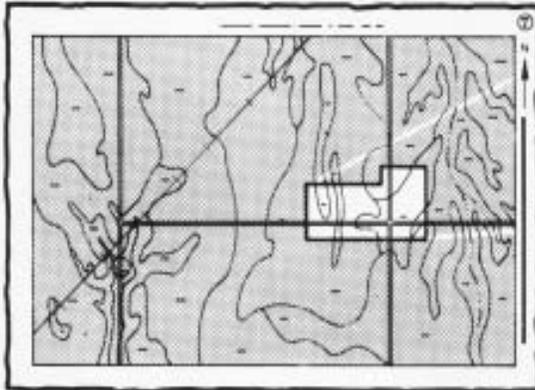
HOW TO USE

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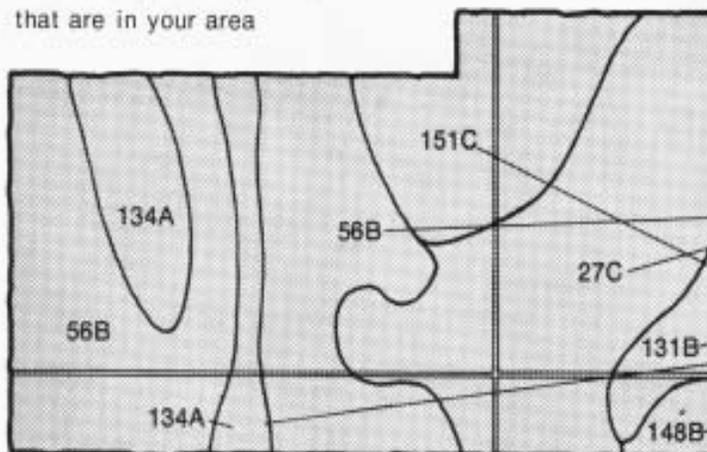


2. Note the number of the map sheet and turn to that sheet.

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



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

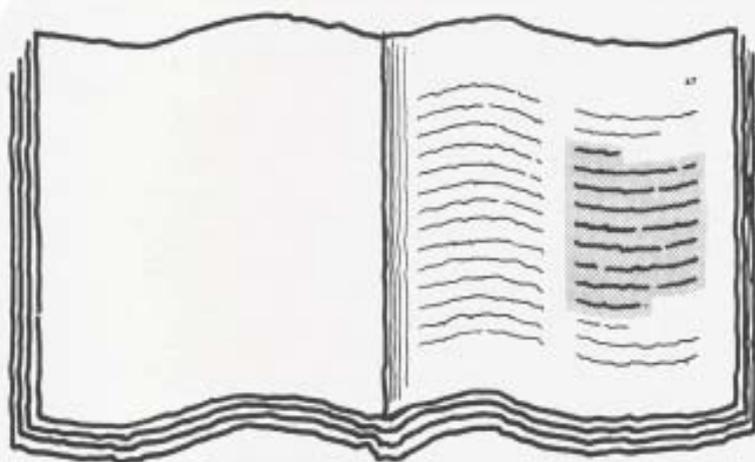


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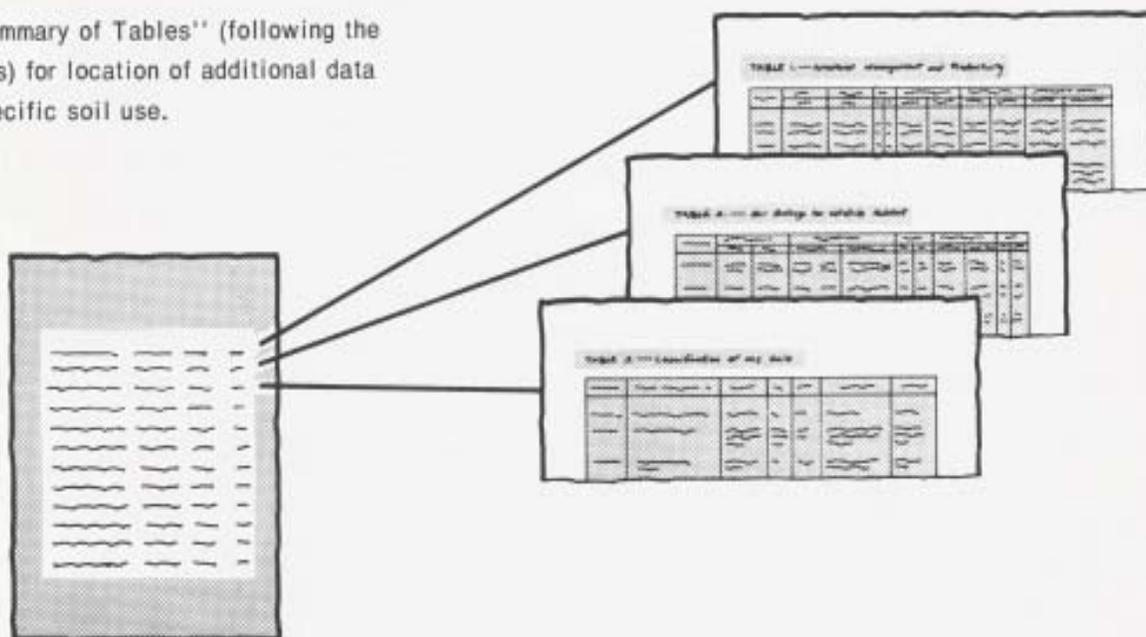
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151C

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.

A detailed illustration of a table with multiple columns and rows of text, representing the 'Index to Soil Map Units'.

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



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

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

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. 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 and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Jackson County Soil and Water Conservation District.

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: Corn in an area of Nicollet clay loam.

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Foreword

This soil survey contains information that can be used in land-planning programs in Jackson 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.

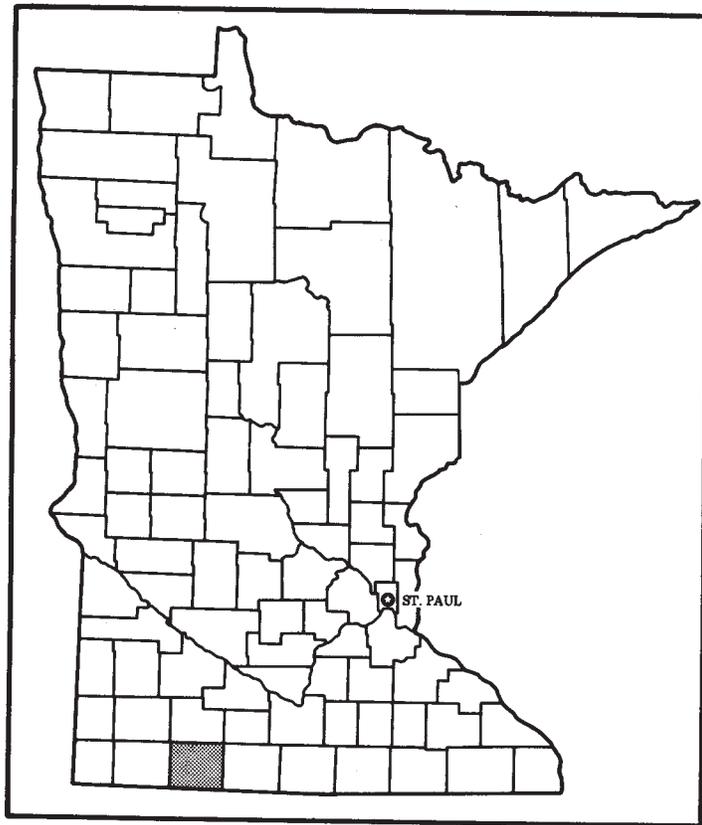
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey 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.



Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Jackson County in Minnesota.

Soil Survey of Jackson County, Minnesota

By Raymond C. Genrich, Soil Conservation Service

Fieldwork by Raymond C. Genrich, Soil Conservation Service, and
H. Gerald Floren, Cathy Krupinski, and Mark Krupinski,
Minnesota Agricultural Experiment Station

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

JACKSON COUNTY is in southwestern Minnesota, on the Iowa border. It is the third county east of South Dakota. It has a population of 13,690. Jackson, the county seat, has a population of 3,550.

Of the 458,880 acres in Jackson County, more than 13,440 acres is water. About 94 percent of the county is farmland. The rest is used for urban or recreational development or for wildlife habitat. The principal industry is agriculture. The main crops are corn and soybeans. Livestock production also is important.

This soil survey updates the survey of Jackson County, published in 1928. It provides additional information and larger scale maps, which show the soils in greater detail (3).

General Nature of the County

This section gives general information concerning the county. It describes physiography, relief, and drainage; history; and climate.

Physiography, Relief, and Drainage

The landscape of Jackson County is the result of glacial activity that occurred 12,000 to 20,000 years ago (6). The reworking of the landscape by the glacier and by glacial meltwater resulted in distinct physiographic regions. Each region has a different topography and different parent material.

The eastern part of the county is characterized by a nearly level to undulating ground moraine. Relief in this area is 5 to 25 feet. The undulating to hilly Altamont

recessional moraine extends from north to south through the central part of the county. Relief on this moraine ranges from 5 to 50 feet. The West Fork of the Des Moines River flows along the east side of the Altamont moraine. The floor of the valley is about 100 feet lower than the top of the steep bluffs bordering the river (6).

A large glacial lake was once in the western part of the county. Heron and South Heron Lakes are remnants of that glacial lake. The glacial lake plain makes up about 17 percent of the county. Local relief is 1 to 15 feet. The glacial lake deposits are silty and clayey.

The southwestern part of the county is characterized by many small, flat-topped hills that were once the bottom of small, ice-walled lakes (6). Glacial lake sediments were deposited on the hilltops and glacial till on the side slopes. Relief ranges from 5 to 30 feet.

The geologically young landscape of the county does not have a well defined drainage pattern. Most depressions do not have a drainage outlet and are subject to ponding. Most of the farmland has been artificially drained.

The watershed divide between the Missouri and Mississippi Rivers runs through the county. The West Fork of the Des Moines River and its tributaries drain the northern and eastern parts of the county. The Des Moines River eventually flows into the Mississippi River. The southwest corner of the county is drained by the Little Sioux River and its tributaries, which eventually flow into the Missouri River.

The highest point above sea level in the county is 1,570 feet, in section 30 of Round Lake Township. The lowest point is 1,280 feet above sea level, in an area

where the West Fork of the Des Moines River leaves the county, in section 34 of Petersburg Township.

History

Jackson County was organized by the Territorial Legislature in 1857. It was named after Henry Jackson, a Minneapolis merchant. The early settlers came from Iowa and Wisconsin and later from northern Europe (7).

The first permanent settlement, Fort Belmont, was near the present site of the town of Jackson. The pioneers cut wood for building and fuel in the valley of the Des Moines River. They farmed the surrounding upland prairie.

Settlement was slowed by the Civil War. The county was depopulated twice. In 1857, the hostile Dakota warrior Inkpaduta led a band of braves against the Fort Belmont settlers. The Indians killed several settlers and drove off the rest. Some settlers returned. They were attacked again during the Great Sioux Uprising of 1862. Eventually, the Indians were defeated by soldiers from Fort Snelling during the Battle of Birch Coulee (7).

Post Civil War settlement was rapid, spurred on by the advent of the railroad in the 1870's (7). The population continued to increase until about 1910. Since 1920, the rural population has decreased, although the towns have grown larger. The trend is toward fewer and larger farms.

Climate

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

Jackson County is cold in winter. Summers are characterized by quite hot temperatures and occasional cool spells. Precipitation frequently occurs as snowstorms during winter. It occurs chiefly as showers during the warmer months, when warm, moist air moves in from the south. The total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Worthington, Minnesota, in the period 1951 to 1980. Worthington is in Nobles County, which is adjacent to Jackson County. 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 15 degrees F, and the average daily minimum temperature is 6 degrees. The lowest temperature on record, which occurred at Worthington on January 16, 1972, is -29 degrees. In summer the average temperature is 69 degrees, and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred at Worthington on July 10, 1976, is 103 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 25.86 inches. Of this, 19 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 6.37 inches at Worthington on June 20, 1969.

Thunderstorms occur on about 44 days each year. Tornadoes and severe thunderstorms strike occasionally. These storms are local in extent and of short duration and result in sparse damage in narrow belts. At times during the warmer part of the year, hailstorms occur in scattered small areas.

The average seasonal snowfall is 39 inches. The greatest snow depth at any one time during the period of record was 29 inches. On the average, 52 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

How This Survey Was Made

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

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

the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

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

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

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

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will

always be at a specific level in the soil on a specific date.

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

Map Unit Composition

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

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

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

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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. Estherville-Dickman Association

Nearly level to rolling, somewhat excessively drained and well drained, loamy soils that formed in glacial outwash on uplands

This association is on glacial outwash plains. Slopes are mainly convex and are separated by a few drainageways.

This association makes up about 2 percent of the county. It is about 40 percent Estherville soils, 25 percent Dickman soils, and 35 percent minor soils (fig. 1).

Estherville soils are on river terraces and upland side slopes. They are nearly level to rolling and are somewhat excessively drained. Typically, they have a surface layer of black sandy loam and a subsoil of dark yellowish brown sandy loam. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand.

Dickman soils are on side slopes and summits. They are nearly level to rolling and are well drained. Typically, they have a surface layer of very dark brown sandy loam and a subsoil of dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown sand.

Minor in this association are the poorly drained Biscay and Delft soils in swales; the poorly drained, calcareous

Mayer soils in low, nearly level areas and on the rims of depressions; the well drained Wadena soils on side slopes and summits; and the well drained Clarion soils on summits and side slopes where glacial till is exposed. Wadena and Clarion soils have a surface layer of loam.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is fairly well suited to cultivated crops. Droughtiness and the hazard of erosion are the main management concerns. The soils are better suited to drought-resistant or early maturing crops than to other crops. Field windbreaks and conservation tillage methods that minimize surface disturbance conserve moisture and help to control erosion.

This association is a good source of sand and gravel. It is well suited to building site development. The effluent in septic tank absorption fields can contaminate ground water because the soils have a poor filtering capacity.

2. Lura-Collinwood Association

Nearly level, very poorly drained, poorly drained, and moderately well drained, clayey soils that formed in lacustrine material on uplands

This association is on glacial lake plains characterized by swales and low rises. Subsurface water and ponded surface water are commonly removed by tile.

This association makes up about 17 percent of the county. It is about 40 percent Lura soils, 25 percent Collinwood soils, and 35 percent minor soils.

Lura soils are in depressions and low swales. They are nearly level and are poorly drained and very poorly drained. Typically, they are black silty clay to a depth of about 60 inches.

Collinwood soils are on broad, low rises. They are nearly level and moderately well drained. Typically, they have a surface soil of black silty clay and a subsoil of dark grayish brown silty clay. The underlying material to a depth of about 60 inches is grayish brown, calcareous silty clay loam.

Minor in this association are the poorly drained, calcareous Spicer soils on low rises and the rims of depressions; the somewhat poorly drained, calcareous Lakefield and Crippin soils on low knolls and rises; and the well drained Clarion soils on summits and side slopes where glacial till is exposed.

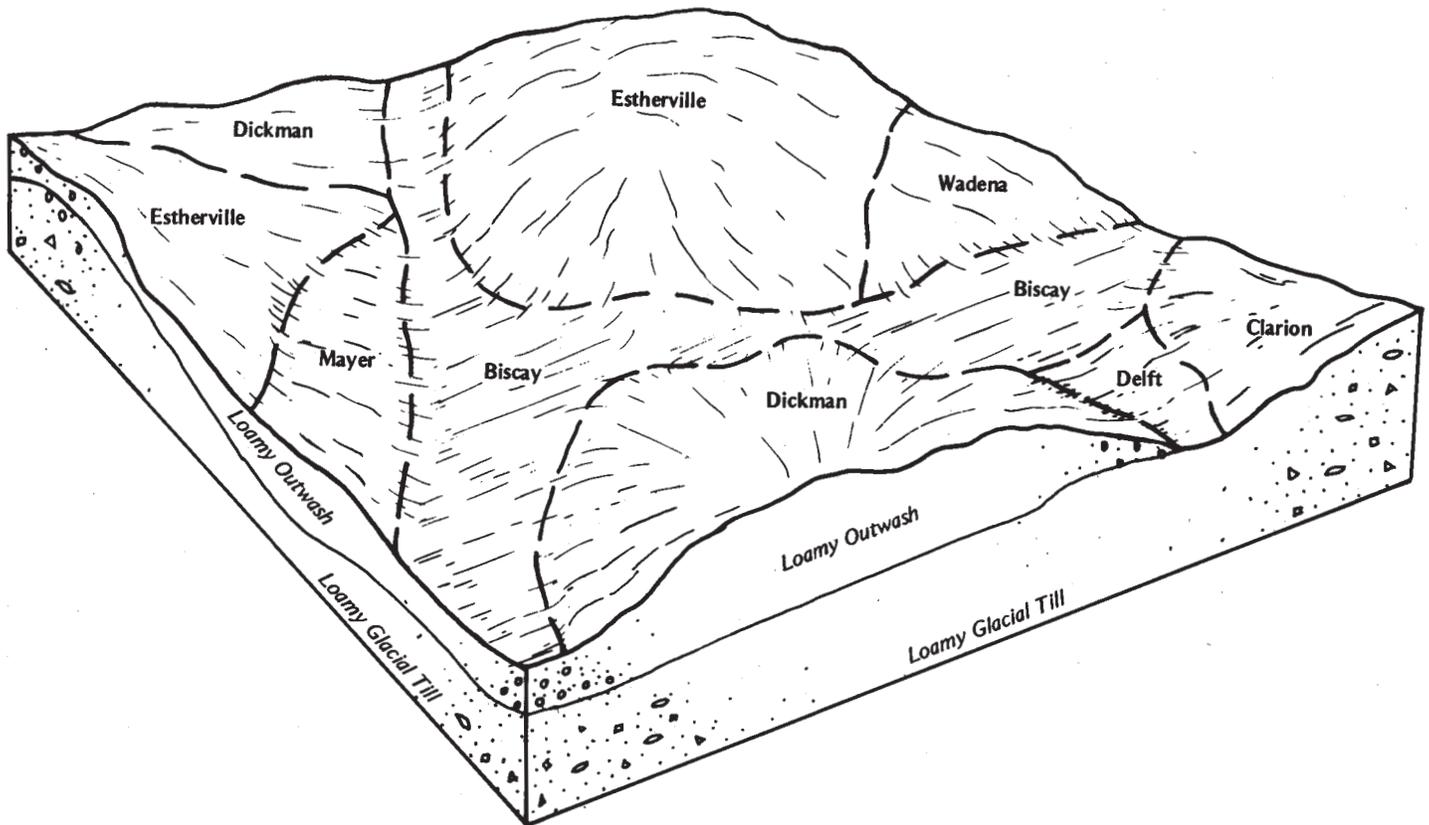


Figure 1.—Pattern of soils and parent material in the Estherville-Dickman association.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is well suited to cultivated crops. Reducing the wetness and maintaining tilth are the major management concerns. The poorly drained and very poorly drained soils can be managed more easily and are more productive if ponded surface water and excess subsurface water are removed by tile drains. Tilth can be maintained by returning crop residue to the soils and by cultivating at the proper moisture content.

These soils are poorly suited to most engineering uses because of the wetness.

3. Collinwood-Waldorf-Clarion Association

Nearly level and gently sloping, moderately well drained, poorly drained, and well drained, clayey and loamy soils that formed in lacustrine material and glacial till on uplands

This association is on glacial lake plains characterized by low, broad rises that are separated by swales and drainageways. Subsurface water and ponded surface water are removed by tile.

This association makes up about 13 percent of the county. It is about 30 percent Collinwood soils, 25 percent Waldorf soils, 20 percent Clarion soils, and 25 percent minor soils.

Collinwood soils are on broad, low rises. They are nearly level and moderately well drained. Typically, they have a surface soil of black silty clay and a subsoil of dark grayish brown silty clay. The underlying material to a depth of about 60 inches is grayish brown, calcareous silty clay loam.

Waldorf soils are in drainageways and low areas. They are nearly level and poorly drained. Typically, they have a surface soil of black silty clay and a subsoil of olive gray silty clay. The underlying material to a depth of about 60 inches is light olive gray, calcareous silty clay loam.

Clarion soils are on side slopes and summits. They are gently undulating and well drained. Typically, they are loam throughout. The surface layer is black, the subsurface layer is very dark gray, and the subsoil is dark yellowish brown. The underlying material to a depth of about 60 inches is light olive brown and yellowish brown and is calcareous.

Minor in this association are the very poorly drained Lura soils in depressions; the poorly drained, calcareous Spicer soils on low rises and the rims of depressions; the well drained, silty Truman soils on the higher rises; and the somewhat poorly drained, calcareous Crippin soils on low knolls where glacial till is exposed.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is well suited to cultivated crops. Reducing the wetness and maintaining tilth are the major management concerns. The poorly drained and very poorly drained soils can be managed more easily and are more productive if excess subsurface water is removed by tile drains. Tilth can be maintained by returning crop residue to the soils and by cultivating at the proper moisture content.

The Clarion soils are well suited to most engineering uses. The Collinwood and Waldorf soils, however, are poorly suited because of the wetness.

4. Clarion-Lura-Collinwood Association

Nearly level to hilly, well drained, very poorly drained, poorly drained, and moderately well drained, loamy and clayey soils that formed in glacial till and lacustrine material on uplands

This association is on glacial lake plains and in other areas on uplands. The landscape is characterized by hills that have a nearly level top and are surrounded by low swales. The top of the hills is plane or slightly concave, and the outer edges are more strongly sloping and convex.

This association makes up about 6 percent of the county. It is about 30 percent Clarion soils, 25 percent Lura soils, 15 percent Collinwood soils, and 30 percent minor soils (fig. 2).

