United States
Department of
Agriculture

Soil
Conservation
Service

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

Soil Survey of Hancock County, Iowa

How To Use This Soil Survey

General Soil Map

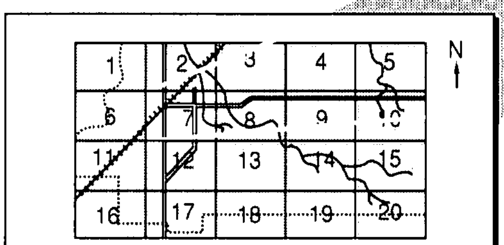
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

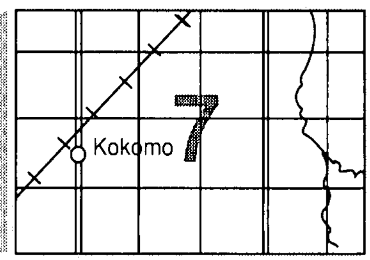
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

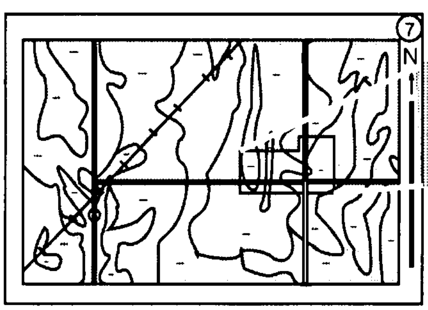


INDEX TO MAP SHEETS



MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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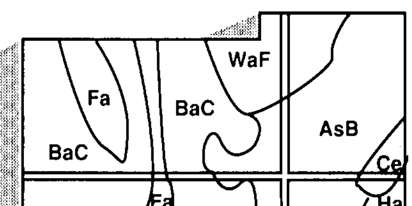

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

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.

Major fieldwork for this soil survey was completed in the period 1980-86. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship. It is part of the technical assistance furnished to the Hancock County Soil Conservation District. Funds appropriated by Hancock County were used to defray part of the cost of the survey.

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

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Soybeans on Canisteo clay loam, 0 to 2 percent slopes. This soil is intensively row cropped.

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Issued September 1989

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Preface

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

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

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

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

Soil Survey of Hancock County, Iowa

By Richard A. Lensch, Soil Conservation Service

Fieldwork by Patrick L. Abel, Robert G. Jones, Richard A. Lensch, Daniel G. Selky, Robert J. Vobra, Robert W. Wilson, and Allan W. Younk, Soil Conservation Service

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

HANCOCK COUNTY is in the north-central part of Iowa (fig. 1). It has a total area of 366,080 acres, or 576 square miles. Garner, the county seat, is in the east-central part of the county.

The county is chiefly agricultural. The principal crops are corn and soybeans, but oats and hay are also grown. Beef cattle and hogs are other important sources of income.

The landscape varies greatly throughout the county. It consists of wide plains and precipitous hills, some of which enclose lakes. Marshes alternate with knobby hills. The valleys have gently flowing streams bordered by rounded, sloping hillsides *(15)*. Elevation ranges from about 1,125 to 1,350 feet above sea level.

This survey updates the soil survey of Hancock County published in 1930 *(29)*. It provides additional information and larger scale maps that show the soils in greater detail.

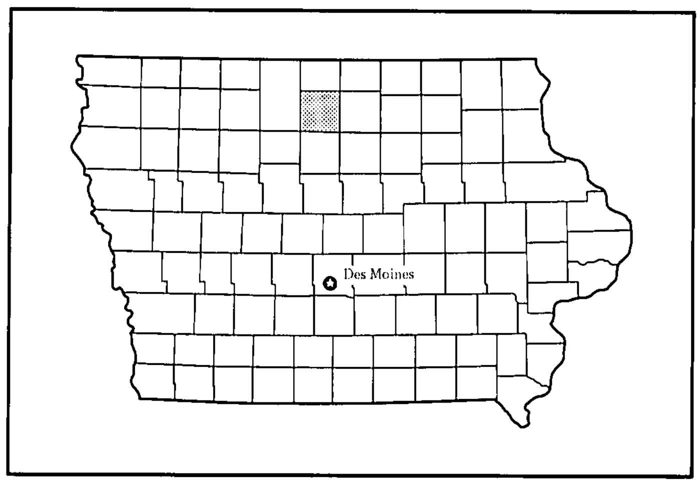

Figure 1.—Location of Hancock County in Iowa.

General Nature of the County

This section provides general information about the history and development, transportation facilities, business and industry, relief and drainage, natural resources, farming, and climate of Hancock County.

History and Development

The history of what is now Hancock County began on September 9, 1854, when Anson Avery and his wife settled at Upper Grove in Avery Township, which was later named after him *(18)*. A year later, an unnamed settlement was started along the Winnebago River, south of Pilot Knob in Ellington Township. These were the first two attempts at settlement in Hancock County.

As settlement continued Hancock County was formed, and then it was attached to Webster County for judicial purposes. In 1857 it was made a part of Winnebago County. Finally, in the spring of 1858, there were believed to be enough inhabitants to organize a separate county. Application was made to the county judge for Winnebago County for the necessary authority to form a separate county *(18)*.

Hancock County, named after John Hancock, was established as a result of an election, held June 28, 1858, in which 22 votes were cast *(18)*. A county court was elected, consisting of judge, prosecuting attorney, and sheriff. During the winter of 1859-60, an act was passed creating the county board of supervisors, bestowing upon them the powers formerly vested in the county court.

County government continued to organize in the early 1860's, and in 1865 James M. Elder, Clerk of Courts, moved his office to Concord, thus creating the first county seat. Concord began to grow, and the courthouse became too small. The following years brought a long fight between Britt and Garner to decide where the new county seat would be located. After 38 years, a vote finally settled the issue, and the county seat was moved to its present location in