Clarion soils are on side slopes, convex shoulder slopes, and summits. They are gently undulating to hilly and are well drained. Typically, they are loam throughout. The surface layer is black, the subsurface

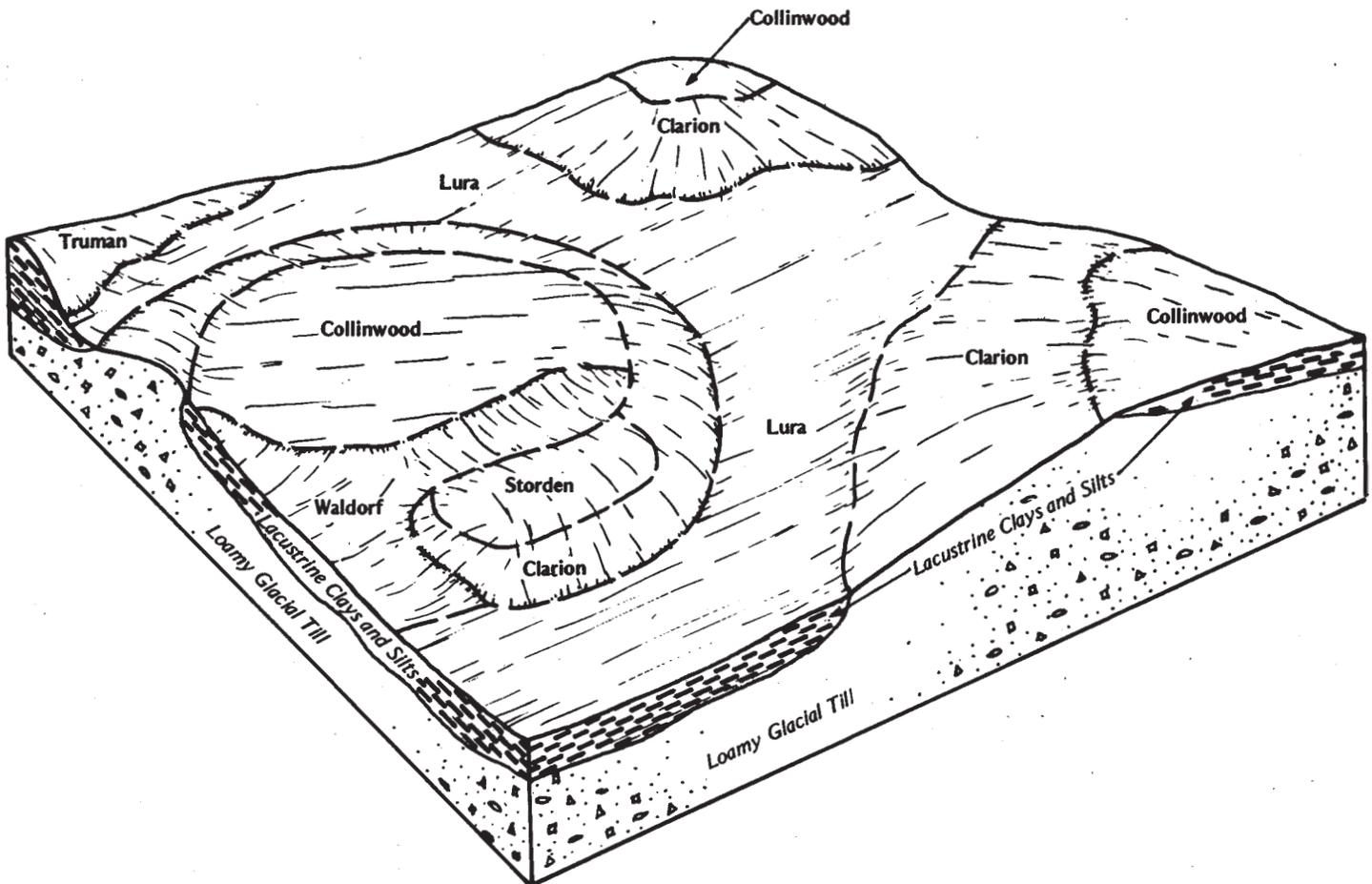


Figure 2.—Pattern of soils and parent material in the Clarion-Lura-Collinwood association.

layer is very dark gray, and the subsoil is dark yellowish brown. The underlying material to a depth of about 60 inches is light olive brown and yellowish brown and is calcareous.

Lura soils are in depressions and drainageways. They are nearly level and are poorly drained and very poorly drained. Typically, they have a surface soil of black silty clay. The underlying material to a depth of about 60 inches is black clay loam.

Collinwood soils are on the top of the hills. They are nearly level and are moderately well drained. Typically, they have a surface soil of black silty clay and a subsoil of dark grayish brown silty clay. The underlying material to a depth of about 60 inches is grayish brown, calcareous silty clay loam.

Minor in this association are the poorly drained Waldorf and poorly drained, loamy Delft soils in draws and drainageways and the well drained, silty Truman and well drained, calcareous Storden soils on shoulder slopes, summits, and side slopes.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is well suited to cultivated crops. Reducing the wetness and the hazard of erosion and maintaining tilth are the major management concerns. These soils can be managed more easily and are more productive if excess subsurface water is removed by tile drains. Tilth can be maintained by returning crop residue to the soils and by cultivating at the proper moisture content. Leaving crop residue on the surface, farming on the contour, and terracing help to control erosion.

The Clarion soils are well suited to most engineering uses. The Collinwood and Lura soils, however, are poorly suited because of the wetness.

5. Clarion-Delft Association

Nearly level to hilly, well drained and poorly drained, loamy soils that formed in glacial till on uplands

This association is on uplands characterized by knolls and hills that are separated by swales and draws. Shallow drainageways remove surface runoff.

This association makes up about 43 percent of the county. It is about 40 percent Clarion soils, 25 percent Delft soils, and 35 percent minor soils (fig. 3)

Clarion soils are on knolls, summits, and side slopes. They are gently undulating to hilly and are well drained. Typically, they are loam throughout. The surface layer is black, the subsurface layer is very dark gray, and the subsoil is dark yellowish brown. The underlying material to a depth of about 60 inches is light olive brown and yellowish brown and is calcareous.

Delft soils are in draws and drainageways. They are nearly level and poorly drained. Typically, they are clay loam to a depth of about 60 inches. The surface soil is black, and the subsoil and underlying material are grayish brown.

Minor in this association are the very poorly drained Glencoe soils in depressions; the poorly drained, calcareous Canisteo soils on low rises and the rims of depressions; the somewhat poorly drained Crippin soils on low knolls; the moderately well drained Nicollet soils in nearly level areas; the moderately well drained Terril soils on foot slopes; and the well drained, calcareous Storden soils on side slopes and shoulder slopes.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is well suited or fairly well suited to cultivated crops. The hazard of erosion and the wetness are the major management concerns. Leaving crop residue on the surface, farming on the contour, and terracing help to control erosion. The wet soils are more productive and can be managed more easily if excess subsurface water is removed by tile drains.

The Clarion soils are well suited or fairly well suited to most engineering uses. The Delft soils, however, are poorly suited because of the wetness.

6. Coland-Terril-Swanlake Association

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

This association is on flood plains and side slopes. The side slopes generally are plane or convex.

This association makes up about 3 percent of the county. It is about 30 percent Coland soils, 25 percent Terril soils, 15 percent Swanlake soils, and 30 percent minor soils.

Coland soils are on flood plains. They are nearly level and poorly drained. Typically, they are black clay loam to a depth of about 60 inches.

Terril soils are on foot slopes and the lower side slopes. They are gently sloping or very steep and are moderately well drained. Typically, they have a surface layer of black loam, a subsurface layer of very dark gray and very dark grayish brown loam, and a subsoil of dark yellowish brown clay loam.

Swanlake soils are on shoulder slopes and the upper side slopes. They are rolling to very steep and are well drained. Typically, they are loam throughout. The surface layer is very dark gray, and the underlying material to a depth of about 60 inches is yellowish brown and calcareous.

Minor in this association are the poorly drained, calcareous Millington and moderately well drained Spillville soils on flood plains; the well drained Storden soils on shoulder slopes and side slopes; the well drained, noncalcareous Clarion soils on summits and side slopes; and the somewhat excessively drained Estherville soils on terraces. The surface layer of Storden soils is thinner than that of the major soils.

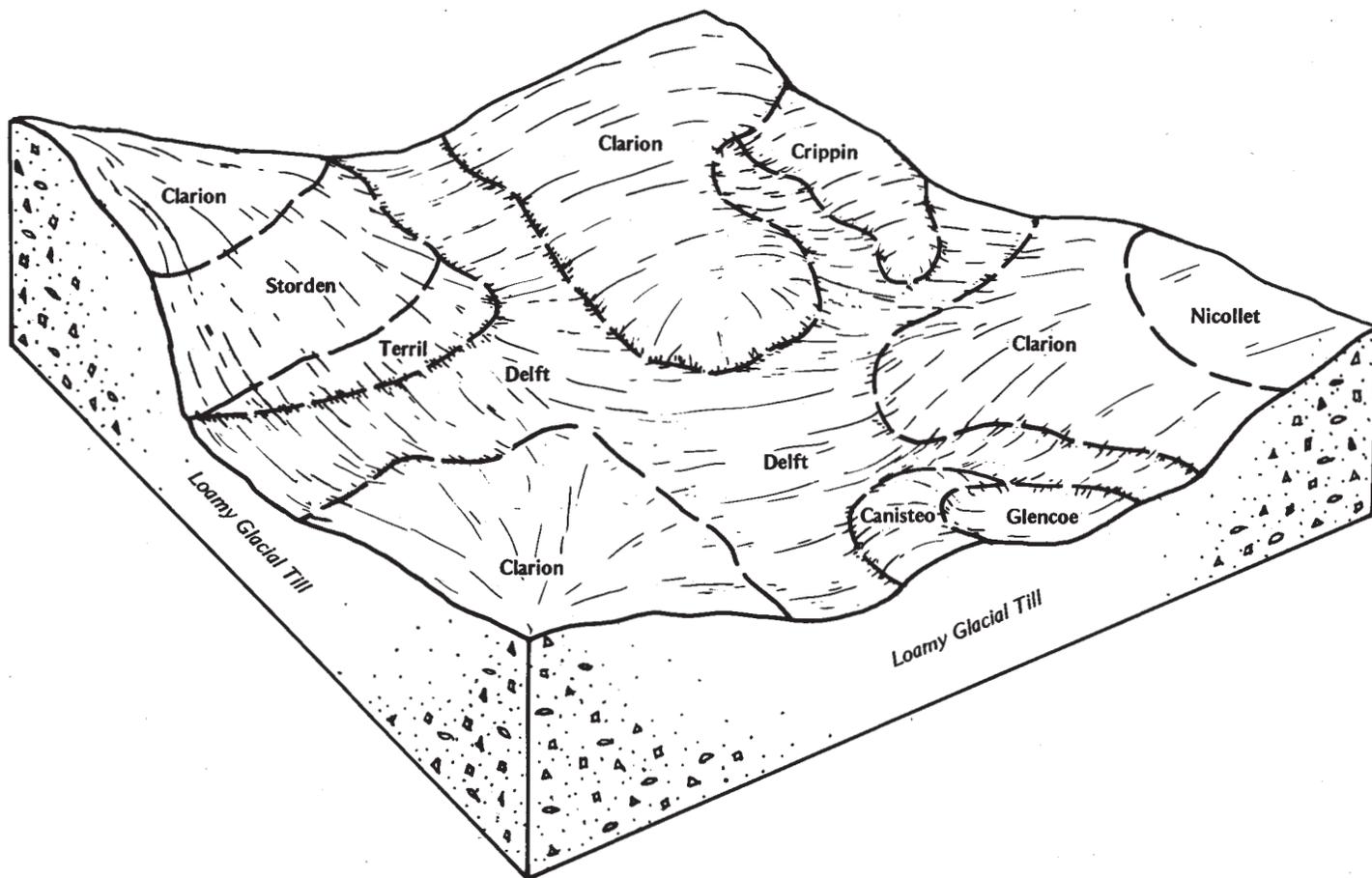


Figure 3.—Pattern of soils and parent material in the Clarion-Delft association.

Most of this association supports trees or grasses. Some areas on the flood plains are farmed.

The soils on side slopes are poorly suited to cropland because of the slope. The ones on flood plains are well suited to cultivated crops. The wetness and the occasional flooding are the major management concerns.

This association is poorly suited to most engineering uses because of the flooding, the wetness, and the slope.

7. Canisteo-Glencoe-Nicollet Association

Nearly level, poorly drained, very poorly drained, and moderately well drained, loamy soils that formed in glacial till and loamy sediments on uplands

This association is on uplands characterized by broad nearly level areas and low rises separated by shallow drainageways. The rises are slightly convex at the outer edges and slightly convex to slightly concave toward the

center. The drainageways remove surface water. In most areas tile drains remove excess subsurface water.

This association makes up 16 percent of the county. It is about 30 percent Canisteo soils, 20 percent Glencoe soils, 15 percent Nicollet soils, and 35 percent minor soils (fig. 4).

Canisteo soils are on low rises and the rims of depressions. They are poorly drained. Typically, they are calcareous clay loam to a depth of about 60 inches. The surface soil is black, and the subsoil and underlying material are grayish brown.

Glencoe soils are in depressions. They are very poorly drained. Typically, they have a surface soil of black loam and a subsoil of grayish brown clay loam. The underlying material to a depth of about 60 inches is grayish brown, calcareous loam.

Nicollet soils are in nearly level areas. They are moderately well drained. Typically, they have a surface layer of black clay loam, a subsurface layer of very dark gray clay loam, and a subsoil of dark grayish brown clay loam. The underlying material to a depth of about 60

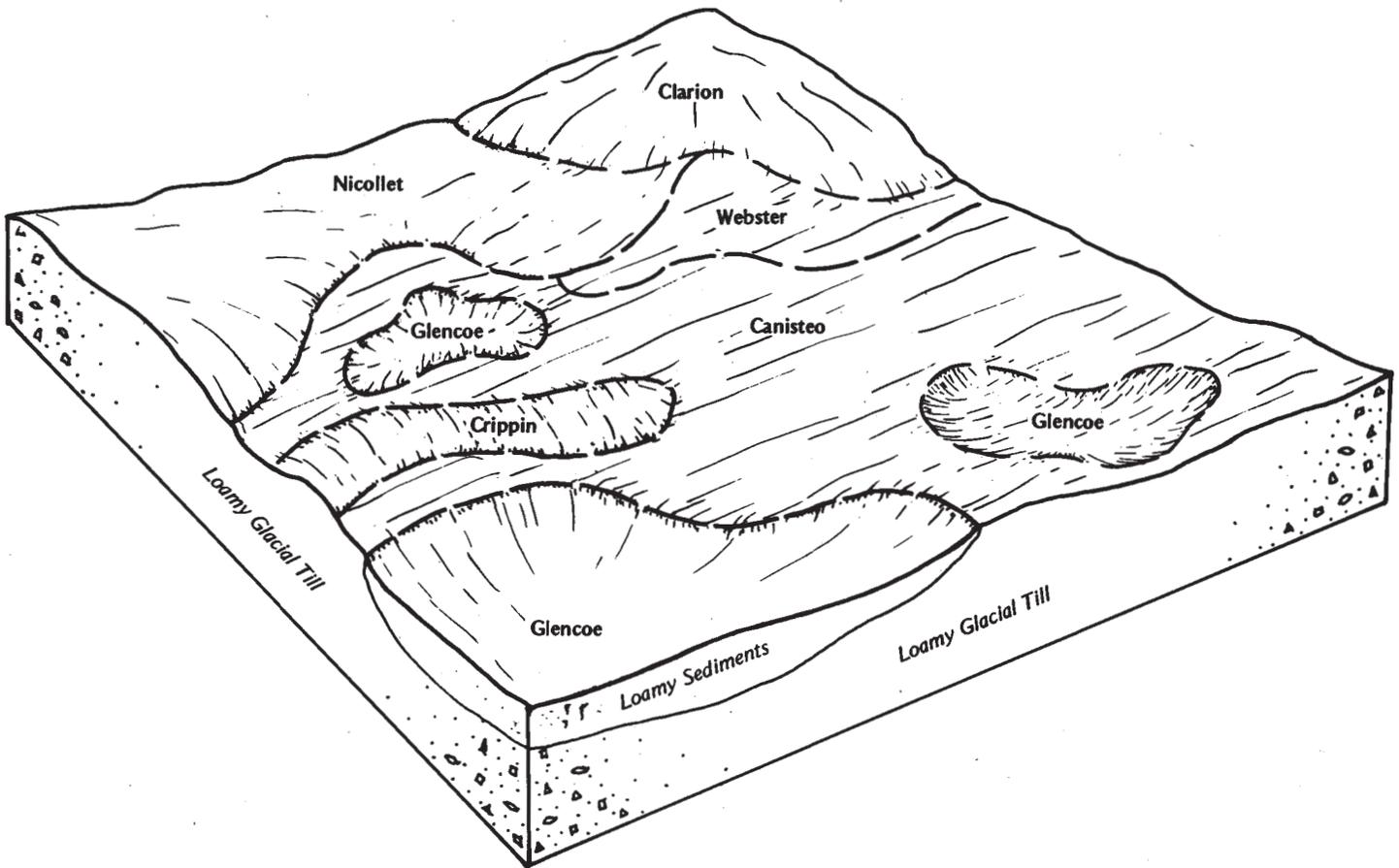


Figure 4.—Pattern of soils and parent material in the Canisteo-Glencoe-Nicollet association.

inches is light olive brown, calcareous clay loam and loam.

Minor in this association are the poorly drained Webster soils in drainageways, the somewhat poorly drained Crippin soils on low knolls, and the well drained Clarion soils on side slopes, summits, and shoulder slopes.

Most of this association is farmed. The principal crops are corn, soybeans, small grain, and forage grasses and legumes.

This association is well suited to cultivated crops. The wetness is the major limitation. The more poorly drained soils can be managed more easily and are more productive if excess subsurface water is removed by tile drains.

This association is poorly suited to most engineering uses because of the wetness.

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 underlying material, 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 underlying material. 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 6 percent slopes, is a phase 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, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Canisteo-Glencoe clay loams 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. The Pits in the Udorthents-Pits complex 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

27B—Dickinson sandy loam, 1 to 6 percent slopes.

This gently undulating, well drained soil is on knolls on glacial outwash plains. Slopes are plane or convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 9 inches thick. The subsoil is about 29 inches thick. It is brown, very friable sandy loam in the upper part and dark yellowish brown, very friable loamy sandy in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown sand. In some places it is calcareous. In other places the subsoil has a higher content of sand.

Included with this soil in mapping are small areas of the well drained Wadena, somewhat excessively drained Estherville, and poorly drained Biscay soils. Wadena and Estherville soils have a higher content of coarse fragments in the underlying material than the Dickinson soil. They are in landscape positions similar to those of the Dickinson soil. Biscay soils are in draws and drainageways. Also included are well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Dickinson soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content also is moderate.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Low natural fertility, the moderate available water capacity, and the hazard of soil blowing are the main management concerns. Applying manure and returning crop residue to the soil help to maintain or increase the supply of available water. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazard of soil blowing. Drought-tolerant crops can make the best use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IIe.

27C—Dickinson sandy loam, 6 to 12 percent slopes. This rolling, well drained soil is on knolls on glacial outwash plains. Slopes are plane or convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray and very dark grayish brown sandy loam about 10 inches thick. The subsoil is dark yellowish brown, friable sandy loam about 21 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In some places the subsoil has a higher content of sand. In other places free carbonates are near the surface.

Included with this soil in mapping are small areas of the somewhat excessively drained Estherville and poorly drained Biscay soils. Estherville soils have a higher content of coarse fragments in the underlying material than the Dickinson soil. Their landscape positions are similar to those of the Dickinson soil. Biscay soils are in drains and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Dickinson soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content also is moderate.

Most areas are farmed. This soil is fairly well suited to small grain, soybeans, corn, and forage grasses and legumes. Low natural fertility, the moderate available water capacity, and the hazard of erosion are the main management concerns. Applying manure and returning crop residue to the soil help to maintain the supply of available water. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazards of soil blowing and water erosion. Drought-tolerant crops can make the best use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Buildings constructed on this soil should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Building local roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. Well compacted, coarse textured base material helps to prevent the damage caused by frost action. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IIIe.

35—Blue Earth mucky silt loam. This level, very poorly drained soil is in former lake basins and large depressions. It is subject to ponding. Individual areas are oblong and range from 5 to 300 acres in size.

Typically, the surface layer is black mucky silt loam about 10 inches thick. The subsurface layer also is black mucky silt loam. It is about 30 inches thick. The underlying material to a depth of about 60 inches is dark gray, mottled silty clay loam. In some places the mucky silt loam is less than 30 inches thick. In other places the content of organic matter is higher.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Mayer soils on the rims of the depressions. Also included are small areas of very poorly drained soils that are coarse textured in the underlying material or contain an appreciable amount of gypsum. These soils are in landscape positions similar to those of the Blue Earth soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Blue Earth soil. Surface runoff is very slow or ponded. The available water capacity is high. A seasonal high water table is 2 feet above the surface to 1 foot below. The organic matter content is very high.

Most areas are farmed. This soil is fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. The wetness, a fertility imbalance, weeds, and soil blowing are the main management concerns. Tile drainage is necessary in many places. Surface ditches help to prevent the accumulation of surface water. The fertility imbalance is caused by the high content of lime, which restricts the availability of phosphorus, potassium, and trace nutrients. Soil tests can be used to monitor the nutrient balance and to determine fertilizer requirements. Crop varieties should be those that are tolerant of the high content of lime and that mature early in the year. The early maturing ones are less likely to be damaged by frost than other varieties. The high content of organic matter and of lime reduces the effectiveness of some preemergence herbicides. Soil blowing is a hazard during winter. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of the high content of lime and the wetness. Seedlings survive and grow well only if competing vegetation is controlled by cultivation or by applications of herbicide.

This soil is generally unsuitable as a site for dwellings and septic tank absorption fields because of the ponding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is IIIw.

39A—Wadena loam, 0 to 2 percent slopes. This nearly level, well drained soil is on glacial outwash plains. Slopes are broad and are slightly convex or concave. Individual areas are irregularly shaped or linear and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsurface layer also is very dark gray loam. It is about 7 inches thick. The subsoil is about 17 inches thick. It is brown, friable loam in the upper part and dark yellowish brown, friable sandy loam in the lower part. The underlying material to a depth of about 60 inches is dark brown, calcareous gravelly coarse sand. In places the surface soil and subsoil have a lower content of clay.

Included with this soil in mapping are small areas of the well drained Dickman and Dickinson and poorly drained Biscay soils. Dickman and Dickinson soils are in landscape positions similar to those of the Wadena soil. They have fewer coarse fragments in the underlying material than the Wadena soil. Biscay soils are in swales and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar

to those of the Wadena soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Wadena soil and very rapid in the underlying material. Surface runoff is medium. The available water capacity is moderate. The organic matter content is high.

Most areas are farmed. This soil is well suited to small grain, corn, soybeans, and forage grasses and legumes. Measures that maintain fertility and the available water capacity and help to control soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or improve the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazard of soil blowing. Drought-tolerant crops can make the best use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IIs.

39B—Wadena loam, 2 to 6 percent slopes. This gently undulating, well drained soil is on knolls on glacial outwash plains. Slopes are broad and are plane or convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsurface layer also is very dark gray loam. It is about 7 inches thick. The subsoil is about 17 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, friable sandy loam. The underlying material to a depth of about 60 inches is dark brown, calcareous gravelly coarse sand. In places the surface soil and subsoil have a lower content of clay.

Included with this soil in mapping are small areas of the well drained Dickman and Dickinson and poorly drained Biscay soils. Dickman and Dickinson soils are in landscape positions similar to those of the Wadena soil. They have fewer coarse fragments in the underlying material than the Wadena soil. Biscay soils are in swales and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar

to those of the Wadena soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Wadena soil and very rapid in the underlying material. Surface runoff is medium. The available water capacity is moderate. The organic matter content is high.

Most areas are farmed. This soil is well suited to small grain, corn, soybeans, and forage grasses and legumes. Measures that maintain fertility, increase the available water capacity, and help to control soil blowing and water erosion are needed. Applying manure and returning crop residue to the soil help to maintain or increase the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazards of soil blowing and water erosion. Drought-tolerant crops can make the best use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water. Installing the distribution lines as close to the surface as possible reduces this hazard.

The land capability classification is IIe.

41A—Estherville sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on glacial outwash plains. Slopes are broad and are slightly convex to slightly concave. Individual areas are irregularly shaped or linear and range from 3 to 50 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is dark yellowish brown, very friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the underlying material has fewer coarse fragments. In other places the surface layer and subsoil contain more clay.

Included with this soil in mapping are small areas of the poorly drained Biscay soils in swales and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Estherville soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the underlying material. Surface runoff is slow. The available water capacity is low. The organic matter content is moderate.

Most areas are farmed. This soil is fairly well suited to small grain, corn, soybeans, and forage grasses and legumes. It is best suited to the forage grasses that can make use of the early season moisture. Measures that maintain fertility and the available water capacity and help to control soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or increase the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazard of soil blowing.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing, but the choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This gently undulating, somewhat excessively drained soil is on knolls on glacial outwash plains. Slopes are broad and are plane or convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsoil is dark yellowish brown, very friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the underlying material has fewer coarse fragments. In other places the surface layer and subsoil have more clay.

Included with this soil in mapping are small areas of the poorly drained Biscay soils in swales and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Estherville soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the underlying material. Surface runoff is slow. The available water capacity is low. The organic matter content is moderate.

Most areas are farmed. This soil is fairly well suited to small grain, corn, soybeans, and forage grasses and legumes. It is best suited to the forage grasses that can make use of the early season moisture. Measures that maintain fertility and the available water capacity and help to control soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or increase the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazard of soil blowing.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing, but the choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IIIs.

41C—Estherville sandy loam, 6 to 12 percent slopes. This rolling, somewhat excessively drained soil is on convex side slopes and summits on outwash plains. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray sandy loam about 9 inches thick. The subsoil is dark yellowish brown, very friable sandy loam about 11 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the underlying material has fewer coarse fragments. In other places free carbonates are near the surface.

Included with this soil in mapping are small areas of the poorly drained Biscay soils in swales and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Estherville soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the underlying material. Surface runoff is medium. The available water capacity is low. The organic matter content is moderate.

Most areas are farmed. This soil is poorly suited to small grain, corn, soybeans, and forage grasses and legumes. It is best suited to the forage grasses that can make use of the early season moisture. Measures that maintain fertility and the available water capacity and

help to control soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or increase the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazards of soil blowing and water erosion.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing, but the choice of trees and shrubs is limited to the varieties that are tolerant of drought. Frequently watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Buildings constructed on this soil should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Building local roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IVs.

86—Canisteo clay loam. This nearly level, poorly drained soil is on low rises and the rims of depressions on glacial moraines. Individual areas are irregular in shape and range from 3 to about 300 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 15 inches thick. The subsoil is dark grayish brown, mottled, friable clay loam about 17 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. The soil is calcareous throughout. In some areas the content of lime is high within 16 inches of the surface. In some places the soil has a high content of gypsum. In other places it is better drained.

Included with this soil in mapping are small areas of the poorly drained, noncalcareous Delft and Webster soils and the very poorly drained, noncalcareous Glencoe soils. Delft and Webster soils are in slightly concave drainageways and swales. Glencoe soils are in depressions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Canisteo soil, and surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and correct a fertility imbalance are needed. Drainage generally is adequate if tile is installed. The fertility imbalance is caused by the high content of lime, which restricts the availability of

phosphorus, potassium, and trace nutrients. Soil tests can be used to monitor the nutrient balance and determine fertilizer requirements. Returning crop residue to the soil helps to maintain good tilth.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of the high content of lime and the wetness. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is poorly suited to dwellings because of the wetness. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is 1lw.

94B—Terril loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on foot slopes and alluvial fans. Individual areas are long and narrow and range from 3 to 40 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 20 inches thick. The subsoil to a depth of about 60 inches is friable loam. The upper part is very dark grayish brown, and the lower part is dark yellowish brown. In places the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the poorly drained Coland soils in the lower landscape positions. These soils make up 2 to 10 percent of the unit.

Permeability is moderate in the Terril soil, and surface runoff is medium. The available water capacity is high. The organic matter content also is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. The hazard of erosion is the main management concern. Establishing grassed waterways wherever water collects on the surface and crosses this soil helps to prevent gullyng.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and septic tank absorption fields. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength.

The land capability classification is 1le.

96—Collinwood silty clay. This nearly level, moderately well drained soil is on glacial lake plains. Slopes are broad and are slightly convex to slightly concave. Individual areas are irregular in shape and range from 3 to 70 acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The subsurface layer also is black silty clay. It is about 13 inches thick. The subsoil is dark grayish brown, firm silty clay about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam. In some places glacial till is closer to the surface. In other places the soil is shallower to lime.

Included with this soil in mapping are small areas of the poorly drained Waldorf, very poorly drained Lura, and well drained Truman soils. Lura and Waldorf soils are in swales and depressions. Truman soils are on the higher rises at the outer edges of the mapped areas. They have less clay in the surface soil and subsoil than the Collinwood soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the upper part of the Collinwood soil and slow in the lower part. Surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 2 to 5 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and help to maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. Tilth can be maintained by returning crop residue to the soil and by deferring cultivation when the soil is too wet.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

If this soil is used as a site for dwellings, the lower or basement level should be constructed above the seasonal high water table. Tile drains around the foundations help to remove excess subsurface water. Proper landscaping helps to keep surface water away from the buildings. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action.

This soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. In some areas a mound type of absorption field is suitable.

The land capability classification is 1lw.

101B—Truman silty clay loam, 2 to 6 percent slopes. This gently undulating, well drained soil is on small lake plains in the uplands. It is on side slopes and summits. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is brown, friable silty clay loam about 15 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous silty clay loam. In some places glacial till is closer to the surface. In other places the surface soil and subsoil contain more clay. In some areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the moderately well drained Collinwood, poorly drained Waldorf, and very poorly drained Lura soils. Collinwood soils are on broad, low rises and in nearly level upland areas. They have more clay in the surface soil and subsoil than the Truman soil. Waldorf soils are on low flats and in drainageways. Lura soils are in depressions and low drainageways. Also included are small areas of well drained, calcareous, silty soils and small areas of sandy soils, both of which are in landscape positions similar to those of the Truman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Truman soil, and surface runoff is medium. The available water capacity is high. The organic matter content also is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that control erosion and maintain fertility are needed. The organic matter content and tilth can be maintained by returning crop residue to the soil. A system of conservation tillage that leaves crop residue on the surface increases or conserves the supply of available water and reduces the hazards of soil blowing and water erosion.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation and erosion is needed to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and septic tank absorption fields. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action.

The land capability classification is IIe.

102B—Clarion loam, 2 to 6 percent slopes. This gently undulating, well drained soil is on side slopes, summits, and knolls in the uplands. Slopes are plane or

slightly convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is dark yellowish brown, friable loam about 15 inches thick. The underlying material to a depth of about 60 inches is light olive brown and yellowish brown, mottled, calcareous loam. In places the soil is deeper to the underlying material. In some areas the surface soil is silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Crippin soils, the moderately well drained Nicollet and Terril soils, the poorly drained Delft and Webster soils, and the well drained, calcareous Swanlake and Storden soils. Crippin soils are on slightly convex rises. Nicollet soils are in nearly level upland areas. Terril soils are on the lower side slopes and on toe slopes. Delft soils are in draws and on toe slopes. Webster soils are in drainageways. Swanlake and Storden soils are on shoulder slopes and summits. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Clarion soil. Surface runoff is medium. The available water capacity is high. The organic matter content also is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that control erosion and maintain fertility are needed. The organic matter content and tilth can be maintained by returning all crop residue to the soil. A system of conservation tillage that leaves crop residue on the surface increases or conserves the supply of available water and reduces the hazards of soil blowing and water erosion.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation is needed to ensure good seedling survival and growth rates. Cultivation and applications of herbicide help to remove competing plants.

This soil is suitable for building site development and septic tank absorption fields. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action.

The land capability classification is IIe.

102B2—Clarion loam, 4 to 8 percent slopes, eroded. This undulating, well drained soil is on summits and the upper side slopes in the uplands. Erosion has exposed the subsoil in places. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is brown, friable loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and dark yellowish brown, calcareous loam. In places the soil is deeper to the underlying material. In some areas the surface soil is silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Crippin soils, the moderately well drained Nicollet and Terril soils, the poorly drained Delft and Webster soils, and the well drained, calcareous Swanlake and Storden soils. Crippin soils are on slightly convex rises. Nicollet soils are in nearly level upland areas. Terril soils are on foot slopes, the lower side slopes, and toe slopes. Their surface layer is thicker than that of the Clarion soil. Delft soils are in draws and on toe slopes. Webster soils are in drainageways. Storden and Swanlake soils are on convex shoulder slopes. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Clarion soil. Surface runoff is medium. The available water capacity is high. The organic matter content is moderate.

Most areas are farmed. This soil is fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Productivity is reduced because the soil is eroded. Measures that control erosion and maintain fertility are the main management needs. Unless erosion is controlled, the further loss of organic matter and deterioration of tilth will continue to reduce yields. Returning crop residue to the soil, including forage grasses and legumes in the cropping sequence, and applying manure help to maintain the organic matter content and tilth. Terraces, conservation tillage, contour farming, and contour stripcropping conserve moisture and reduce the hazard of erosion.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation and erosion is needed to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable for building site development and septic tank absorption fields. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action.

The land capability classification is IIIe.

113—Webster clay loam. This nearly level, poorly drained soil is in swales and drainageways on till plains. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 11 inches thick. The subsoil is grayish brown, mottled, friable clay loam about 21 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous clay loam. In some places the surface soil is thicker. In other places the soil is very poorly drained.

Included with this soil in mapping are small areas of the poorly drained Canisteo, somewhat poorly drained Crippin, and moderately well drained Nicollet soils. Canisteo and Crippin soils are calcareous. Canisteo soils

are on low rises and the rims of depressions. Crippin soils are on low rises and knolls. Nicollet soils are in nearly level upland areas at the upper end of drainageways. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Webster soil, and surface runoff is slow. A seasonal high water table is at a depth of 1 to 2 feet. The available water capacity is high. The organic matter content also is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. Tilth can be maintained by returning crop residue to the soil.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of trees and shrubs is limited to the varieties that are tolerant of wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is poorly suited to building site development because of the wetness. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in drainageways and depressions on glacial moraines. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 65 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 30 inches thick. The subsoil is grayish brown, mottled, friable clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some places the surface layer is calcareous. In other places the soil is poorly drained.

Included with this soil in mapping are small areas of the poorly drained, calcareous Canisteo soils on low rises and the rims of depressions. Also included are small areas of soils that have a muck surface layer and areas of soils that have a higher content of clay than the Glencoe soil. Both of these soils are in landscape positions similar to those of the Glencoe soil. Included soils make up 2 to 10 percent of the unit.

Permeability is moderate or moderately slow in the Glencoe soil, and surface runoff is slow to ponded. The available water capacity is high. A seasonal high water table is 1 foot above the surface to 1 foot below. The organic matter content is high.

Most areas are farmed. This soil is fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain tilth and fertility are needed. Drainage generally is adequate if tile is installed. Ditches, waterways, and measures that divert runoff from the adjacent soils help to prevent the accumulation of surface water on this soil. Good tilth can be maintained by deferring cultivation during wet periods and by returning crop residue to the soil.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. The choice of trees and shrubs is limited to the varieties that are tolerant of the occasional ponding and the wet conditions. Removal of surface water and control of competing vegetation help to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the ponding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is IIIw.

118—Crippin clay loam. This nearly level, somewhat poorly drained soil is on slightly convex rises in the uplands. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is black, calcareous clay loam about 12 inches thick. The subsoil is dark grayish brown, mottled, friable, calcareous clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places carbonates are leached to a greater depth. In other places the surface soil is silty clay loam. In some areas the soil is poorly drained.

Included with this soil in mapping are small areas of the well drained Swanlake and very poorly drained Glencoe soils. Swanlake soils are on the steeper slopes. Glencoe soils are in depressions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Crippin soil. Surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 2 to 4 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. It has few limitations as cropland and can be cropped intensively. Tilth can be maintained by returning crop residue to the soil.

This soil is well suited to the trees and shrubs grown as windbreaks. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

If this soil is used as a site for dwellings, the basement level should be constructed above the seasonal high water table. Proper landscaping helps to keep surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is I.

130—Nicollet clay loam. This nearly level, moderately well drained soil is on glacial till plains and moraines. Slopes are slightly concave to slightly convex. Individual areas are irregular in shape and range from 3 to 90 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark gray clay loam about 15 inches thick. The subsoil is dark grayish brown, mottled, friable clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam and loam. In some places carbonates are closer to the surface. In other places the surface soil is silty clay loam.

Included with this soil in mapping are small areas of the well drained Clarion and Swanlake, poorly drained Canisteo and Webster, and very poorly drained Glencoe soils. Clarion and Swanlake soils are in the more sloping areas. Webster soils are in drainageways. Canisteo soils are on the rims of depressions. Glencoe soils are in the depressions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Nicollet soil, and surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. It has few limitations as cropland and can be cropped intensively. Tilth can be maintained by returning crop residue to the soil.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and

growth rates. Cultivation or applications of herbicide help to remove competing plants.

If this soil is used as a site for dwellings, the basement level should be constructed above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping helps to keep surface water away from the buildings. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on well compacted, coarse textured base material help to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is I.

197—Kingston silty clay loam. This nearly level, moderately well drained soil is on lake plains. Slopes are broad and are slightly convex to slightly concave. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 6 inches thick. The subsoil is dark grayish brown, friable silty clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous silty clay loam. In some places glacial till is closer to the surface. In other places the surface soil is thicker. In some areas lime is closer to the surface. In other areas the content of clay is higher.

Included with this soil in mapping are small areas of the poorly drained Waldorf, very poorly drained Lura, and well drained Truman soils. Lura soils are in depressions. Waldorf soils are in swales and drainageways. Truman soils are in the higher landscape positions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Kingston soil. Surface runoff is slow or medium. The available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Returning crop residue to the soil helps to maintain fertility and good tilth.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

If this soil is used as a site for dwellings, the basement level should be constructed above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping

helps to keep surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is I.

211—Lura silty clay. This nearly level, very poorly drained soil is in depressions and drainageways on lake plains. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsurface layer to a depth of about 60 inches also is black silty clay. In some places glacial till is closer to the surface. In other places carbonates are close to the surface. In some areas the content of clay is lower. In other areas the soil is poorly drained.

Included with this soil in mapping are small areas of the poorly drained Spicer soils on the rims of depressions and on low rises. These soils make up 2 to 15 percent of the unit.

Permeability is slow in the Lura soil, and surface runoff is very slow or ponded. The available water capacity is high. A seasonal high water table is 1 foot above the surface to 1 foot below. The organic matter content is high.

Most areas are farmed. This soil is fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain tilth and fertility are needed. Drainage is adequate if tile is installed. Ditches, waterways, and measures that divert runoff from the adjacent soils help to prevent the accumulation of surface water on this soil. Good tilth can be maintained by deferring cultivation during wet periods and by returning crop residue to the soil.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. The choice of trees and shrubs is limited to the varieties that are tolerant of the occasional ponding and the wet conditions. Removal of surface water and control of competing vegetation help to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the ponding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is IIIw.

229—Waldorf silty clay. This nearly level, poorly drained soil is in drainageways and broad, low areas on

glacial lake plains. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is black silty clay about 9 inches thick. The subsurface layer also is black silty clay. It is about 14 inches thick. The subsoil is olive gray, mottled, firm silty clay about 17 inches thick. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous silty clay loam. In some places glacial till is closer to the surface. In other places carbonates are closer to the surface. In some areas the content of clay is lower. In other areas the surface soil is thicker. In places the soil is very poorly drained.

Included with this soil in mapping are small areas of the moderately well drained Collinwood and Kingston soils on broad, low rises and nearly level uplands and small areas of the poorly drained, calcareous Spicer soils on the rims of depressions and on low rises. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Waldorf soil, and surface runoff is slow. The available water capacity is high. A seasonal high water table is within a depth of 3 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. The organic matter content and tilth can be maintained by returning crop residue to the soil. Timely tillage, or cultivation at the proper moisture content, also helps to maintain tilth.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Because of the wetness, this soil is poorly suited to building site development. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Properly designing foundations and footings and backfilling around the foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness, frost action, and low strength.

This soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

255—Mayer loam. This nearly level, poorly drained, calcareous soil is on outwash plains. It is in broad, slightly convex, low areas and on the rims of

depressions. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer also is black loam. It is about 11 inches thick. The subsoil is dark grayish brown, mottled, friable sandy clay loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown and brown gravelly sand. The soil is calcareous throughout. In places the surface soil is thicker.

Included with this soil in mapping are small areas of the poorly drained, noncalcareous Biscay soils. These soils are in plane or slightly concave, low areas. They make up 2 to 10 percent of the unit.

Permeability is moderate in the upper part of the Mayer soil and rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. A seasonal high water table is at a depth of 1 to 3 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and correct a fertility imbalance are needed. Drainage generally is adequate if tile is installed. The interval between tile lines should be wider than that needed in soils that are finer textured in the underlying material. The fertility imbalance is caused by a high content of lime, which restricts the availability of phosphorus, potassium, and trace nutrients. Soil tests can be used to monitor the nutrient balance and to determine fertilizer requirements. Returning crop residue to the soil helps to maintain tilth. The grasses and legumes planted on this soil should be those that are tolerant of the wetness and the high content of lime.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of the high content of lime and the wetness. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is poorly suited to building site development because of the wetness. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because it has a seasonal high water table and does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

313—Spillville loam, occasionally flooded. This nearly level, moderately well drained soil is in slightly

convex to slightly concave areas along streams. Individual areas are long and narrow and range from 5 to 300 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is loam about 44 inches thick. The upper part is black, and the lower part is very dark gray. The underlying material to a depth of about 60 inches is very dark grayish brown loam. In places the soil is well drained.

Included with this soil in mapping are small areas of the poorly drained Coland and Millington soils. These soils are in low areas. Also included are small areas of moderately well drained and somewhat poorly drained soils that have stratified sand and gravel. These soils are in landscape positions similar to those of the Spillville soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Spillville soil, and surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 3 to 5 feet. The organic matter content is high.

Most areas are farmed or pastured. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. It has few limitations. The occasional flooding delays planting in some years. Crops that mature early in the year are less likely to be damaged by frost than other crops.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding and low strength.

The land capability classification is 1lw.

327B—Dickman sandy loam, 1 to 6 percent slopes.

This gently undulating, well drained soil is on side slopes and knolls on outwash plains. Slopes are broad and are plane or convex. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black sandy loam about 12 inches thick. The subsoil is dark yellowish brown, very friable loamy sand about 24 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown sand. In places the upper part of the soil contains more clay.

Included with this soil in mapping are small areas of the well drained Wadena and somewhat excessively drained Estherville soils on side slopes and the poorly drained Biscay soils in draws and drainageways. Estherville and Wadena soils have a higher content of coarse fragments in the underlying material than the

Dickman soil. Also included are well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the Dickman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Dickman soil, and surface runoff is slow or medium. The available water capacity is low. The organic matter content is moderate.

Most areas are farmed. This soil is fairly well suited to small grain, corn, soybeans, and forage grasses and legumes. Measures that maintain fertility and the available water capacity and help to control soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or improve the available water capacity. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and reduces the hazard of soil blowing. Drought-tolerant crops can make good use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is suitable as a site for dwellings and local roads. It readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is 1lle.

327C—Dickman sandy loam, 6 to 12 percent slopes. This rolling, well drained soil is on broad, plane or convex side slopes and summits on outwash plains. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray sandy loam about 10 inches thick. The subsoil is dark yellowish brown, very friable loamy sand about 22 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In places the upper part of the soil contains more clay.

Included with this soil in mapping are small areas of the somewhat excessively drained Estherville and poorly drained Biscay soils. Estherville soils have more gravel in the underlying material than the Dickman soil. They are in landscape positions similar to those of the Dickman soil. Biscay soils are in draws and drainageways. Also included are small areas of well drained to somewhat poorly drained soils underlain by glacial till. These soils are in landscape positions similar to those of the

Dickman soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the Dickman soil, and surface runoff is slow or medium. The available water capacity is low. The organic matter content is moderate.

Most areas are farmed. This soil is poorly suited to small grain, corn, soybeans, and forage grasses and legumes. Measures that maintain fertility and the available water capacity and help to control water erosion and soil blowing are needed. Applying manure and returning crop residue to the soil help to maintain or increase the supply of available water. A system of conservation tillage that leaves crop residue on the surface helps to maintain the moisture supply, increases the rate of water infiltration, and helps to prevent excessive soil loss. Drought-tolerant crops can make the best use of the limited amount of available water.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. Field windbreaks conserve moisture and help to control soil blowing. The choice of trees and shrubs is limited to the varieties that are tolerant of drought. Watering tree seedlings and shrubs and controlling competing vegetation help to ensure good survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Buildings constructed on this soil should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Constructing local roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soil readily absorbs but does not adequately filter the effluent in septic tank absorption fields. The poor filtering capacity can result in the pollution of ground water.

The land capability classification is IVe.

336—Delft clay loam. This nearly level, poorly drained soil is in draws and swales on glacial moraines. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 19 inches thick. The subsoil is grayish brown, mottled, friable clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled clay loam. In places the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the poorly drained, calcareous Canisteo soils and the somewhat poorly drained, calcareous Crippin soils. Canisteo soils are on low rises and the rims of depressions. Crippin soils are on low rises and knolls. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow in the Delft soil, and surface runoff is slow. The available water capacity is

high. A seasonal high water table is at a depth of 1 to 2 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. Tilth can be maintained by returning crop residue to the soil.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is poorly suited to building site development because of the wetness. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

362—Millington clay loam, frequently flooded. This nearly level, calcareous, poorly drained soil is in low, plane or slightly convex areas along streams. Individual areas are linear and range from 5 to 300 acres in size.

Typically, the surface layer is black, calcareous clay loam about 14 inches thick. The subsoil is black, calcareous, friable clay loam about 21 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous, stratified loam and clay loam. In places the surface soil has no free carbonates.

Included with this soil in mapping are small areas of the moderately well drained Spillville soils on low rises and in the higher landscape positions. Also included, in positions on the landscape similar to those of the Millington soil, are small areas of poorly drained soils that have a muck surface layer, have thick seams of coarse textured material, or formed in clayey material. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Millington soil, and surface runoff is slow. The available water capacity is high. A seasonal high water table is within a depth of 2 feet. The organic matter content is high.

Most areas are pastured. This soil is generally unsuited to cultivation because of the frequent flooding. A planned grazing system that includes proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing helps to keep the pasture in good condition.

Because of the frequent flooding, this soil is poorly suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of flooding and wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding, wetness, and low strength.

The land capability classification is Vw.

392—Biscay clay loam. This nearly level, poorly drained soil is on outwash plains. Slopes are plane or slightly concave. Individual areas are irregular in shape and range from 3 to 150 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 14 inches thick. The subsoil is dark grayish brown, mottled, friable clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown gravelly loamy coarse sand. In some places the soil is shallower to sandy material or lime. In other places the surface soil is thicker.

Included with this soil in mapping are small areas of the well drained Wadena soils in the higher landscape positions. These soils make up 2 to 10 percent of the unit.

Permeability is moderate in the upper part of the Biscay soil and rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. A seasonal high water table is at a depth of 1 to 3 feet. Organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. The interval between the tile lines should be wider than that needed in soils that are finer textured in the underlying material. Tilth can be maintained by returning crop residue to the soil.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is poorly suited to building site development because of the wetness. The buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Tile drains around foundations help to remove excess subsurface water. Constructing local roads on well

compacted, coarse textured base material helps to prevent the damage caused by low strength and frost action. The soil is poorly suited to septic tank absorption fields because it has a seasonal high water table and does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

539—Palms muck. This nearly level, very poorly drained soil is in former lake basins and large depressions on glacial till plains and moraines. It is subject to ponding. Individual areas are oblong and range from 5 to 300 acres in size.

Typically, the surface layer is black muck about 9 inches thick. The subsurface layer also is black muck. It is about 10 inches thick. The underlying material to a depth of about 60 inches is gray, mottled, calcareous clay loam. In some places the muck is thinner. In other places it contains free carbonates.

Included with this soil in mapping are small areas of the poorly drained, calcareous Canisteo and Mayer soils on former beaches. Also included are small areas of soils that are coarse textured in the underlying material. These soils are in landscape positions similar to those of the Palms soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderately slow to moderately rapid in the upper part of the Palms soil and moderate or moderately slow in the lower part. Surface runoff is very slow or ponded. The available water capacity is very high. A seasonal high water table is 1 foot above the surface to 1 foot below. The organic matter content is very high.

Most areas are farmed. This soil is fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and control weeds and soil blowing are needed. Tile drainage is needed in many places. Surface ditches help to prevent the accumulation of surface water. The high organic matter content reduces the effectiveness of some preemergence herbicides. Soil blowing is a hazard during winter. It can be controlled by a conservation tillage system, such as strip tillage.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. The choice of trees and shrubs is limited to varieties that are tolerant of the occasional ponding and the wet conditions. Removal of surface water and control of competing vegetation help to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the ponding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate

side ditches, and installing culverts help to prevent the damage caused by ponding, subsidence, and frost action.

The land capability classification is IIIw.

595E—Swanlake loam, 18 to 25 percent slopes.

This steep, well drained soil is on side slopes and shoulder slopes on glacial moraines. Individual areas are linear or irregularly shaped and range from 3 to 100 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In places the surface layer is lighter colored.

Included with this soil in mapping are small areas of the well drained Clarion, moderately well drained Terril and Spillville, and poorly drained Coland and Delft soils. The noncalcareous Clarion soils are on the plane or slightly convex parts of slopes. The noncalcareous Terril soils are on the lower side slopes and on foot slopes. Delft soils are in upland draws and on toe slopes. The nearly level Coland and Spillville soils are on narrow flood plains. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Swanlake soil, and surface runoff is very rapid. The available water capacity is high. The organic matter content is moderate.

Most areas support native grass. This soil is generally unsuited to cultivated crops because of the slope and a severe hazard of erosion. Deferred, limited, and rotational grazing can increase pasture yields by maintaining a balance between cool- and warm-season grasses. Applications of fertilizer and control of brush and weeds also increase pasture yields.

This soil is fairly well suited to trees and shrubs. Most species grow well on north- and east-facing slopes. Hand planting generally is needed because of the slope. Measures that control competing vegetation and protect the trees and shrubs from the damage caused by livestock help to ensure good survival and growth rates. Applications of herbicide help to remove competing plants.

The slope is the main limitation if this soil is used for building site development. In most areas extensive land shaping is needed. The buildings should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soil is generally unsuited to septic tank absorption fields because of the slope. Better suited soils commonly are nearby.

The land capability classification is VIe.

595F—Swanlake loam, 25 to 40 percent slopes.

This very steep, well drained soil is on side slopes and

shoulder slopes on glacial moraines. Individual areas are linear or irregularly shaped and range from 3 to 300 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown loam. The soil is calcareous throughout. In places the surface layer is lighter colored.

Included with this soil in mapping are small areas of the well drained Clarion, moderately well drained Terril and Spillville, and poorly drained Coland and Delft soils. The noncalcareous Clarion soils are on the plane or slightly convex parts of slopes. The noncalcareous Terril soils are on the lower side slopes and on foot slopes. Delft soils are in upland draws and on toe slopes. The nearly level Coland and Spillville soils are on narrow flood plains. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Swanlake soil, and surface runoff is very rapid. The available water capacity is high. The organic matter content is moderate.

Most areas support native grasses. This soil is generally unsuited to cultivated crops because of the slope. Deferred, limited, and rotational grazing can increase pasture yields by maintaining a balance between cool- and warm-season grasses. Applications of fertilizer and control of brush and weeds also increase pasture yields.

This soil is fairly well suited to trees and shrubs. Most species grow well on north- and east-facing slopes. Hand planting generally is needed because of the slope. Measures that control competing vegetation and protect the trees and shrubs from the damage caused by livestock help to ensure the best survival and growth rates. Applications of herbicide help to remove competing plants.

The slope is the main limitation if this soil is used for building site development. In most areas extensive land shaping is needed. Buildings and lots should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soil is generally unsuited to septic tank absorption fields because of the slope. Better suited soils commonly are nearby.

The land capability classification is VIe.

664—Zook silty clay, frequently flooded. This nearly level, poorly drained soil is on slightly concave, low areas along streams. Individual areas are long and narrow and range from 5 to 300 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsurface layer also is black silty clay. It is about 34 inches thick. The underlying material to a

depth of about 60 inches is very dark gray silty clay. In places the soil has less clay.

Included with this soil in mapping are small areas of the poorly drained Millington and moderately well drained Spillville soils. Millington soils are calcareous. They are in landscape positions similar to those of the Zook soil. Spillville soils are in the higher landscape positions. Also included are small areas of poorly drained soils that have a muck surface layer or thick seams of coarse textured material. These soils are in landscape positions similar to those of the Zook soil. Included soils make up 5 to 15 percent of the unit.

Permeability is slow in the Zook soil, and surface runoff is slow or very slow. The available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. The organic matter content is high.

Most areas are pastured. This soil is generally unsuited to cultivation because of the frequent flooding. A planned grazing system that includes proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep pastures in good condition.

This soil is poorly suited to trees and shrubs because of the frequent flooding. The choice of varieties is limited to those that are tolerant of flooding and wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the flooding and the seasonal high water table. Also, buildings can be damaged by the shrinking and swelling of the soil. Soils that are better suited to these uses generally are nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding, low strength, and frost action.

The land capability classification is Vw.

813—Spicer-Lura complex. These nearly level soils are on lake plains. The poorly drained, calcareous Spicer soil is on low rises and the rims of depressions. The very poorly drained Lura soil is in depressions. It is subject to ponding. Individual areas are irregular in shape and range from 5 to several hundred acres in size. They are 35 to 60 percent Spicer soil and 25 to 40 percent Lura soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Spicer soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 14 inches thick. The subsoil is olive gray, mottled, friable silty clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is olive gray silty clay loam. The soil

is calcareous throughout. In some places a high content of lime is within 16 inches of the surface. In other places the surface soil has a high content of gypsum. In some areas glacial till is closer to the surface. In other areas the content of clay is higher.

Typically, the Lura soil has a surface layer of black silty clay about 8 inches thick. The subsurface layer is black and very dark gray silty clay about 32 inches thick. The underlying material to a depth of about 60 inches is dark gray and grayish brown, mottled, calcareous silty clay and silty clay loam. In some places glacial till is closer to the surface. In some areas carbonates are closer to the surface. In other areas the content of clay is lower.

Included with these soils in mapping are small areas of the poorly drained Waldorf, moderately well drained Collinwood, and somewhat poorly drained Lakefield soils. The noncalcareous Waldorf soils are in slightly concave drainageways. Collinwood soils are on broad rises. Lakefield soils are on knolls. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Spicer soil and slow in the Lura soil. Surface runoff is slow on the Spicer soil and very slow or ponded on the Lura soil. Both soils have a high available water capacity. A seasonal high water table is at a depth of 1 to 3 feet in the Spicer soil and is 1 foot above to 1 foot below the surface of the Lura soil. The organic matter content is high in both soils.

Most areas are farmed. These soils are well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and correct a fertility imbalance are needed. Drainage generally is adequate if tile is installed. The fertility imbalance is caused by a high content of lime in the Spicer soil. The lime restricts the availability of phosphorus, potassium, and trace nutrients. Soil tests can be used to monitor the nutrient balance and to determine fertilizer requirements. Returning crop residue to the soil helps to maintain tilth.

These soils are fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of a high content of lime and the wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

These soils are generally unsuitable for building site development and septic tank absorption fields because of the wetness of the Spicer soil and the ponding on the Lura soil. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is llw.

887C—Clarion-Swanlake loams, 6 to 12 percent slopes. These rolling, well drained soils are on knolls, shoulder slopes, and side slopes in the uplands. The Clarion soil is on plane or slightly convex slopes. The Swanlake soil is in the more strongly sloping, convex areas. Individual areas are irregular in shape and range from 3 to 50 acres in size. They are 50 to 65 percent Clarion soil and 25 to 35 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of black and very dark gray loam about 11 inches thick. The subsoil is dark yellowish brown, friable loam about 11 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In places the soil is shallower to the underlying material.

Typically, the Swanlake soil has a surface layer of very dark gray loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In places the surface layer is lighter colored.

Included with these soils in mapping are small areas of the moderately well drained Nicollet and Terril soils and the poorly drained Delft and Webster soils. Nicollet soils are in the less sloping upland areas. Terril soils are on the lower side slopes and on toe slopes. Their surface layer is thicker than that of the Clarion soil and than that of the Swanlake soil. Delft and Webster soils are in draws and drainageways. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Clarion and Swanlake soils. Surface runoff is medium on the Clarion soil and medium to very rapid on the Swanlake soil. Both soils have a high available water capacity. The organic matter content is high in the Clarion soil and moderate in the Swanlake soil.

These soils are fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that control erosion and help to maintain fertility and the organic matter content are the main management needs. The organic matter content and tilth can be maintained by returning crop residue to the soil, by including forage grasses and legumes in the cropping sequence, and by applying manure. A system of conservation tillage that leaves crop residue on the surface, terraces, contour farming, and contour stripcropping reduce the hazard of erosion and conserve moisture.

These soils are fairly well suited to the trees and shrubs grown as windbreaks. Because of excess lime, trees and shrubs planted on the Swanlake soil have a high mortality rate and grow slowly. Control of competing vegetation and erosion helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Buildings constructed on these soils should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Building

local roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. Well compacted, coarse textured base material helps to prevent the damage caused by frost action. The slope is a limitation on sites for septic tank absorption fields. Installing the distribution lines across the slope helps to overcome this limitation.

The land capability classification is IIIe.

887D—Clarion-Swanlake loams, 12 to 18 percent slopes. These hilly, well drained soils are on summits, shoulder slopes, and side slopes in the uplands. The Clarion soil is on plane or slightly convex slopes, and the Swanlake soil is in the more strongly sloping, convex areas. Individual areas are irregular in shape and range from 3 to 40 acres in size. They are 40 to 55 percent Clarion soil and 35 to 45 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of black loam about 10 inches thick. The subsoil is dark yellowish brown, friable loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the soil is shallower to the underlying material.

Typically, the Swanlake soil has a surface layer of very dark gray loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In places the surface layer is lighter colored.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Delft and Webster soils. Terril soils are on the lower side slopes and on toe slopes. Their surface layer is thicker than that of the Clarion soil and than that of the Swanlake soil. Delft and Webster soils are in draws and drainageways. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Clarion and Swanlake soils. Surface runoff is medium on the Clarion soil and medium to very rapid on the Swanlake soil. Both soils have a high available water capacity. The organic matter content is high in the Clarion soil and moderate in the Swanlake soil.

Most areas support native grasses. These soils are poorly suited to cultivated crops because of the slope. Deferred, limited, and rotational grazing can increase pasture yields by maintaining a balance between cool- and warm-season grasses. Applications of fertilizer and control of brush and weeds also increase pasture yields.

These soils are fairly well suited to trees and shrubs. Most species grow well on north- and east-facing slopes. Machine planting is limited by the slope. Measures that control competing vegetation and protect the trees and shrubs from the damage caused by livestock help to ensure good survival and growth rates. Cultivation or

applications of herbicide help to remove competing plants.

The slope is the main limitation if these soils are used for building site development. In most areas extensive land shaping is needed. The buildings should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soils are generally unsuited to septic tank absorption fields because of the slope. Better suited soils commonly are nearby.

The land capability classification is IVe.

921C2—Clarion-Storden loams, 6 to 12 percent slopes, eroded. These rolling, well drained soils are on summits, shoulder slopes, and side slopes in the uplands. The Clarion soil is on plane or slightly convex slopes, and the Storden soil is in the more strongly sloping, convex areas. Erosion has exposed the subsoil in places. Individual areas are irregular in shape and range from 3 to 50 acres in size. They are 50 to 65 percent Clarion soil and 25 to 35 percent Storden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 8 inches thick. The subsoil is dark yellowish brown, friable loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown, mottled, calcareous loam. In places the soil is shallower to the underlying material.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout (fig. 5). In places the surface layer is darker.

Included with these soils in mapping are small areas of the moderately well drained Nicollet and Terril soils and the poorly drained Delft and Webster soils. Nicollet soils are in the less sloping upland areas. Terril soils are on the lower side slopes and on foot slopes. Their surface layer is thicker than that of the Clarion soil and that of the Storden soil. Delft and Webster soils are in draws and drainageways. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Clarion and Storden soils. Surface runoff is medium on the Clarion soil and medium or rapid on the Storden soil. Both soils have a high available water capacity. The content of organic matter is moderate in the Clarion soil and low in the Storden soil.

Most areas are farmed. These soils are fairly well suited to corn, soybeans, small grain, and forage grasses and legumes. Productivity has been reduced by erosion. Measures that control erosion and maintain fertility and



Figure 5.—Profile of the calcareous Storden soil in an area of Clarion-Storden loams, 6 to 12 percent slopes, eroded. Depth is marked in feet.

the organic matter content are the main management needs. Unless erosion is controlled, the loss of organic matter and deterioration of tilth will continue to reduce yields. Returning crop residue to the soil, including

forage grasses and legumes in the cropping sequence, and applying manure help to maintain the organic matter content and tilth. Conservation tillage, terraces, contour farming, and contour stripcropping reduce the hazard of erosion and conserve moisture.

These soils are fairly well suited to the trees and shrubs grown as windbreaks. Because of excess lime, the trees and shrubs planted on the Storden soil have a high mortality rate and grow slowly. Control of competing vegetation and erosion helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

Buildings constructed on these soils should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Building local roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. Well compacted, coarse textured base material helps to prevent the damage caused by frost action. Because of the slope, considerable land shaping generally is necessary on sites for septic tank absorption fields. Also, the distribution lines should be installed across the slope.

The land capability classification is IIIe.

956—Canisteo-Glencoe clay loams. These nearly level soils are on glacial moraines. The poorly drained, calcareous Canisteo soil is on low rises and the rims of depressions. The very poorly drained Glencoe soil is in the depressions (fig. 6). It is subject to ponding. Individual areas are irregular in shape and range from 5 to about 300 acres in size. They are 40 to 65 percent Canisteo soil and 20 to 35 percent Glencoe soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Canisteo soil has a surface layer of black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 14 inches thick. The subsoil is grayish brown, mottled, friable clay loam about 17 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled clay loam. The soil is calcareous throughout. In some places a high content of lime is within 16 inches of the surface. In other places the soil has a high content of gypsum.

Typically, the Glencoe soil has a surface layer of black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 32 inches thick. The subsoil is grayish brown, mottled, friable clay loam about 12 inches thick. The underlying material to a depth of



Figure 6.—An area of Canisteo-Glencoe clay loams. The dark Glencoe soil surrounds the light colored Canisteo soil.

about 60 inches is grayish brown, mottled, calcareous clay loam. In places the surface layer is calcareous.

Included with these soils in mapping are small areas of the poorly drained, noncalcareous Webster soils and the somewhat poorly drained Crippin soils. Webster soils are in slightly concave swales. Crippin soils are on slightly convex rises. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Canisteo soil and moderate or moderately slow in the Glencoe soil. Surface runoff is slow on the Canisteo soil and slow to ponded on the Glencoe soil. Both soils have a high available water capacity. A seasonal high water table is at a depth of 1 to 3 feet in the Canisteo soil and is 1 foot above to 1 foot below the surface of the Glencoe soil. Both soils have a high content of organic matter.

Most areas are farmed. These soils are well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and correct a fertility imbalance are needed. Drainage generally is adequate if tile is installed. The fertility imbalance is caused by the high content of lime in the Canisteo soil. The lime restricts the availability of phosphorus, potassium, and trace nutrients. Soil tests can be used to monitor the nutrient balance and to determine fertilizer requirements. Returning crop residue to the soil helps to maintain tilth.

These soils are fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of a high content of lime and the wet conditions. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

These soils are generally unsuitable for building site development and septic tank absorption fields because of the wetness of the Canisteo soil and the ponding on the Glencoe soil. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is 1lw.

960D2—Storden-Clarion loams, 12 to 18 percent slopes, eroded. These hilly, well drained soils are on summits and shoulder slopes in the uplands. The Storden soil is in the more strongly sloping, convex areas. The Clarion soil is on plane or slightly convex slopes. Erosion has exposed the subsoil in places. Individual areas are irregular in shape and range from 3 to 30 acres in size. They are 40 to 55 percent Storden soil and 35 to 45 percent Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In places the surface layer is darker.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 8 inches thick. The subsoil is dark yellowish brown, friable loam about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. In places the soil is shallower to the underlying material.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Delft soils. Terril soils are on foot slopes and toe slopes. Their surface layer is thicker than that of the Storden soil and than that of the Clarion soil. Delft soils are in draws and drainageways. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Storden and Clarion soils. Surface runoff is medium or rapid on the Storden soil and rapid on the Clarion soil. Both soils have a high available water capacity. The content of organic matter is low in the Storden soil and moderate in the Clarion soil.

Most areas are farmed. These soils are poorly suited to corn, soybeans, and small grain. Productivity has been reduced by erosion. Measures that control erosion and maintain fertility and the organic matter content are the main management needs. Unless erosion is controlled, the loss of organic matter and deterioration of tilth will continue to reduce yields. Returning crop residue to the soil, including forage grasses and legumes in the cropping sequence, and applying manure help to maintain the organic matter content and tilth. Conservation tillage, contour farming, contour stripcropping, and grade stabilization structures reduce the hazard of erosion and conserve moisture.

These soils are fairly well suited to forage grasses and legumes. Pasture yields can be increased by deferred, limited, and rotational grazing. Applications of fertilizer and control of brush and weeds also increase yields.

These soils are fairly well suited to trees and shrubs. Most species grow well on north- and east-facing slopes. Machine planting is limited by the slope. Measures that control competing vegetation and protect the trees and shrubs from the damage caused by livestock help to ensure the best survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

The slope is the main limitation if these soils are used for building site development. In most areas extensive land shaping is needed. The buildings should be designed so that they conform to the natural slope of the land. Extensive cutting and filling generally are needed on sites for local roads. Building the roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soils are

generally unsuited to septic tank absorption fields because of the slope. Better suited soils commonly are nearby.

The land capability classification is IVe.

1030—Udorthents-Pits complex. This map unit consists of reclaimed and active gravel pits. The pits were or are used as a source of gravel, sand, and topsoil. Individual areas are irregular in shape and range from 3 to 50 acres in size. They are 50 to 70 percent Udorthents and 20 to 50 percent Pits. The Udorthents and Pits occur as areas so intricately mixed or so small that mapping them separately is not practical.

The Udorthents are mainly reclaimed gravel pits in nearly level and gently sloping areas where the original soil has been removed. The landscape has been altered by intensive cutting and filling. The thickness of fill material generally is more than 5 feet, but it varies. In places topsoil has been spread over the fill. It provides a better seedbed for plants. Abandoned pits that have not been reclaimed support grasses and small trees. Most areas of these soils are fairly well suited or poorly suited to crops and pasture.

The Pits consist of excavations and stockpiles of sand, gravel, topsoil, and boulders. Some were dug below the water table and are now ponds. Former pits can be reclaimed for other purposes, but reclamation generally involves extensive filling and grading. Some areas can be reclaimed for agricultural uses if the surface is graded and covered with topsoil, fertilizer is applied, and drought-tolerant species are selected for planting. Some of the pits that contain water can be reclaimed for recreational uses or wildlife habitat.

Included with this unit in mapping are small undisturbed areas of Estherville and Wadena soils and areas of soils underlain by stony glacial till. Included soils make up 5 to 10 percent of the unit.

Because the properties of the soil material vary, onsite investigation is needed to determine the suitability for specific uses.

No land capability classification is assigned.

1051—Glencoe clay loam, ponded. This nearly level, very poorly drained soil is in undrained depressions on glacial moraines. It is covered by 1 to 3 feet of water during all periods, except for extended dry periods. Individual areas are irregularly shaped or circular and range from 3 to 300 acres in size.

Typically, the surface layer is black clay loam about 6 inches thick. The subsurface layer also is black clay loam. It is about 30 inches thick. The subsoil is dark gray, mottled, friable clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam.

Included with this soil in mapping are small areas of Palms, Blue Earth, and Lura soils. Palms soils, which have a thick organic layer, and Blue Earth soils, which

have a surface soil of sedimentary peat, are in the centers of the larger wet areas. Lura soils are in landscape positions similar to those of the Glencoe soil. They have a higher content of clay than the Glencoe soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow in the Glencoe soil, and surface runoff is ponded. The available water capacity is high. A seasonal high water table is 3 feet above the surface to 1 foot below. The organic matter content is high.

Most areas support reeds, sedges, and cattails. Because of the ponding, this soil is generally unsuitable for cultivated crops, pasture, and windbreaks. It is well suited to the development of wetland wildlife habitat. Some areas have been excavated and are used as livestock-watering ponds.

This soil is unsuitable for building site development and septic tank absorption fields because of the ponding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding, frost action, and low strength.

The land capability classification is VIIIw.

1833—Coland clay loam, occasionally flooded. This nearly level, poorly drained soil is in plane or slightly concave, low areas along streams. Individual areas are long and narrow and range from 5 to 300 acres in size.

Typically, the soil is black clay loam to a depth of 60 inches or more. The surface layer is about 15 inches thick, and the subsurface layer is about 21 inches thick. In places the surface soil has free carbonates.

Included with this soil in mapping are small areas of the moderately well drained Spillville soils in the higher landscape positions. Also included are small areas of poorly drained soils that have a muck surface layer or thick seams of coarse textured material. These soils are in landscape positions similar to those of the Coland soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Coland soil. Surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. The organic matter content is high.

Most areas are farmed or pastured. This soil is well suited to corn (fig. 7), soybeans, small grain, and forage grasses. Measures that improve drainage and maintain fertility are necessary. Some areas are drained by tile. Deferred, limited, and rotational grazing can increase pasture yields by maintaining a balance between cool- and warm-season grasses. Applications of fertilizer and control of brush and weeds also increase pasture yields.

This soil is poorly suited to most of the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of the occasional flooding and the wet conditions. Control of competing



Figure 7.—Corn in an area of Coland clay loam, occasionally flooded, along a stream.

vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding, low strength, and frost action.

The land capability classification is *1lw*.

1834—Coland loam, frequently flooded. This nearly level, poorly drained soil is in plane or slightly concave, low areas along streams. It is in oxbow depressions and former stream channels. Individual areas are long and narrow and range from 5 to 300 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark

gray clay loam about 38 inches thick. The underlying material to a depth of about 60 inches is very dark gray clay loam. In places the surface soil has free carbonates.

Included with this soil in mapping are small areas of the moderately well drained Spillville soils in the higher landscape positions. Also included are small areas of poorly drained soils that have a muck surface layer or thick seams of coarse textured material. These soils are in landscape positions similar to those of the Coland soil. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Coland soil. Surface runoff is slow. The available water capacity is high. A seasonal high water table is at a depth of 1 to 3 feet. The organic matter content is high.

Most areas are pastured. Because of the frequent flooding, this soil is generally unsuitable as cropland. It is better suited to pasture. A planned grazing system that includes proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing helps to keep the pasture in good condition.

This soil is poorly suited to trees and shrubs because of the frequent flooding. The choice of varieties is limited to those that are tolerant of flooding and wet conditions. Control of competing vegetation helps to ensure optimum growth of seedlings. Cultivation or applications of herbicide help to remove competing plants.

This soil is generally unsuitable for building site development and septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by flooding, low strength, and frost action.

The land capability classification is Vw.

1852F—Terril-Swanlake loams, 25 to 40 percent slopes. These very steep soils are on side slopes and shoulder slopes in the uplands. The moderately well drained Terril soil is on the lower side slopes. The well drained Swanlake soil is on the strongly convex, upper side slopes and shoulder slopes. Individual areas are linear or irregularly shaped and range from 3 to 300 acres in size. They are 50 to 65 percent Terril soil and 25 to 35 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Terril soil has a surface layer of black loam about 12 inches thick. The subsurface layer is very dark gray and very dark grayish brown loam about 24 inches thick. The subsoil to a depth of about 60 inches is dark yellowish brown, friable clay loam. In places the surface soil is not so thick. In some areas the soil is somewhat poorly drained.

Typically, the Swanlake soil has a surface layer of very dark gray loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. In places the surface layer is lighter in color.

Included with these soils in mapping are small areas of the well drained Clarion and poorly drained Coland soils. The noncalcareous Clarion soils are on plane or slightly convex slopes. Coland soils are in the lower landscape positions. Included soils make up 10 to 25 percent of the unit.

Permeability is moderate in the Terril and Swanlake soils. Surface runoff is very rapid. Available water capacity is high. The organic matter content is high in the Terril soil and moderate in the Swanlake soil.

Most of the acreage is idle land that supports natural vegetation. Because of the slope, these soils are generally unsuitable for cultivated crops. They have limited value as pasture. They are well suited to woodland wildlife habitat.

Windbreaks can be established in most areas of these soils. Most species grow well on north- and east-facing slopes. Hand planting generally is needed because of

the slope. Measures that protect the trees and shrubs from the damage caused by livestock are needed. Control of competing vegetation helps to ensure optimum growth of seedlings. Cultivation or applications of herbicide help to remove competing plants.

The slope is the main limitation if these soils are used for building site development. In most areas extensive land shaping is needed. The buildings should be designed so that they conform to the natural slope of the land. The soils are poorly suited to local roads because of the slope and low strength. Extensive cutting and filling generally are needed. Well compacted, coarse textured base material helps to prevent the damage caused by low strength. Building the roads on the contour and planting well suited grasses on the roadbanks minimize the erosion hazard. The soils are generally unsuitable for septic tank absorption fields because of the slope. Better suited soils commonly are nearby.

The land capability classification is VIe.

1907—Lakefield silty clay loam. This nearly level, somewhat poorly drained soil is on low, slightly convex rises on glacial lake plains. Individual areas are irregular in shape and range from 3 to 70 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is very dark gray silty clay loam about 9 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, grayish brown, and light brownish gray, mottled, calcareous silty clay loam. In places glacial till is closer to the surface. In some areas the soil is deeper to free lime. In other areas the content of clay is higher.

Included with this soil in mapping are small areas of the moderately well drained Collinwood, poorly drained Spicer and Waldorf, and very poorly drained Lura soils. Collinwood soils are on broad, low rises. They are deeper to carbonates than the Lakefield soil. Waldorf soils are in drainageways. Spicer soils are on the lower rises and on the rims of depressions. Lura soils are in depressions. Included soils make up 5 to 15 percent of the unit.

Permeability is moderate in the Lakefield soil. Surface runoff is slow or medium. The available water capacity is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that maintain fertility and tilth are needed. Tilth can be maintained by returning crop residue to the soil.

Most of the trees and shrubs used as windbreaks in the county grow well on this soil. Control of competing vegetation helps to ensure good seedling survival and growth rates. Cultivation or applications of herbicide help to remove competing plants.

If this soil is used as a site for dwellings, the basement level should be constructed above the seasonal high

water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping helps to keep surface water away from the buildings. Constructing local roads on well compacted, coarse textured base material helps to prevent the damage caused by frost action. The soil is poorly suited to septic tank absorption fields because of the seasonal high water table. In some areas a mound type of absorption field is suitable.

The land capability classification is I.

1914—Lura silty clay, nearly level. This poorly drained soil is in draws and drainageways on glacial lake plains. Individual areas are irregular in shape and range from 3 to several hundred acres in size.

Typically, the surface layer is black silty clay about 8 inches thick. The subsurface layer also is black silty clay. It is about 34 inches thick. The subsoil is olive, mottled, firm silty clay about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, calcareous silty clay. In some places the content of sand is higher. In other places the content of clay is lower. In some areas the surface soil is thinner.

Included with this soil in mapping are small areas of the moderately well drained Terril soils on foot slopes and the lower side slopes. These soils make up 2 to 10 percent of the unit.

Permeability is slow in the Lura soil. Surface runoff also is slow. The available water capacity is high. A seasonal high water table is at a depth of 0.5 foot to 3.0 feet. The organic matter content is high.

Most areas are farmed. This soil is well suited to corn, soybeans, small grain, and forage grasses and legumes. Measures that improve drainage and maintain fertility and tilth are needed. Drainage generally is adequate if tile is installed. The organic matter content and tilth can be maintained by returning crop residue to the soil. Cultivating at the proper moisture content also helps to maintain good tilth.

This soil is fairly well suited to the trees and shrubs grown as windbreaks. The choice of varieties is limited to those that are tolerant of wet conditions. Control of competing vegetation helps to ensure optimum growth of seedlings. Cultivation or applications of herbicide help to remove competing plants.

Because of the wetness, this soil is poorly suited to building site development. Buildings should be constructed without basements. Proper landscaping helps to keep surface water away from the buildings. Properly designing foundations and footings and backfilling around foundations with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Constructing local roads on raised, coarse textured base material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by wetness, frost action, and low strength.

This soil is poorly suited to septic tank absorption fields because of the seasonal high water table and the restricted permeability. In some areas a mound type of absorption field is suitable.

The land capability classification is IIw.

Prime Farmland

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

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

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 370,000 acres in the survey area, or 83 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are throughout the county. Most are used for corn or soybeans.

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

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

and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table, qualify for prime farmland only in areas where this limitation has been overcome by drainage measures.

The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

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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 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 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

Joel A. Poppe, district conservationist, Soil Conservation Service, helped prepare this section.

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.

According to farm records of the Agricultural Stabilization and Conservation Service, about 404,400 acres in Jackson County was cropland in 1980. Of this total, about 380,700 acres was used for row crops, mainly corn and soybeans; 8,600 acres for small grain, such as oats and wheat; 10,700 acres for hay, mainly alfalfa; 900 acres for sunflowers; and 3,500 acres for pasture. The acreage used for corn and soybeans is increasing, and the acreage used for pasture is decreasing. Fruits, vegetables, and other speciality crops are grown in a few areas.

The soils in Jackson County generally are well suited to crop production. Productivity can be increased or maintained on most soils by selection of improved crop varieties, soil conservation practices, maintenance of proper fertility levels, and other good management practices. This soil survey can help in the application of such technology. The main concerns in managing the cropland in the county are water erosion, soil blowing, droughtiness, wetness, fertility, and tilth.

Water erosion is the major concern on the more sloping soils, such as Clarion and Storden. The measures used to control erosion include contour farming, contour stripcropping, grassed waterways (fig. 8), terraces, diversions, systems of conservation tillage that leave crop residue on the surface, and cropping sequences that include forage grasses and legumes.

Soil blowing can be a major problem on Dickman, Estherville, and Dickinson soils in winter and spring. It is especially damaging if the soil is dry and bare during periods of high wind. Measures that help to control soil blowing include a cover of crop residue throughout the winter, cover crops, field stripcropping, and field windbreaks.

Droughtiness is a major problem on Estherville, Dickman, Dickinson, and Wadena soils. Measures that conserve moisture include field windbreaks and systems of conservation tillage that leave crop residue on the



Figure 8.—Grassed waterways in an area of Clarion loam, 2 to 6 percent slopes.

surface throughout the winter. Returning crop residue to the soil increases the available water capacity.

Wetness can be a problem in poorly drained and very poorly drained soils, such as Spicer, Lura, Glencoe, Palms, and Blue Earth soils. Ditches provide outlets for many tile drainage systems. Properly timed tillage increases the productivity of these soils.

Fertility is affected by reaction and the content of plant nutrients. High alkalinity can be a problem on some soils, such as Canisteo and Spicer. These soils are on the rims of depressions. Selection of suitable crop varieties and applications of the proper kind and amount of fertilizer help to overcome the alkalinity.

The soils in the county are generally low in content of phosphorus and medium or high in content of potash and lime. Crops respond to applications of most kinds of fertilizer. The amount to be applied depends on past and present management, the kind of crop to be grown, and

the anticipated level of yields. A soil fertility test is needed.

Tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Maintaining good tilth is difficult on fine textured soils, such as Waldorf, Lura, and Collinwood. Tilling at the proper moisture content is critical. If the soil is tilled when it is too wet, clods form. Because of the cloddiness, preparing a good seedbed is difficult. Soils with good tilth have good soil structure in the surface layer. A system of conservation tillage that leaves crop residue on the surface, a proper subsurface drainage system, timely tillage, a cropping sequence that includes grasses and legumes, and incorporation of organic matter into the upper part of the soil can improve tilth and increase the rate of water infiltration.

Pasture makes up about 3,500 acres in the county. The pastured areas generally are along the Des Moines River and other streams. Most are steep or are affected

by some other limiting factor, such as droughtiness or wetness.

Overgrazing and the failure to apply good management practices can result in poor-quality pastures. Proper stocking rates, a rotational system of grazing, and timely grazing of seasonal grasses are needed. Weed control, reseeding, and applications of fertilizer help to keep the pasture productive. Including a native grass pasture in the rotation increases production by providing a forage supply in midsummer.

Further information about the management and crops described in this section can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Yields Per Acre

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

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

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

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

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

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops,

the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects.

Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for engineering purposes.

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

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

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

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

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

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

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

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

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

Windbreaks and Environmental Plantings

Joel A. Poppe, district conservationist, Soil Conservation Service, and Ralph McNab, district technician, Jackson County Soil and Water Conservation District, helped prepare this section.

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. Most of the windbreaks in Jackson County protect farmsteads (fig. 9).

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, 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

Opportunities for outdoor recreation in Jackson County are provided by Kilen Woods State Park, along the West Fork of the Des Moines River, by six county parks, and by several city parks. The potential for future development of recreational areas is fair.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for



Figure 9.—A farmstead windbreak on Clarion soils. Delft soils are in the foreground.

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 or a hardpan 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

The soils in Jackson County can provide the habitat elements needed for an abundance of wildlife. Intensive agriculture, however, has reduced the extent of the available habitat. Most of the wildlife is concentrated in and around undrained marshes and near lakes and rivers. The county has more than 4,000 acres of publicly owned wildlife areas.

Ducks and geese migrate through the county. Also, the county has a resident population of ducks and geese. Other common game animals are deer, pheasants, Hungarian partridge, rabbits, and squirrels. The most common furbearers are muskrat, fox, beaver, raccoon, and mink. The deeper lakes have populations of northern pike, walleye, crappie, perch, and bullheads.

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 soybeans.

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 brome grass, 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, 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, hackberry, ash, crabapple, cottonwood, basswood, maple, and chokecherry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive and honeysuckle.

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, 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, barnyardgrass, bulrush, cordgrass, 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 Hungarian partridge, pheasant, meadowlark, morning dove, field sparrow, cottontail, badger, skunk, jackrabbit, 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 thrushes, woodpeckers, squirrels, owls, 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 or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. 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 or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials 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 or a cemented pan 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 toxic material and 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, bedrock, and toxic material.

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 low in content of soluble salts, 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, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

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

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. 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, irrigation, 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.

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. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone and soil reaction.

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 soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

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

Soil Properties

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

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

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

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

Engineering Index Properties

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "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.

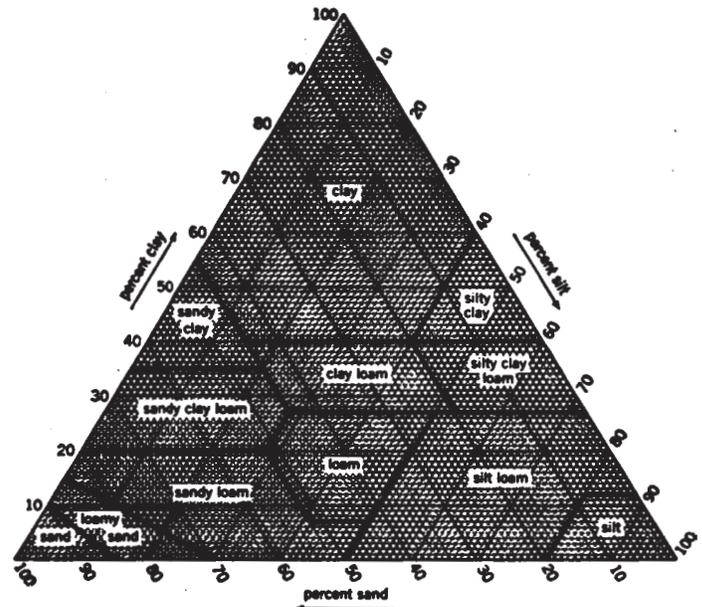


Figure 10.—Percentages of sand, clay, and silt in the basic USDA soil textural classes.

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

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

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

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

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

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

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

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

Physical and Chemical Properties

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

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

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

Moist bulk density is the weight of soil (oven-dry) per unit volume. Volume is measured when the soil is at field

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

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

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

- 4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, 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.

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.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

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 (9). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties

and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (8). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (9). 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 deep, poorly drained soils formed in a loamy mantle over sandy outwash. These soils are on broad outwash plains. Permeability is moderate in the loamy mantle and rapid in the sandy underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Biscay clay loam, 700 feet west and 600 feet north of the southeast corner of sec. 22, T. 102 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

- A—9 to 23 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.
- Bg—23 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.
- 2Cg—30 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly loamy coarse sand; single grain; loose; about 30 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to loamy sand or coarser textured material and to free carbonates range from 25 to 40 inches. The mollic epipedon is 16 to 24 inches thick. The content of coarse fragments ranges from 2 to 10 percent in the solum and from 5 to 50 percent in the underlying material. The fragments are 2 to 25 millimeters in size.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3. It is loam, clay loam, sandy clay loam, or silty clay loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 to 3. It is sandy clay loam, loam, or clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loamy sand, sand, coarse sand, or loamy coarse sand and has a gravel content of 5 to 50 percent.

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained soils in former lake basins on glacial moraines and till plains. These soils formed in coprogenous earth that mantles silty glaciolacustrine sediments or loamy till. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Blue Earth mucky silt loam, 200 feet south and 150 feet west of the northeast corner of sec. 29, T. 101 N., R. 38 W.

- Ap—0 to 10 inches; black (10YR 2/1) mucky silt loam (coprogenous earth), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many fragments of snail shells; strong effervescence; moderately alkaline; abrupt smooth boundary.
- C—10 to 40 inches; black (10YR 2/1) mucky silt loam (coprogenous earth), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many snail shells and fragments of snail shells; strong effervescence; moderately alkaline; gradual smooth boundary.
- 2Cg—40 to 60 inches; dark gray (5Y 4/1) silty clay loam; common medium distinct olive brown (2.5Y 4/4)

mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the coprogenous earth and the depth to glacial till or glacial lacustrine sediments is 30 to about 60 inches. The content of coarse fragments in the coprogenous earth is 0 to 25 percent. The coarse fragments are snail and clam shells.

A layer of sapric material as much as 8 inches thick overlies the coprogenous earth in some pedons. The coprogenous earth has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4, and chroma of 1 or 2. It is mucky silt loam, mucky silty clay loam, loam, or clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay loam, loam, silt loam, or clay loam.

Canisteo Series

The Canisteo series consists of deep, poorly drained, moderately permeable soils on glacial moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo clay loam, in an area of Canisteo-Glencoe clay loams, 250 feet south and 2,600 feet east of the northwest corner of sec. 3, T. 104 N., R. 34 W.

- Ap—0 to 9 inches; black (N 2/0) clay loam, black (N 2/0) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.
- A—9 to 23 inches; black (10YR 2/1) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.
- Bg—23 to 40 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.
- Cg—40 to 60 inches; grayish brown (2.5Y 5/2) clay loam; many medium distinct light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 50 inches. Free carbonates are in all parts of the fine-earth fraction between depths of 10 and 20 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of coarse fragments ranges from 2 to 8 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A and B horizons are dominantly clay loam, but the range includes loam, silty clay loam, and silt loam. The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3. The B horizon has hue of 2.5Y or 5Y and value of 4 or 5. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is dominantly clay loam, but the range includes loam.

Clarion Series

The Clarion series consists of deep, well drained, moderately permeable soils. These soils formed in loamy glacial till on uplands. Slopes range from 2 to 18 percent.

Typical pedon of Clarion loam, 2 to 6 percent slopes, 1,400 feet east and 100 feet south of the northwest corner of sec. 1, T. 103 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A—8 to 12 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine and very fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bw—12 to 27 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

C1—27 to 42 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—42 to 60 inches; yellowish brown (10YR 5/6) loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 50 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

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

Coland Series

The Coland series consists of deep, poorly drained, moderately permeable soils. These soils formed in loamy alluvial sediments on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Coland clay loam, occasionally flooded, 300 feet south and 1,200 feet east of the northwest corner of sec. 19, T. 101 N., R. 36 W.

A—0 to 15 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate very fine granular structure; friable; neutral; gradual smooth boundary.

Ag—15 to 36 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—36 to 60 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; massive; friable; neutral.

The thickness of the solum ranges from 36 to 48 inches. The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3. It is dominantly clay loam, but the range includes silty clay loam and loam. The C horizon is neutral in hue or has hue of 5Y. It has value of 2 to 5. It is dominantly clay loam, but the range includes loam. Sandy or gravelly material is below a depth of 48 inches in some pedons.

Collinwood Series

The Collinwood series consists of deep, moderately well drained soils. These soils formed in clayey and silty lacustrine sediments on glacial lake plains. Permeability is moderately slow in the upper part of the profile and slow in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Collinwood silty clay, 1,000 feet north and 150 feet east of the southwest corner of sec. 36, T. 101 N., R. 36 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; slightly acid; abrupt smooth boundary.

A—8 to 21 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate fine and very fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

Bw—21 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay; moderate fine and very fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

C1—31 to 43 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak thick platy structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—43 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium distinct yellowish brown (10YR 5/6) mottles; weak thick platy structure; firm; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 54 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches.

The A horizon has value of 2 or 3. It is silty clay or silty clay loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is silty clay, clay, or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4. It is silty clay loam, clay, silty clay, or silt loam. Some pedons have a loam or clay loam layer below a depth of 48 inches.

Crippin Series

The Crippin series consists of deep, somewhat poorly drained, moderately permeable soils formed in loamy glacial till on uplands. Slopes range from 1 to 3 percent.

Typical pedon of Crippin clay loam, 500 feet west and 2,620 feet south of the northeast corner of sec. 3, T. 103 N., R. 34 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—8 to 20 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw—20 to 31 inches; dark grayish brown (2.5Y 4/3) clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C—31 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 48 inches. The depth to free carbonates ranges from 0 to 10 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A, B, and C horizons are clay loam or loam. The A horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B horizon has hue of 2.5Y or 10YR, value of 3 to 5, and chroma of 2 to 4. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 2 to 4.

Delft Series

The Delft series consists of deep, poorly drained, moderately slowly permeable soils on glacial moraines. These soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Delft clay loam, 800 feet south and 1,800 feet west of the northeast corner of sec. 4, T. 103 N., R. 36 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, black (10YR 2/1) dry; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—9 to 28 inches; black (10YR 2/1) clay loam, black (10YR 2/1) dry; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

Bg—28 to 38 inches; grayish brown (2.5Y 5/2) clay loam; few medium distinct light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure parting to weak medium subangular blocky; friable; about 3 percent coarse fragments; neutral; gradual wavy boundary.

Cg—38 to 60 inches; grayish brown (2.5Y 5/2) clay loam; many medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 55 inches. The depth to free carbonates and the thickness of the mollic epipedon range from 24 to 60 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3. It is clay loam, loam, or silty clay loam high in content of sand. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, loam, or silt loam high in content of sand. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, loam, sandy loam, or silt loam.

Dickinson Series

The Dickinson series consists of deep, well drained soils formed in glacial outwash that is loamy in the upper part and sandy in the lower part. These soils are on outwash plains. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 1 to 12 percent.

Typical pedon of Dickinson sandy loam, 1 to 6 percent slopes, 300 feet east and 600 feet south of the northwest corner of sec. 6, T. 102 N., R. 35 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—9 to 18 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

Bw—18 to 26 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

BC—26 to 47 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

C—47 to 60 inches; dark yellowish brown (10YR 4/6) sand; single grain; loose; slightly acid.

The thickness of the solum ranges from 24 to 50 inches. The depth to loamy sand or sand ranges from 20 to 42 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, or loam. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 2 to 6. It is dominantly sandy loam, but the range includes fine sandy loam, loamy fine sand, loamy sand, fine sand, and sand. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is loamy sand, loamy fine sand, or sand.

Dickman Series

The Dickman series consists of deep, well drained soils formed in glacial outwash material that is loamy in the upper part and sandy in the lower part. These soils are outwash plains. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 1 to 12 percent.

Typical pedon of Dickman sandy loam, 1 to 6 percent slopes, 2,000 feet west and 1,200 feet north of the southeast corner of sec. 30, T. 101 N., R. 36 W.

Ap—0 to 12 inches; very dark brown (10YR 2/2) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; slightly acid; abrupt smooth boundary.

Bw—12 to 36 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

C1—36 to 48 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 2 percent coarse fragments; medium acid; gradual smooth boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) sand; single grain; loose; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The depth to loamy fine sand or coarser textured

material ranges from 12 to 20 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. The content of coarse fragments in the underlying material is 0 to 10 percent. The fragments are 2 to 25 millimeters in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, or coarse sandy loam. The B horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. It is loamy sand, fine sandy loam, loamy fine sand, coarse sandy loam, sandy loam, loamy coarse sand, fine sand, coarse sand, or sand. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is sand, fine sand, or coarse sand.

Estherville Series

The Estherville series consists of deep, somewhat excessively drained soils formed in loamy sediments over sandy glacial outwash. These soils are on outwash plains. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 12 percent.

Typical pedon of Estherville sandy loam, 2 to 6 percent slopes, 2,100 feet west and 2,000 feet south of the northeast corner of sec. 30, T. 101 N., R. 36 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; about 8 percent coarse fragments; neutral; abrupt smooth boundary.

Bw—10 to 20 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; about 14 percent coarse fragments; neutral; clear smooth boundary.

2C—20 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 32 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 24 inches. The thickness of the mollic epipedon ranges from 9 to 20 inches. The thickness of the loamy mantle is 10 to 20 inches. The content of coarse fragments ranges from 2 to 15 percent in the loamy mantle and from 10 to 35 percent in the underlying material. The fragments are 2 to 25 millimeters in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. The B horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam, loam, or coarse sandy loam. The 2C horizon has value of 4 to 7 and chroma of 2 to 6. It is gravelly coarse sand or coarse sand.

Glencoe Series

The Glencoe series consists of deep, very poorly drained, moderately permeable or moderately slowly permeable soils on glacial moraines. These soils formed in loamy sediments derived from glacial till. Slope is 0 to 1 percent.

Typical pedon of Glencoe clay loam, 250 feet east and 150 feet south of the northwest corner of sec. 10, T. 101 N., R. 36 W.

- Ap—0 to 9 inches; black (N 2/0) clay loam, black (N 2/0) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.
- A—9 to 39 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; gradual irregular boundary.
- Bg—39 to 50 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; gradual irregular boundary.
- Cg—50 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The thickness of the mollic epipedon ranges from 24 to 46 inches. The content of coarse fragments ranges from 0 to 8 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3. It is dominantly clay loam, but the range includes silty clay loam and loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam and silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4. It is loam or clay loam.

Kingston Series

The Kingston series consists of deep, moderately well drained, moderately permeable soils on lake plains. These soils formed in silty lacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Kingston silty clay loam, 2,300 feet north and 750 feet west of the southeast corner of sec. 26, T. 101 N., R. 35 W.

- Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular

blocky structure; friable; neutral; abrupt smooth boundary.

- A—9 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

- Bw—15 to 22 inches; dark grayish brown (2.5Y 4/3) silty clay loam; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

- C1—22 to 36 inches; light olive brown (2.5Y 5/4) silty clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

- C2—36 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches.

The A horizon has value of 2 or 3. It is dominantly silty clay loam, but the range includes silt loam and loam high in content of very fine sand. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is dominantly silty clay loam, but the range includes silt loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is silty clay loam or silt loam.

Lakefield Series

The Lakefield series consists of deep, somewhat poorly drained, moderately permeable soils on lake plains. These soils formed in calcareous, silty lacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Lakefield silty clay loam, 1,100 feet north and 150 feet east of the southwest corner of sec. 21, T. 102 N., R. 38 W.

- Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

- A—9 to 18 inches; very dark gray (10YR 3/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

- C1—18 to 34 inches; dark grayish brown (2.5Y 4/2) silty clay loam; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

- C2—34 to 53 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular

blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C3—53 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 12 to 24 inches. The depth to free carbonates is 0 to 10 inches.

The A horizon has value of 2 or 3. It is dominantly silty clay loam, but the range includes silty clay and silt loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 6. It is dominantly silty clay loam, but the range includes silt loam.

Lura Series

The Lura series consists of deep, very poorly drained and poorly drained, slowly permeable soils in depressions on glacial lake plains. These soils formed in clayey glaciolacustrine sediments. Slopes are 0 to 1 percent.

Typical pedon of Lura silty clay, 1,100 feet west and 200 feet north of the southeast corner of sec. 7, T. 103 N., R. 37 W.

Ap—0 to 10 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; strong fine angular blocky structure; firm; neutral; abrupt smooth boundary.

A1—10 to 24 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; strong fine angular blocky structure; firm; neutral; gradual smooth boundary.

A2—24 to 41 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; strong very fine angular blocky structure; firm; neutral; gradual smooth boundary.

A3—41 to 52 inches; black (N 2/0) silty clay, dark (N 4/0) dry; weak medium prismatic structure parting to strong very fine angular blocky; firm; neutral; gradual smooth boundary.

A4—52 to 60 inches; black (5Y 2/1) silty clay, dark gray (N 4/0) dry; weak medium prismatic structure parting to strong very fine angular blocky; firm; neutral.

The thickness of the solum and the depth to free carbonates range from 40 to 80 inches. The thickness of the mollic epipedon ranges from 30 to 66 inches.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3. It is dominantly silty clay, but the range includes clay. Some pedons have B and C horizons.

Mayer Series

The Mayer series consists of deep, poorly drained soils formed in a loamy mantle overlying sandy outwash sediments. These soils are on outwash plains. Permeability is moderate in the loamy material and rapid

in the sandy underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Mayer loam, 2,500 feet east and 150 feet south of the northwest corner of sec. 20, T. 104 N., R. 38 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

A—9 to 20 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Bg—20 to 28 inches; dark grayish brown (2.5Y 4/2) sandy clay loam; few large distinct yellowish brown (10YR 5/4) mottles; massive; friable; about 10 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg1—28 to 38 inches; grayish brown (2.5Y 5/2) gravelly sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

2Cg2—38 to 60 inches; brown (10YR 5/3) gravelly sand; common medium faint grayish brown (2.5Y 5/2) mottles; single grain; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and of the loamy mantle ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The content of coarse fragments ranges from 0 to 10 percent in the loamy mantle and from 15 to 50 percent in the underlying material. The fragments are 2 to 25 millimeters in size.

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

Millington Series

The Millington series consists of deep, poorly drained, moderately permeable, calcareous soils formed in loamy alluvial sediments on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Millington clay loam, frequently flooded, 100 feet west and 600 feet south of the northeast corner of sec. 19, T. 101 N., R. 36 W.

- A—0 to 14 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; few snail shells; slight effervescence; mildly alkaline; gradual smooth boundary.
- Bg—14 to 35 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; few snail shells; slight effervescence; mildly alkaline; clear smooth boundary.
- Cg—35 to 60 inches; grayish brown (2.5Y 5/2) stratified loam and clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; massive; firm; slight effervescence; mildly alkaline.

The thickness of the solum and of the mollic epipedon ranges from 24 to 40 inches. Most pedons have few to many snail shells.

The A and B horizons are clay loam, silt loam, silty clay loam, or loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 to 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly loam or clay loam, but the range includes sandy clay loam and silty clay loam.

Nicollet Series

The Nicollet series consists of deep, moderately well drained, moderately permeable soils on till plains and moraines. These soils formed in loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet clay loam, 100 feet north and 1,600 feet west of the southeast corner of sec. 16, T. 101 N., R. 34 W.

- Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.
- A—8 to 23 inches; very dark gray (10YR 3/1) clay loam, very dark grayish brown (10YR 3/2) dry; weak fine and very fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.
- Bw—23 to 29 inches; dark grayish brown (10YR 4/2) clay loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.
- C1—29 to 34 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; weak fine and very fine subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.
- C2—34 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y

6/2) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 48 inches. The content of coarse fragments ranges from 1 to 8 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A and B horizons are dominantly clay loam, but the range includes loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y and chroma of 2 to 4. It is clay loam or loam.

Palms Series

The Palms series consists of deep, very poorly drained soils formed in sapric material underlain by loamy glacial material. These soils are in former lake basins on glacial moraines and till plains. Permeability is moderately slow to moderately rapid in the upper part of the profile and moderate or moderately slow in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Palms muck, 1,400 feet east and 100 feet south of the northwest corner of sec. 2, T. 101 N., R. 36 W.

- Oap—0 to 9 inches; black (10YR 2/1 broken face and rubbed) sapric material; about 5 percent fiber, less than 2 percent rubbed; weak medium subangular blocky structure; friable; herbaceous fibers; less than 50 percent mineral material; neutral; abrupt smooth boundary.
- Oa—9 to 19 inches; black (10YR 2/1 broken face and rubbed) sapric material; about 5 percent fiber, less than 2 percent rubbed; weak fine subangular blocky structure; friable; herbaceous fibers; less than 50 percent mineral material; neutral; gradual smooth boundary.
- Cg1—19 to 46 inches; gray (5Y 5/1) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; slight effervescence; mildly alkaline; gradual smooth boundary.
- Cg2—46 to 60 inches; gray (5Y 5/1) clay loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The depth to the loamy C horizon ranges from 16 to 24 inches. The surface tier has chroma of 1 or 2. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 1 or 2. It is clay loam, fine sandy loam, loam, silt loam, or silty clay loam.

Spicer Series

The Spicer series consists of deep, poorly drained, calcareous, moderately permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, in an area of Spicer-Lura complex, 1,800 feet east and 200 feet south of the northwest corner of sec. 32, T. 102 N., R. 38 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A—9 to 23 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Bkg—23 to 43 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate very fine subangular blocky structure; friable; common large soft lime accumulations; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg—43 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak thin to thick platy structure; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 22 to 48 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. Typically, free carbonates are throughout the profile.

The A, B, and C horizons are dominantly silty clay loam, but the range includes silt loam. The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2.

Spillville Series

The Spillville series consists of deep, moderately well drained, moderately permeable soils formed in loamy alluvial sediments on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Spillville loam, occasionally flooded, 2,300 feet north and 250 feet west of the southeast corner of sec. 17, T. 103 N., R. 35 W.

A1—0 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.

A2—12 to 28 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—28 to 56 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

C—56 to 60 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; massive; friable; neutral.

The thickness of the solum ranges from 30 to 56 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam, clay loam, and silt loam having a noticeable content of sand. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is dominantly loam, but the range includes sandy loam.

Storden Series

The Storden series consists of deep, well drained, moderately permeable soils on glacial moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 6 to 18 percent.

Typical pedon of Storden loam, in an area of Clarion-Storden loams, 6 to 12 percent slopes, eroded, 1,150 feet north and 150 feet west of the southeast corner of sec. 32, T. 103 N., R. 35 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1—6 to 28 inches; yellowish brown (10YR 5/4) loam; moderate fine subangular blocky structure; friable; few reddish iron stains; about 4 percent coarse fragments; violent effervescence; moderately alkaline; clear smooth boundary.

C2—28 to 41 inches; yellowish brown (10YR 5/4) loam; massive; friable; few reddish iron stains; about 6 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—41 to 60 inches; yellowish brown (10YR 5/4) loam; few medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable few reddish iron stains; about 6 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum is 7 to 10 inches and commonly is the same as the thickness of the A horizon. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon has value of 4 or 5 and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 6.

Swanlake Series

The Swanlake series consists of deep, well drained, moderately permeable soils on glacial moraines. These soils formed in calcareous, loamy glacial till. Slopes range from 6 to 40 percent.

Typical pedon of Swanlake loam, 18 to 25 percent slopes, 200 feet south and 1,700 feet east of the northwest corner of sec. 25, T. 104 N., R. 36 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

C1—7 to 17 inches; yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—17 to 60 inches; yellowish brown (10YR 5/4) loam; massive; friable; about 5 percent coarse fragments; few reddish iron stains; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches. Carbonates are typically at the surface but may be leached to a depth of as much as 10 inches. The content of coarse fragments ranges from 2 to 15 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The C horizon has hue of 10YR or 2.5Y, value of 5, and chroma of 4 to 6.

Terril Series

The Terril series consists of deep, moderately well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in loamy colluvial sediments. Slopes range from 2 to 6 percent and from 25 to 40 percent.

Typical pedon of Terril loam, in an area of Terril-Swanlake loams, 25 to 40 percent slopes, 1,700 feet north and 100 feet east of the southwest corner of sec. 16, T. 103 N., R. 35 W.

A1—0 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; gradual smooth boundary.

A2—12 to 22 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; gradual smooth boundary.

A3—22 to 36 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 1

percent coarse fragments; neutral; clear smooth boundary.

Bw—36 to 60 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; neutral.

The thickness of the solum ranges from 36 to 60 inches. The content of coarse fragments ranges from 0 to 15 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes silt loam that has a high content of sand. It also includes clay loam. The B horizon has value of 3 or 4 and chroma of 2 to 4. It is clay loam or loam.

Truman Series

The Truman series consists of deep, well drained, moderately permeable soils on small lake plains in the uplands. These soils formed in silty lacustrine sediments. Slopes range from 2 to 6 percent.

Typical pedon of Truman silty clay loam, 2 to 6 percent slopes, 200 feet west and 500 feet north of the southeast corner of sec. 34, T. 102 N., R. 38 W.

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

A—8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw—14 to 29 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

C—29 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 56 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches.

The A, B, and C horizons are silty clay loam or silt loam. The A horizon has value of 2 or 3 and chroma of 1 to 3. The B horizon has value of 3 to 5 and chroma of 3 to 6. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 to 6.

Wadena Series

The Wadena series consists of deep, well drained soils formed in glacial outwash material that is loamy in the upper part and sandy in the lower part. These soils are on outwash plains. Permeability is moderate in the upper part of the profile and very rapid in the underlying material. Slopes range from 0 to 6 percent.

Typical pedon of Wadena loam, 2 to 6 percent slopes, 2,480 feet north and 400 feet west of the southeast corner of sec. 36, T. 102 N., R. 35 W.

- Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.
- A—8 to 15 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.
- Bw—15 to 27 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.
- BC—27 to 32 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.
- 2C—32 to 60 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 40 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 40 inches. The depth to free carbonates ranges from 30 to 50 inches. The content of gravel ranges from 1 to 15 percent in the loamy mantle and from 5 to 50 percent in the 2C horizon. The mollic epipedon is 12 to 20 inches thick.

The A and B horizons are loam or clay loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 to 5 and chroma of 3 or 4. Some pedons have a thin 2B horizon. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is sand, gravelly sand, coarse sand, or gravelly coarse sand.

Waldorf Series

The Waldorf series consists of deep, poorly drained, moderately slowly permeable soils on glacial lake plains. These soils formed in clayey and silty glaciolacustrine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Waldorf silty clay, 800 feet north and 500 feet east of the southwest corner of sec. 36, T. 101 N., R. 36 W.

- Ap—0 to 9 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate fine and very fine subangular blocky structure; firm; slightly acid; abrupt smooth boundary.
- A—9 to 23 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; moderate fine and very fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bg—23 to 40 inches; olive gray (5Y 5/2) silty clay; many fine distinct light olive brown (2.5Y 5/6) mottles; moderate fine and very fine angular blocky structure; firm; mildly alkaline; clear wavy boundary.

Cg—40 to 60 inches; light olive gray (5Y 6/2) silty clay loam; many medium distinct light olive brown (2.5Y 5/6) mottles; weak thick platy structure parting to weak medium angular blocky; firm; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 26 to 48 inches. The depth to free carbonates ranges from 26 to 55 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3. It is silty clay or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay, silty clay loam, or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is silty clay loam, silty clay, clay, or silt loam. Some pedons have strata of clay loam or loam below a depth of 48 inches.

Webster Series

The Webster series consists of deep, poorly drained, moderately permeable soils on glacial till plains. These soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Webster clay loam, 200 feet west and 2,050 feet north of the southeast corner of sec. 4, T. 104 N., R. 34 W.

- Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.
- A—9 to 20 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.
- Bg—20 to 41 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.
- Cg—41 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. The fragments are 2 to 25 millimeters in size.

The A horizon is neutral in hue or has hue of 10YR. It is clay loam, silty clay loam, or loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly clay loam, but the range includes silty clay loam. The C horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 to 3. It is loam or clay loam. Some pedons have thin strata of silty or sandy material in the lower part.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in clayey alluvial sediments. Slopes are 0 to 1 percent.

Typical pedon of Zook silty clay, frequently flooded, 200 feet east and 800 feet north of the southwest corner of sec. 12, T. 101 N., R. 37 W.

A1—0 to 10 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; moderate fine and medium granular structure; friable; neutral; gradual smooth boundary.

A2—10 to 44 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; weak very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—44 to 60 inches; very dark gray (10YR 3/1) silty clay; massive; friable; mildly alkaline.

The thickness of the solum ranges from 36 to 64 inches. The thickness of the mollic epipedon ranges from 36 to 60 inches.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3. It is silty clay loam or silty clay. The C horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 to 5.

Formation of the Soils

Soil formation results from the interaction among five major factors. Two of these, namely plant and animal life and climate are considered active, whereas the other three, namely parent material, topography, and time, are considered passive. Plant and animal life and climate modify the parent material over time and under the influence of topography. The paragraphs that follow relate the five factors to the soils in Jackson County.

Parent Material

The soils in Jackson County formed in the glacial drift and related sediments of the late Wisconsin Glaciation. These mineral materials were transported to this region by the Des Moines lobe of the continental ice sheet, which buried previous glacial material (11). They occur as glacial till, glacial outwash, and glaciolacustrine sediments, any of which can dominate a geomorphic region. Postglacial sediments can be locally significant. They include alluvium, colluvium, and organic and limnic deposits. The county has six geomorphic regions, each of which is characterized by different kinds of parent material and topography.

The Altamont moraine, a recessional moraine of the Des Moines lobe, trends north and south through the central part of Jackson County (5). The soils in this region formed mainly in glacial till and in local deposits of material sorted from till by water. The glacial till is high in content of shale and calcium carbonate (6). It is dominantly loam or clay loam. Clarion and Delft are the major soils in this region.

The Des Moines River Valley is on the east edge of the Altamont moraine. It has the steepest terrain in the county and has nearly level flood plains. The soils on the steeper slopes formed in glacial till and colluvium. Swanlake and Terril soils are on these slopes. Alluvium on the flood plains is postglacial and is indicative of upstream erosion. Coland and Spillville soils formed in this alluvium.

The part of Jackson County east of the Des Moines River is a ground moraine made up of clay loam glacial till. Canisteo, Glencoe, and Nicollet are the dominant soils on this nearly level to gently rolling moraine.

The voluminous sediment-laden glacial meltwater was often dammed by ice and superglacial till (10). As a result, temporary glacial lakes formed. Sediments were deposited in these basins. The coarser particles settled from the water first and then were covered by silty and

clayey material. Eventually, the dams were broken and most of the water drained, exposing fine textured sediments. The soils in the northwestern part of the county formed in these glaciolacustrine sediments or in exposures of glacial till. They are nearly level or gently undulating and generally are poorly drained or very poorly drained. Lura and Waldorf soils are examples.

The southwestern part of the county also is characterized by extensive glaciolacustrine deposits, but these sediments were deposited in much smaller lakes that formed in disintegrating glacial ice (4). As the glacier melted further, these ice-walled lakes became flat-topped hills. Fine textured sediments were deposited on the nearly level hilltops, clay loam glacial till or sandy outwash on the side slopes, and fine textured sediments in the draws and drainageways between the hills (6). Clarion, Lura, and Collinwood are the dominant soils in this region.

Rapidly moving glacial meltwater removed fine textured particles from the glacial till and deposited coarse textured material in areas where the current slowed. Sand and gravel deposits are along the present-day streams and rivers and along former glacial streams and beaches. They also occur as local deposits within the glacial till. Estherville soils formed in gravelly outwash deposits, and Dickman soils formed in sandy outwash deposits.

The postglacial landscape had numerous closed depressions that were filled with water. As plants and animals recolonized the landscape, shallow bodies of water began to fill with organic detritus. If the water level dropped far enough, soils formed in these organic or limnic deposits. Palms soils formed in the organic deposits, and Blue Earth soils formed in the limnic material.

Topography

Topography influences soil formation through its effects on drainage, runoff, erosion, and deposition. The postglacial landscape of Jackson County generally is nearly level or gently undulating but has hilly or steep areas of lesser extent. It also has numerous closed depressions or potholes. Soil profile development is more extensive in the nearly level or gently sloping soils than in either the steeply sloping soils or the depressional soils, mainly because the rate of water

infiltration is higher on the gentle slopes. On the steeper slopes, the runoff rate is high, and in the depressional areas, saturated soils are subject to ponding.

Time

Soil formation in Jackson County began anew about 12,000 years ago, when the glacier retreated and plants recolonized the new landscape (11). Some soils are younger than others because of subsequent drainage or additions of new parent material. Geologically, the landscape of the county is very recent, but sufficient time has elapsed for well developed soils to form.

Climate

Jackson County has a subhumid, continental climate characterized by cold winters and hot summers. Temperature and precipitation help to determine the kind of vegetation on the soil, the length of the growing season, the soil moisture regime, and the freeze-thaw cycle.

Temperature affects the soil in several important ways. It largely determines the rate of chemical reactions within the soil, from the decaying of organic matter and other biological activity to the weathering of mineral components. It significantly influences the type of plant and animal life on and in the soil through its limiting effect on the growing season of macrophytes and its effect on the metabolic rate of micro-organisms. The freeze-thaw cycle also affects soil formation. This cycle plays a part in the formation of soil structure and the physical weathering of soil minerals. Frost action helps to mix the soil material.

Precipitation affects the soil in many ways. All biological activity in the soil depends on water. Water dissolves minerals. Some mineral salts can then be transported to the surface and deposited as water evaporates, or they can be leached to lower horizons. As it moves through the soil, water transports plant nutrients, which can then be absorbed by plants or by soil colloids or leached from the root zone.

Soil microclimates result from the landscape position, texture, water content, and vegetative cover. Soils on

south- and west-facing slopes are generally warmer and drier than those on north- and east-facing slopes. Wet, depressional soils are generally colder than other soils. Local factors that affect soil microclimates are drainage, infiltration rate, and hydraulic conductivity.

The native vegetation of a region is, to a large extent, attributable to the climate. Prairie vegetation and cold winters promote the accumulation of organic matter in soils. Most of the soils in Jackson County have a high organic matter content, which results in a dark surface layer. More information about the climate is given under the heading "General Nature of the County."

Plants and Animals

Living organisms are the most dynamic of the soil-forming factors. All micro-organisms, plants, and animals affect soil formation. The soils in Jackson County formed under tall prairie grasses. Although the soils supported hundreds of plant species, the tall grasses were dominant. They provided the organic matter necessary in the formation of the thick, dark surface layer typical of the soils in the county.

The contribution of micro-organisms to soil formation is very significant. Soil micro-organisms are largely responsible for the decomposition of fresh organic matter, the recycling of plant nutrients, and the formation of structure, mottles, and other morphological features of the soil.

Burrowing animals, such as earthworms, ants, and some mammals, mix soil layers. In the past, large herbivores, such as bison, grazed the grasses, stimulating new growth as their waste provided valuable plant nutrients.

Human activities have also affected soil formation. Prairie fires, most of which are started by humans, rejuvenate the prairie ecosystem. Intensive agriculture has resulted in an accelerated erosion-deposition sequence and in a loss of granular structure and of organic matter in the plow layer. Conversely, various soil conservation practices have restored beneficial soil properties.

References

- (1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.
- (2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.
- (3) Beck, M.W., J. Ambrose Elwell, J.S. Hall, and G.B. Bodman. 1928. Soil survey of Jackson County, Minnesota. U.S. Dep. Agric., Bur. of Chem. and Soils, 24 pp., illus.
- (4) Lee, Clayton, and Theodore Freers. 1967. Glacial geology of the Missouri Coteau and adjacent areas. N. Dak. Geol. Surv., Misc. Ser. 30, 170 pp., illus. 327
- (5) Matsch, Charles L. 1972. Quaternary geology of northeastern South Dakota and southwestern Minnesota. Minn. Geol. Surv., 29 pp., illus.
- (6) Matsch, Charles L. 1972. Quaternary geology of southwestern Minnesota. *In* Geology of Minnesota: A Centennial Volume, pp. 548-560, illus.
- (7) Rose, Arthur P. 1910. An illustrated history of Jackson County. Vol. 2, 586 pp., illus.
- (8) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.
- (9) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.
- (10) Winchell, N.H., and Warren Upham. 1884. Geology of Minnesota. Minn. Geol. and Nat. Hist. Surv., Vol. 1, 697 pp., illus.
- (11) Wright, H.E., Jr. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota: A Centennial Volume, pp. 515-547, illus.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	<i>Inches</i>
Very low.....	0 to 3
Low.....	3 to 6
Moderate.....	6 to 9
High.....	9 to 12
Very high.....	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

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.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

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.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

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.

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.

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 80 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.

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.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity*, *normal moisture capacity*, or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. 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.

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.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

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.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

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.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

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).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

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 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.

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.

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.

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.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	<i>pH</i>
Extremely acid.....	below 4.5
Very strongly acid.....	4.5 to 5.0
Strongly acid.....	5.1 to 5.5
Medium acid.....	5.6 to 6.0
Slightly acid.....	6.1 to 6.5
Neutral.....	6.6 to 7.3
Mildly alkaline.....	7.4 to 7.8
Moderately alkaline.....	7.9 to 8.4
Strongly alkaline.....	8.5 to 9.0
Very strongly alkaline.....	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the

soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

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 intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	<i>Millimeters</i>
Very coarse sand.....	2.0 to 1.0
Coarse sand.....	1.0 to 0.5
Medium sand.....	0.5 to 0.25
Fine sand.....	0.25 to 0.10
Very fine sand.....	0.10 to 0.05
Silt.....	0.05 to 0.002
Clay.....	less than 0.002

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.

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 grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

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

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

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.

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.

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.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION
(Recorded in the period 1951-80 at Worthington, Minnesota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have--		Average number of growing degree days*	Average	2 years in 10 will have--		Average number of days with 0.10 inch or more	Average snowfall
				Maximum temperature higher than--	Minimum temperature lower than--			Less than--	More than--		
	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>°F</u>	<u>Units</u>	<u>In</u>	<u>In</u>	<u>In</u>		<u>In</u>
January----	19.9	1.2	10.6	45	-25	0	0.52	0.14	0.82	2	6.1
February---	26.2	7.1	16.7	52	-19	0	.80	.21	1.27	2	8.1
March-----	36.4	17.8	27.1	70	-10	13	1.57	.73	2.29	4	10.6
April-----	54.7	33.3	44.0	86	15	39	2.27	1.22	3.18	5	2.2
May-----	68.9	45.0	57.0	91	25	248	3.26	1.68	4.63	7	.0
June-----	78.2	55.4	66.8	96	40	504	4.22	2.27	5.93	7	.0
July-----	83.1	60.2	71.7	97	47	673	3.13	1.18	4.74	6	.0
August-----	80.6	57.6	69.1	95	43	592	3.60	1.79	5.16	6	.0
September--	70.7	47.6	59.2	92	31	282	2.88	1.13	4.34	6	.0
October----	59.6	36.6	48.1	85	18	101	1.83	.47	2.93	4	.8
November---	41.5	22.5	32.0	69	-5	0	1.08	.24	1.73	3	3.8
December---	26.8	9.9	18.4	52	-18	0	.70	.28	1.05	2	7.4
Yearly:											
Average---	53.9	32.9	43.4	---	---	---	---	---	---	---	---
Extreme---	---	---	---	99	-25	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,452	25.86	20.31	31.20	54	39.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL
(Recorded in the period 1951-80 at Worthington, Minnesota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 30	May 12	May 19
2 years in 10 later than--	Apr. 24	May 7	May 15
5 years in 10 later than--	Apr. 14	Apr. 26	May 6
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 7	Oct. 1	Sept. 22
2 years in 10 earlier than--	Oct. 12	Oct. 6	Sept. 27
5 years in 10 earlier than--	Oct. 23	Oct. 15	Oct. 6

TABLE 3.--GROWING SEASON
(Recorded in the period 1951-80 at Worthington, Minnesota)

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	168	151	134
8 years in 10	176	158	141
5 years in 10	192	171	153
2 years in 10	207	183	165
1 year in 10	215	190	171

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
27B	Dickinson sandy loam, 1 to 6 percent slopes-----	2,155	0.5
27C	Dickinson sandy loam, 6 to 12 percent slopes-----	700	0.2
35	Blue Earth mucky silt loam-----	4,075	0.9
39A	Wadena loam, 0 to 2 percent slopes-----	520	0.1
39B	Wadena loam, 2 to 6 percent slopes-----	1,475	0.3
41A	Estherville sandy loam, 0 to 2 percent slopes-----	535	0.1
41B	Estherville sandy loam, 2 to 6 percent slopes-----	3,500	0.8
41C	Estherville sandy loam, 6 to 12 percent slopes-----	625	0.1
86	Canisteo clay loam-----	11,075	2.5
94B	Terril loam, 2 to 6 percent slopes-----	1,025	0.2
96	Collinwood silty clay-----	40,700	9.1
101B	Truman silty clay loam, 2 to 6 percent slopes-----	9,600	2.2
102B	Clarion loam, 2 to 6 percent slopes-----	75,040	16.9
102B2	Clarion loam, 4 to 8 percent slopes, eroded-----	29,325	6.6
113	Webster clay loam-----	20,775	4.7
114	Glencoe clay loam-----	6,450	1.4
118	Crippin clay loam-----	11,975	2.7
130	Nicollet clay loam-----	27,260	6.1
197	Kingston silty clay loam-----	1,300	0.3
211	Lura silty clay-----	12,575	2.8
229	Waldorf silty clay-----	30,900	6.9
255	Mayer loam-----	1,100	0.2
313	Spillville loam, occasionally flooded-----	1,100	0.2
327B	Dickman sandy loam, 1 to 6 percent slopes-----	1,800	0.4
327C	Dickman sandy loam, 6 to 12 percent slopes-----	1,050	0.2
336	Delft clay loam-----	38,525	8.6
362	Millington clay loam, frequently flooded-----	800	0.2
392	Biscay clay loam-----	925	0.2
539	Palms muck-----	1,700	0.4
595E	Swanlake loam, 18 to 25 percent slopes-----	720	0.2
595F	Swanlake loam, 25 to 40 percent slopes-----	1,500	0.3
664	Zook silty clay, frequently flooded-----	1,750	0.4
813	Spicer-Lura complex-----	29,425	6.6
887C	Clarion-Swanlake loams, 6 to 12 percent slopes-----	485	0.1
887D	Clarion-Swanlake loams, 12 to 18 percent slopes-----	1,050	0.2
921C2	Clarion-Storden loams, 6 to 12 percent slopes, eroded-----	8,725	2.0
956	Canisteo-Glencoe clay loams-----	34,550	7.8
960D2	Storden-Clarion loams, 12 to 18 percent slopes, eroded-----	2,400	0.5
1030	Udorthents-Pits complex-----	700	0.2
1051	Glencoe clay loam, ponded-----	7,400	1.7
1833	Coland clay loam, occasionally flooded-----	3,875	0.9
1834	Coland loam, frequently flooded-----	2,725	0.6
1852F	Terril-Swanlake loams, 25 to 40 percent slopes-----	4,275	1.0
1907	Lakefield silty clay loam-----	1,250	0.3
1914	Lura silty clay, nearly level-----	6,025	1.4
	Total-----	445,440	100.0

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
27B	Dickinson sandy loam, 1 to 6 percent slopes
39A	Wadena loam, 0 to 2 percent slopes
39B	Wadena loam, 2 to 6 percent slopes
86	Canisteo clay loam (where drained)
94B	Terril loam, 2 to 6 percent slopes
96	Collinwood silty clay
101B	Truman silty clay loam, 2 to 6 percent slopes
102B	Clarion loam, 2 to 6 percent slopes
113	Webster clay loam (where drained)
114	Glencoe clay loam (where drained)
118	Crippin clay loam
130	Nicollet clay loam
197	Kingston silty clay loam
211	Lura silty clay (where drained)
229	Waldorf silty clay (where drained)
255	Mayer loam (where drained)
313	Spillville loam, occasionally flooded
336	Delft clay loam (where drained)
392	Biscay clay loam (where drained)
813	Spicer-Lura complex (where drained)
956	Canisteo-Glencoe clay loams (where drained)
1833	Coland clay loam, occasionally flooded (where drained)
1907	Lakefield silty clay loam
1914	Lura silty clay, nearly level (where drained)

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	Grass-legume hay	Brome-grass- alfalfa
		<u>Bu</u>	<u>Bu</u>	<u>Bu</u>	<u>Tons</u>	<u>AUM*</u>
27B----- Dickinson	IIe	85	28	60	2.8	4.5
27C----- Dickinson	IIIe	70	20	45	2.0	3.5
35----- Blue Earth	IIIw	100	30	60	2.5	3.5
39A----- Wadena	IIs	95	30	65	3.0	5.0
39B----- Wadena	IIe	90	28	60	2.8	4.5
41A----- Estherville	IIIs	70	22	45	2.0	3.5
41B----- Estherville	IIIs	60	20	40	1.8	3.0
41C----- Estherville	IVs	50	18	35	1.5	2.5
86----- Canisteo	IIw	140	40	85	4.2	6.5
94B----- Terril	IIe	145	46	88	4.8	7.6
96----- Collinwood	IIw	135	42	85	4.5	7.2
101B----- Truman	IIe	140	45	85	4.6	7.2
102B----- Clarion	IIe	140	45	85	4.5	7.2
102B2----- Clarion	IIIe	120	38	75	3.8	6.2
113----- Webster	IIw	145	46	88	4.4	6.8
114----- Glencoe	IIIw	115	35	70	3.0	4.5
118----- Crippin	I	145	42	88	4.8	7.6
130----- Niccollet	I	150	48	90	5.0	8.0
197----- Kingston	I	150	48	90	5.0	8.0

See footnote 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	Grass-legume hay	Bromegrass- alfalfa
		<u>Bu</u>	<u>Bu</u>	<u>Bu</u>	<u>Tons</u>	<u>AUM*</u>
211----- Lura	IIIw	105	32	65	2.8	4.0
229----- Waldorf	IIw	125	40	80	3.8	5.8
255----- Mayer	IIw	85	25	50	2.0	3.0
313----- Spillville	IIw	125	40	80	4.5	7.2
327B----- Dickman	IIIe	70	22	45	2.0	3.5
327C----- Dickman	IVe	55	18	35	1.5	2.5
336----- Delft	IIw	145	45	88	4.5	6.8
362----- Millington	Vw	---	---	---	---	---
392----- Biscay	IIw	90	28	55	2.5	3.5
539----- Palms	IIIw	110	35	70	3.0	4.5
595E, 595F----- Swanlake	VIe	---	---	---	1.8	3.0
664----- Zook	Vw	---	---	---	2.8	4.0
813----- Spicer-Lura	IIw	120	35	74	3.5	5.5
887C----- Clarion-Swanlake	IIIe	100	30	60	3.2	5.5
887D----- Clarion-Swanlake	IVe	75	22	45	2.5	4.0
921C2----- Clarion-Storden	IIIe	90	28	55	3.6	5.0
956----- Canistee-Glencoe	IIw	135	38	82	4.0	6.2
960D2----- Storden-Clarion	IVe	70	20	40	2.0	3.5
1030. Udorthents-Pits						
1051----- Glencoe	VIIIw	---	---	---	---	---

See footnote 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	Grass-legume hay	Bromegrass- alfalfa
		<u>Bu</u>	<u>Bu</u>	<u>Bu</u>	<u>Tons</u>	<u>AUM*</u>
1833----- Coland	IIw	115	35	70	3.8	5.5
1834----- Coland	Vw	---	---	---	3.5	5.5
1852F----- Terril-Swanlake	VIe	---	---	---	---	---
1907----- Lakefield	I	140	42	88	4.8	7.6
1914----- Lura	IIw	125	40	80	3.8	5.8

* 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.

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
27B, 27C----- Dickinson	Lilac-----	Eastern redcedar, Russian-olive, Arnold red honeysuckle, Siberian peashrub.	Eastern white pine, green ash, Norway spruce, honeylocust, red pine, Amur maple, hackberry.	---	---
35----- Blue Earth	---	Redosier dogwood	Black ash, tall purple willow.	Black ash, golden willow, white willow.	---
39A, 39B----- Wadena	Siberian peashrub, lilac, Arnold red honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
41A, 41B, 41C----- Estherville	Siberian peashrub	Eastern redcedar, lilac, Arnold red honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
86----- Canisteo	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
94B----- 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.	---
96----- Collinwood	Lilac, Siberian peashrub, Arnold red honeysuckle.	Manchurian crabapple, eastern redcedar.	Hackberry, green ash, Russian-olive, Austrian pine, honeylocust.	Siberian elm-----	---
101B----- Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, hackberry, Russian-olive, eastern redcedar, Amur maple.	Eastern white pine, green ash.	---
102B, 102B2----- 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.	---

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
113----- Webster	---	Redosier dogwood, American plum, Arnold red honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
114----- Glencoe	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
118----- Crippin	---	Northern white- cedar, Arnold red honeysuckle, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
130----- Nicollet	---	Redosier dogwood, Arnold red honeysuckle, lilac.	Northern white- cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
197----- Kingston	---	Lilac, Arnold red honeysuckle, redosier dogwood.	Northern white- cedar, white spruce, Amur maple, blue spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
211----- Lura	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
229----- Waldorf	---	Redosier dogwood, Arnold red honeysuckle, American plum.	Northern white- cedar, white spruce, Amur maple, tall purple willow, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
255----- Mayer	---	Arnold red honeysuckle, northern white- cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
313----- Spillville	---	Redosier dogwood, Arnold red honeysuckle, lilac.	Northern white- cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
327B, 327C----- Dickman	Siberian peashrub	Eastern redcedar, Arnold red honeysuckle, lilac.	Green ash, honeylocust, red pine, jack pine, Austrian pine, Russian-olive.	Eastern white pine, Siberian elm.	---
336----- Delft	---	Arnold red honeysuckle, redosier dogwood, American plum.	Hackberry, Amur maple, white spruce, northern white-cedar, tall purple willow.	Green ash, golden willow.	Silver maple, 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
362----- Millington	---	Northern white-cedar, lilac, Siberian peashrub.	Hackberry, white spruce, eastern redcedar.	Honeylocust, silver maple, green ash, red maple, white ash.	Eastern cottonwood.
392----- Biscay	---	Redosier dogwood, American plum, Arnold red honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
539----- Palms	Common ninebark---	Whitebelle honeysuckle, Amur privet, silky dogwood, nannyberry viburnum, Arnold red honeysuckle.	Tall purple willow	Golden willow, black willow.	Imperial Carolina poplar.
595E, 595F----- Swanlake	American plum-----	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm-----	---
664----- Zook	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern white-cedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
813*: Spicer-----	---	Arnold red honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Lura-----	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
887C*, 887D*: 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.	---

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
887C*, 887D*: Swanlake-----	American plum-----	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian- olive.	Siberian elm-----	---
921C2*: 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, Arnold red honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian- olive.	Siberian elm-----	---
956*: Canistee-----	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Glencoe-----	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
960D2*: Storden-----	American plum-----	Eastern redcedar, hackberry, Arnold red honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian- olive.	Siberian elm-----	---
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.	---
1030*: Udorthents. Pits. 1051. Glencoe					

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
1833, 1834----- Coland	---	Redosier dogwood, Arnold red honeysuckle, American plum.	White spruce, hackberry, northern white- cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1852F*: 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.	---
Swanlake-----	American plum-----	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian- olive.	Siberian elm-----	---
1907----- Lakefield	---	Siberian peashrub, lilac, northern white-cedar, Arnold red honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
1914----- Lura	---	American plum, Arnold red honeysuckle, redosier dogwood.	Northern white- cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.

* 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
27B----- Dickinson	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
27C----- Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
35----- Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
39A----- Wadena	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
39B----- Wadena	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
41A----- Estherville	Slight-----	Slight-----	Moderate: small stones.	Slight-----	Moderate: droughty.
41B----- Estherville	Slight-----	Slight-----	Moderate: slope, small stones.	Slight-----	Moderate: droughty.
41C----- Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: droughty, slope.
86----- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
94B----- Terril	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
96----- Collinwood	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
101B----- Truman	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
102B----- Clarion	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
102B2----- Clarion	Slight-----	Slight-----	Severe: slope.	Slight-----	Slight.
113----- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114----- Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
118----- Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight-----	Slight.
130----- Nicollet	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
197----- Kingston	Slight-----	Slight-----	Slight-----	Slight-----	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
211----- Lura	Severe: ponding, too clayey, excess humus.	Severe: ponding, too clayey, excess humus.	Severe: too clayey, excess humus, ponding.	Severe: ponding, too clayey, excess humus.	Severe: ponding, too clayey.
229----- Waldorf	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
255----- Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
313----- Spillville	Severe: flooding.	Slight-----	Moderate: flooding.	Slight-----	Moderate: flooding.
327B----- Dickman	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.
327C----- Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: droughty, slope.
336----- Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
362----- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
392----- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
539----- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
595E----- Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
595F----- Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
664----- Zook	Severe: wetness, flooding, too clayey.	Severe: too clayey.	Severe: too clayey, wetness, flooding.	Severe: too clayey.	Severe: too clayey, flooding.
813*: Spicer-----	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Lura-----	Severe: ponding, too clayey, excess humus.	Severe: ponding, too clayey, excess humus.	Severe: too clayey, excess humus, ponding.	Severe: ponding, too clayey, excess humus.	Severe: ponding, too clayey.
887C*: 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
887C*: Swanlake-----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
887D*: Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
921C2*: Clarion-----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
Storden-----	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
956*: Canisteo-----	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Glencoe-----	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
960D2*: Storden-----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1030*: Udorthents. Pits.					
1051----- Glencoe	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1833----- Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
1834----- Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1852F*: Terrill-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1907----- Lakefield	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
1914----- Lura	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.

* 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 herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
27B----- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
27C----- Dickinson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
35----- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
39A, 39B----- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
41A, 41B, 41C----- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
86----- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94B----- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
96----- Collinwood	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
101B----- Truman	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
102B----- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
102B2----- Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
113----- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114----- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
118----- Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
130----- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
197----- Kingston	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
211----- Lura	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
229----- Waldorf	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
255----- Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
313----- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
327B, 327C----- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
336----- Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
362----- Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
392----- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
539----- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
595E, 595F----- Swanlake	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
664----- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
813*: Spicer-----	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
Lura-----	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
887C*: Clarion-----	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Swanlake-----	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
887D*: Clarion-----	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Swanlake-----	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
921C2*: 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.
956*: Canisteo-----	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Glencoe-----	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
960D2*: Storden-----	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	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 herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
960D2*: Clarion-----	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1030*: Udorthents. Pits.										
1051----- Glencoe	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1833----- Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
1834----- Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1852F*: Terril-----	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Swanlake-----	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
1907----- Lakefield	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1914----- Lura	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

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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
118----- Crippin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
130----- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
197----- Kingston	Moderate: wetness.	Slight-----	Moderate: wetness.	Slight-----	Severe: frost action.	Slight.
211----- Lura	Severe: excess humus, ponding.	Severe: ponding, shrink-swell, low strength.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding, too clayey.
229----- Waldorf	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness, too clayey.
255----- Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
313----- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
327B----- Dickman	Severe: cutbanks cave.	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.
327C----- Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
336----- Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
362----- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
392----- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
539----- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
595E, 595F----- Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
664----- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Severe: too clayey, flooding.

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
813*: Spicer-----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
Lura-----	Severe: excess humus, ponding.	Severe: ponding, shrink-swell, low strength.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding, too clayey.
887C*: Clarion-----	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Swanlake-----	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.
887D*: Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
921C2*: 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.
956*: Canisteo-----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Glencoe-----	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
960D2*: Storden-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1030*: Udorthents. Pits.						
1051----- Glencoe	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.

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
1833----- 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.
1834----- 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.
1852F*: Terril-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1907----- Lakefield	Moderate: wetness.	Slight-----	Moderate: wetness.	Slight-----	Severe: low strength, frost action.	Slight.
1914----- Lura	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness, too clayey.

* 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
27B----- Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
27C----- Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
35----- Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
39A, 39B----- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41A, 41B----- Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41C----- Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
86----- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
94B----- Terril	Slight-----	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----	Fair: too clayey.
96----- Collinwood	Severe: wetness, percs slowly.	Slight-----	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
101B----- Truman	Slight-----	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----	Fair: too clayey.
102B, 102B2----- Clarion	Slight-----	Moderate: slope, seepage.	Slight-----	Slight-----	Good.
113----- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114----- Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
118----- Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

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
130----- Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
197----- Kingston	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
211----- Lura	Severe: ponding, percs slowly.	Slight-----	Severe: ponding, too clayey, excess humus.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
229----- Waldorf	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
255----- Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
313----- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
327B----- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
327C----- Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
336----- Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
362----- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
392----- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
539----- Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
595E, 595F----- Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
664----- Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.

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
813*: Spicer-----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Lura-----	Severe: ponding, percs slowly.	Slight-----	Severe: ponding, too clayey, excess humus.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
887C*: Clarion-----	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Swanlake-----	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
887D*: Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
921C2*: Clarion-----	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden-----	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
956*: Canisteo-----	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Glencoe-----	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
960D2*: Storden-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Clarion-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1030*: Udorthents. Pits.					
1051----- Glencoe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
1833, 1834----- Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
1852F*: Terril-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

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
1852F*: Swanlake-----	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1907----- Lakefield	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1914----- Lura	Severe: wetness, percs slowly.	Slight-----	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
27B----- Dickinson	Good-----	Probable-----	Improbable: too sandy.	Good.
27C----- Dickinson	Good-----	Probable-----	Improbable: too sandy.	Fair: slope.
35----- Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
39A, 39B----- Wadena	Good-----	Probable-----	Probable-----	Poor: small stones, area reclaim.
41A, 41B, 41C----- Estherville	Good-----	Probable-----	Probable-----	Poor: small stones, area reclaim.
86----- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
94B----- Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
96----- Collinwood	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
101B----- Truman	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
102B, 102B2----- Clarion	Good-----	Improbable: excess fines.	Improbable: excess fines.	Good.
113----- Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114----- Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
118----- Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
130----- Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
197----- Kingston	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
211----- Lura	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
229----- Waldorf	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
255----- Mayer	Fair: wetness.	Probable-----	Probable-----	Fair: area reclaim, thin layer.
313----- Spillville	Good-----	Improbable: excess fines.	Improbable: excess fines.	Good.
327B, 327C----- Dickman	Good-----	Probable-----	Improbable: too sandy.	Poor: thin layer.
336----- Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
362----- Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
392----- Biscay	Fair: wetness.	Probable-----	Probable-----	Fair: area reclaim, thin layer.
539----- Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
595E----- Swanlake	Fair: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
595F----- Swanlake	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
664----- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
813*: Spicer-----	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Lura-----	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
887C*: Clarion-----	Good-----	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Swanlake-----	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
887D*: Clarion-----	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Swanlake-----	Fair: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
921C2*: Clarion-----	Good-----	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden-----	Good-----	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
956*: Canisteo-----	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Glencoe-----	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
960D2*: Storden-----	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Clarion-----	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1030*: Udorthents. Pits.				
1051----- Glencoe	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1833, 1834----- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1852F*: Terril-----	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Swanlake-----	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1907----- Lakefield	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1914----- Lura	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

* 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	Drainage	Irrigation	Terraces and diversions	Grassed waterways
27B----- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
27C----- Dickinson	Severe: slope, seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy, slope.	Slope.
35----- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding-----	Ponding-----	Wetness.
39A----- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable-----	Too sandy-----	Favorable.
39B----- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope-----	Too sandy-----	Favorable.
41A----- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
41B----- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
41C----- Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
86----- Canisteo	Moderate: seepage.	Severe: wetness.	Frost action--	Wetness-----	Wetness-----	Wetness.
94B----- Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope-----	Favorable-----	Favorable.
96----- Collinwood	Slight-----	Severe: hard to pack.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Percs slowly.
101B----- Truman	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----	Erodes easily	Erodes easily.
102B, 102B2----- Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope-----	Erodes easily	Erodes easily.
113----- Webster	Moderate: seepage.	Severe: wetness.	Frost action--	Wetness-----	Wetness-----	Wetness.
114----- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding-----	Ponding-----	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
118----- Crippin	Moderate: seepage.	Moderate: wetness, piping.	Frost action---	Wetness-----	Wetness, erodes easily.	Erodes easily.
130----- Nicollet	Moderate: seepage.	Moderate: piping.	Frost action---	Wetness-----	Wetness-----	Favorable.
197----- Kingston	Moderate: seepage.	Severe: piping.	Frost action---	Wetness-----	Erodes easily, wetness.	Erodes easily.
211----- Lura	Slight-----	Severe: excess humus, hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
229----- Waldorf	Moderate: seepage.	Severe: hard to pack, wetness.	Frost action---	Wetness, slow intake.	Wetness-----	Wetness.
255----- Mayer	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness-----	Wetness, too sandy.	Wetness.
313----- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding-----	Favorable-----	Favorable.
327B----- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
327C----- Dickman	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
336----- Delft	Slight-----	Severe: wetness.	Frost action---	Wetness-----	Wetness-----	Wetness.
362----- Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness-----	Wetness.
392----- Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness-----	Wetness, too sandy.	Wetness.
539----- Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
595E, 595F----- Swanlake	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
664----- Zook	Slight-----	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, slow intake, percs slowly.	Not needed----	Not needed.
813*: Spicer-----	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness-----	Wetness, erodes easily.	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	Drainage	Irrigation	Terraces and diversions	Grassed waterways
813*: Lura-----	Slight-----	Severe: excess humus, hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
887C*, 887D*: Clarion-----	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
Swanlake-----	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
921C2*: Clarion-----	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
Storden-----	Severe: slope.	Moderate: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
956*: Canisteo-----	Moderate: seepage.	Severe: wetness.	Frost action--	Wetness-----	Wetness-----	Wetness.
Glencoe-----	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding-----	Ponding-----	Wetness.
960D2*: Storden-----	Severe: slope.	Moderate: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
Clarion-----	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
1030*: Udorthents. Pits.						
1051----- Glencoe	Moderate: seepage.	Severe: excess humus, hard to pack, ponding.	Ponding, frost action.	Ponding-----	Ponding-----	Wetness.
1833, 1834----- Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness-----	Wetness.
1852F*: Terril-----	Severe: slope.	Moderate: piping.	Deep to water	Slope-----	Slope-----	Slope.
Swanlake-----	Severe: slope.	Severe: piping.	Deep to water	Slope-----	Slope, erodes easily.	Slope, erodes easily.
1907----- Lakefield	Moderate: seepage.	Severe: piping.	Frost action--	Wetness-----	Wetness-----	Favorable.
1914----- Lura	Slight-----	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* 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	
27B, 27C----- Dickinson	0-18	Sandy loam-----	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	18-26	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	26-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
35----- Blue Earth	0-10	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	10-40	Mucky silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	40-60	Clay loam, loam, silty clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
39A, 39B----- Wadena	0-15	Loam-----	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	15-32	Loam, sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	32-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
41A, 41B, 41C----- Estherville	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
	10-20	Sandy loam, loam, coarse sandy loam.	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, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
86----- Canisteo	0-23	Clay loam-----	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	23-40	Clay loam, loam, sandy loam.	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	40-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
94B----- Terril	0-36	Loam-----	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	36-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
96----- Collinwood	0-21	Silty clay-----	CL, CH, ML, MH	A-7	0	100	100	95-100	90-95	40-55	15-25
	21-31	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-95	50-65	20-35
	31-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-95	40-60	15-30
101B----- Truman	0-14	Silty clay loam	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	14-29	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-100	25-45	5-20
	29-60	Silt loam, silty clay loam.	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
102B, 102B2----- Clarion	0-12	Loam-----	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	12-27	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	27-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15

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	
113----- Webster	0-20	Clay loam-----	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	20-41	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
	41-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114----- Glencoe	0-39	Clay loam-----	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	39-50	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	50-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
118----- Crippin	0-20	Clay loam-----	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	20-31	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	31-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
130----- Nicollet	0-23	Clay loam-----	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	23-29	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
197----- Kingston	0-15	Silty clay loam	ML, OL, CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	6-20
	15-22	Silty clay loam, silt loam.	CL, ML, CL-ML	A-6, A-7, A-4	0	100	100	95-100	85-100	35-50	6-20
	22-60	Silt loam, silty clay loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-50	5-15
211----- Lura	0-10	Silty clay-----	OH, CH	A-7	0	100	100	95-100	90-100	50-75	25-45
	10-60	Silty clay, clay	OH, CH	A-7	0	100	100	95-100	90-100	50-75	25-45
229----- Waldorf	0-23	Silty clay-----	ML, MH	A-7	0	100	100	95-100	90-100	45-65	14-30
	23-40	Silty clay, silty clay loam.	MH	A-7	0	100	100	95-100	95-100	50-70	20-35
	40-60	Silty clay loam, silty clay, silt loam.	MH, CL, ML, CH	A-7, A-6	0	100	100	95-100	90-100	35-65	11-30
255----- Mayer	0-20	Loam-----	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	20-28	Loam, sandy clay loam, silt loam.	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
313----- Spillville	0-56	Loam-----	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	56-60	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
327B, 327C----- Dickman	0-12	Sandy loam-----	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	12-60	Stratified loamy sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
336----- Delft	0-28	Clay loam-----	CL	A-6, A-7	0	95-100	90-98	75-90	60-80	30-45	10-20
	28-38	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	90-98	70-90	50-75	25-40	7-15
	38-60	Loam, clay loam, sandy loam.	CL, ML, CL-ML	A-6, A-4	0-5	90-100	85-100	55-90	50-85	20-40	3-15

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	
362----- Millington	0-14	Clay loam-----	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	14-35	Loam, silty clay loam, clay loam.	CL	A-7, A-6	0	95-100	90-100	80-100	70-95	28-50	10-22
	35-60	Stratified sandy loam 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
392----- Biscay	0-23	Clay loam-----	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	23-30	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	30-60	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
539----- Palms	0-19	Sapric material	PT	A-8	---	---	---	---	---	---	---
	19-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
595E, 595F----- Swanlake	0-7	Loam-----	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	7-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
664----- Zook	0-44	Silty clay-----	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	44-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
813*: Spicer-----	0-23	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	23-43	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	43-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
Lura-----	0-40	Silty clay-----	OH, CH	A-7	0	100	100	95-100	90-100	50-75	25-45
	40-60	Silty clay, clay	OH, CH	A-7	0	100	100	95-100	90-100	50-75	25-45
887C*, 887D*: Clarion-----	0-12	Loam-----	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	12-27	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	27-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Swanlake-----	0-7	Loam-----	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	7-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
921C2*: Clarion-----	0-12	Loam-----	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	12-27	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	27-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden-----	0-6	Loam-----	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	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
956*: Canisteco-----	0-23	Clay loam-----	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	23-40	Clay loam, loam	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	40-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth In	USDA texture	Classification		Frag- ments > 3 inches Pct	Percentage passing sieve number--				Liquid limit Pct	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
956*: Glencoe	0-39	Clay loam	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	39-50	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	50-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
960D2*: Storden	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	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
Clarion	0-12	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	12-27	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	27-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
1030*: Udorthents. Pits.											
1051----- Glencoe	0-39	Clay loam	OL, OH, MH, CL	A-6, A-7	0	96-100	92-100	75-98	60-90	30-55	10-25
	39-50	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	96-100	92-100	75-98	60-90	30-50	10-25
	50-60	Loam, clay loam	CL, ML	A-6, A-7	0	94-100	88-97	60-95	55-75	30-50	10-20
1833----- Coland	0-36	Clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	36-60	Loam, clay 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
1834----- Coland	0-36	Loam	CL	A-6	0	100	95-100	85-95	60-75	30-40	10-20
	36-60	Loam, clay 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
1852F*: Terril	0-36	Loam	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	36-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
Swanlake	0-7	Loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	7-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
1907----- Lakefield	0-18	Silty clay loam	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	25-45	6-20
	18-60	Silty clay loam, silt loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	25-45	6-20
1914----- Lura	0-42	Silty clay	CH	A-7	0	100	100	95-100	90-100	50-75	25-45
	42-72	Silty clay, silty clay loam, clay.	CL, CH	A-7	0	100	100	95-100	90-100	40-75	15-45

* 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" and "Organic matter" 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	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
27B, 27C----- Dickinson	0-18	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low-----	0.20	4	3	2-4
	18-26	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.6-6.5	Low-----	0.20			
	26-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	Low-----	0.15			
35----- Blue Earth	0-10	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Moderate----	0.28	5	4L	10-25
	10-40	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low-----	0.28			
	40-60	18-32	1.30-1.60	0.2-2.0	0.14-0.16	7.4-8.4	Moderate----	0.28			
39A, 39B----- Wadena	0-15	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low-----	0.24	4	5	3-6
	15-32	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low-----	0.32			
	32-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low-----	0.10			
41A, 41B, 41C---- Estherville	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	2-4
	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			
86----- Canistee	0-23	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate----	0.24	5	4L	4-8
	23-40	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low-----	0.32			
	40-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----	0.32			
94B----- Terril	0-36	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----	0.24	5	6	4-5
	36-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----	0.32			
96----- Collinwood	0-21	35-45	1.20-1.30	0.2-0.6	0.14-0.17	5.6-7.3	Moderate----	0.32	5	4	5-7
	21-31	35-60	1.25-1.35	0.06-0.6	0.13-0.16	5.6-7.3	High-----	0.32			
	31-60	35-45	1.25-1.40	0.06-0.6	0.11-0.15	7.4-8.4	High-----	0.32			
101B----- Truman	0-14	18-32	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	Low-----	0.32	5	6	4-8
	14-29	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	Low-----	0.43			
	29-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Low-----	0.43			
102B, 102B2----- Clarion	0-12	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----	0.28	5	6	3-6
	12-27	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----	0.37			
	27-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
113----- Webster	0-20	26-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate----	0.24	5	6	6-7
	20-41	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate----	0.32			
	41-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate----	0.32			
114----- Glencoe	0-39	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate----	0.28	5	6	5-10
	39-50	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate----	0.28			
	50-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low-----	0.28			
118----- Crippin	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	5-6
	20-31	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.28			
	31-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low-----	0.37			
130----- Nicollet	0-23	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate----	0.24	5	6	4-8
	23-29	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			
197----- Kingston	0-15	18-32	1.20-1.30	0.6-2.0	0.18-0.24	5.6-7.3	Low-----	0.28	5	7	4-8
	15-22	18-32	1.25-1.35	0.6-2.0	0.16-0.20	5.6-7.8	Low-----	0.37			
	22-60	18-32	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	Low-----	0.37			
211----- Lura	0-10	45-60	1.25-1.35	0.06-0.2	0.14-0.17	6.1-7.3	High-----	0.28	5	4	4-8
	10-60	45-60	1.25-1.35	0.06-0.2	0.14-0.17	6.1-7.3	High-----	0.28			

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	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
229----- Waldorf	0-23	35-45	1.20-1.30	0.2-2.0	0.18-0.25	6.1-7.3	Moderate-----	0.28	5	4	6-8
	23-40	40-55	1.25-1.35	0.2-0.6	0.13-0.16	6.6-7.8	High-----	0.28			
	40-60	24-45	1.25-1.35	0.2-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.28			
255----- Mayer	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	4-8
	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			
313----- Spillville	0-56	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-6
	56-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low-----	0.28			
327B, 327C----- Dickman	0-12	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low-----	0.20	3	3	2-4
	12-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low-----	0.15			
336----- Delft	0-28	24-35	1.40-1.65	0.2-2.0	0.18-0.20	6.6-7.8	Moderate-----	0.24	5	6	4-8
	28-38	18-32	1.30-1.40	0.2-0.6	0.19-0.22	6.6-7.8	Low-----	0.32			
	38-60	15-32	1.40-1.55	0.2-2.0	0.15-0.19	7.4-8.4	Low-----	0.32			
362----- Millington	0-14	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	Moderate-----	0.28	5	6	4-6
	14-35	18-35	1.40-1.60	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.28			
	35-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	Moderate-----	0.28			
392----- Biscay	0-23	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6	4-8
	23-30	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28			
	30-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----	0.10			
539----- Palms	0-19	---	0.25-0.45	0.2-6.0	0.35-0.45	6.1-7.8	-----	---	2	2	>75
	19-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low-----	---			
595E, 595F----- Swanlake	0-7	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low-----	0.28	5	4L	2-4
	7-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
664----- Zook	0-44	40-44	1.35-1.40	0.06-0.2	0.11-0.13	5.6-7.3	High-----	0.28	5	4	5-7
	44-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High-----	0.28			
813*: Spicer-----	0-23	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L	4-8
	23-43	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37			
	43-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low-----	0.37			
Lura-----	0-40	45-60	1.25-1.35	0.06-0.2	0.14-0.17	6.1-7.3	High-----	0.28	5	4	4-8
	40-60	45-60	1.25-1.35	0.06-0.2	0.14-0.17	6.1-7.3	High-----	0.28			
887C*, 887D*: Clarion-----	0-12	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----	0.28	5	6	4-6
	12-27	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----	0.37			
	27-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
Swanlake-----	0-7	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low-----	0.28	5	4L	2-4
	7-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
921C2*: Clarion-----	0-12	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----	0.28	5	6	3-5
	12-27	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----	0.37			
	27-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
Storden-----	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----	0.28	5	4L	1-2
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
956*:											
Canisteo-----	0-23	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	4L	4-8
	23-40	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low-----	0.32			
	40-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----	0.32			
Glencoe-----	0-39	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate-----	0.28	5	6	5-10
	39-50	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	50-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low-----	0.28			
960D2*:											
Storden-----	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----	0.28	5	4L	1-2
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
Clarion-----	0-12	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----	0.28	5	6	3-5
	12-27	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----	0.37			
	27-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
1030*:											
Udorthents.											
Pits.											
1051-----	0-39	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate-----	0.28	5	8	5-10
Glencoe	39-50	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	50-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low-----	0.28			
1833-----	0-36	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High-----	0.28	5	7	5-7
Coland	36-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low-----	0.28			
1834-----	0-36	22-26	1.40-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6	5-7
Coland	36-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low-----	0.28			
1852F*:											
Terril-----	0-36	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----	0.24	5	6	4-5
	36-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----	0.32			
Swanlake-----	0-7	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low-----	0.28	5	4L	2-4
	7-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low-----	0.37			
1907-----	0-18	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.32	5	7	4-8
Lakefield	18-60	18-35	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	Low-----	0.32			
1914-----	0-42	45-60	1.25-1.35	0.06-0.2	0.14-0.17	6.1-7.3	High-----	0.32	5	4	4-8
Lura	42-60	28-60	1.30-1.45	0.06-0.6	0.11-0.19	6.6-7.8	High-----	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "occasional," "brief," and "apparent" 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			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
27B, 27C- Dickinson	B	None	---	---	>6.0	---	---	---	Moderate	Low	Moderate.
35- Blue Earth	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	---	High	High	Low.
39A, 39B- Wadena	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
41A, 41B, 41C- Estherville	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
86- Canistota	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	---	High	High	Low.
94B- Terril	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
96- Collinwood	C	None	---	---	2.0-5.0	Apparent	Nov-May	---	High	High	Low.
101B- Truman	B	None	---	---	>6.0	---	---	---	High	Low	Low.
102B, 102B2- Clarion	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
113- Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	---	High	High	Low.
114- Glencoe	B/D	None	---	---	+1-1.0	Apparent	Oct-Jun	---	High	High	Low.
118- Crippin	B	None	---	---	2.0-4.0	Apparent	Nov-Jun	---	High	High	Low.
130- Nicollet	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	---	High	High	Low.
197- Kingston	B	None	---	---	2.5-5.0	Apparent	Apr-May	---	High	High	Low.
211- Lura	C/D	None	---	---	+1-1.0	Apparent	Nov-May	---	High	High	Low.

TABLE 16.---SOIL AND WATER FEATURES---Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence In	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth Ft	Kind	Months			Uncoated steel	Concrete
229----- Waldorf	C/D	None-----	---	---	0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
255----- Mayer	B/D	None-----	---	---	1.0-3.0	Apparent	Oct-Jun	---	High-----	High-----	Low.
313----- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	---	Moderate	High-----	Moderate.
327B, 327C----- Dickman	A	None-----	---	---	>6.0	---	---	---	Low-----	Low-----	Moderate.
336----- Delft	B/D	None-----	---	---	1.0-2.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
362----- Millington	B/D	Frequent-----	Brief-----	Apr-Jun	0-2.0	Apparent	Mar-Jul	---	High-----	High-----	Low.
392----- Biscay	B/D	None-----	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	Moderate	Low.
539----- Palms	A/D	None-----	---	---	+1-1.0	Apparent	Nov-May	5-15	High-----	High-----	Moderate.
595E, 595F----- Swanlake	B	None-----	---	---	>6.0	---	---	---	Moderate	Low-----	Low.
664----- Zook	C/D	Frequent-----	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	---	High-----	High-----	Moderate.
813*: Spicer-----	B/D	None-----	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
Lura-----	C/D	None-----	---	---	+1-1.0	Apparent	Nov-May	---	High-----	High-----	Low.
887C*, 887D*: Clarion-----	B	None-----	---	---	>6.0	---	---	---	Moderate	Low-----	Low.
Swanlake-----	B	None-----	---	---	>6.0	---	---	---	Moderate	Low-----	Low.
921C2*: Clarion-----	B	None-----	---	---	>6.0	---	---	---	Moderate	Low-----	Low.
Storden-----	B	None-----	---	---	>6.0	---	---	---	Moderate	Low-----	Low.
956*: Canistota-----	B/D	None-----	---	---	1.0-3.0	Apparent	Oct-Jul	---	High-----	High-----	Low.
Glencoe-----	B/D	None-----	---	---	+1-1.0	Apparent	Oct-Jun	---	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			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
960D2*: Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.	
Clarion	B	None	---	---	>6.0	---	---	Moderate	Low	Low.	
1030*: Udorthents. Pits.											
1051 Glencoe	D	None	---	---	+3-1.0	Apparent	Jan-Dec	High	High	Low.	
1833 Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.	
1834 Coland	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.	
1852F*: Terril	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.	
Swanlake	B	None	---	---	>6.0	---	---	Moderate	Low	Low.	
1907 Lakefield	B	None	---	---	2.5-5.0	Apparent	Apr-May	High	High	Low.	
1914 Lura	C/D	None	---	---	0.5-3.0	Apparent	Nov-May	High	High	Low.	

* 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
Blue Earth-----	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Canisteo-----	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion-----	Fine-loamy, mixed, mesic Typic Hapludolls
Coland-----	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Collinwood-----	Fine, montmorillonitic, mesic Aquic Hapludolls
Crippin-----	Fine-loamy, mixed, mesic Aquic Hapludolls
Delft-----	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson-----	Coarse-loamy, mixed, mesic Typic Hapludolls
Dickman-----	Sandy, mixed, mesic Typic Hapludolls
Estherville-----	Sandy, mixed, mesic Typic Hapludolls
Glencoe-----	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Kingston-----	Fine-silty, mixed, mesic Aquic Hapludolls
Lakefield-----	Fine-silty, mixed, mesic Aquic Hapludolls
Lura-----	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Mayer-----	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Millington-----	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Nicollet-----	Fine-loamy, mixed, mesic Aquic Hapludolls
Orthents-----	Sandy or sandy-skeletal, mixed, mesic Typic Udorthents
Palms-----	Loamy, mixed, euic, mesic Terric Medisaprists
Spicer-----	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillville-----	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden-----	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake-----	Fine-loamy, mixed, mesic Entic Hapludolls
Terril-----	Fine-loamy, mixed, mesic Cumulic Hapludolls
Truman-----	Fine-silty, mixed, mesic Typic Hapludolls
Wadena-----	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Waldorf-----	Fine, montmorillonitic, mesic Typic Haplaquolls
Webster-----	Fine-loamy, mixed, mesic Typic Haplaquolls
Zook-----	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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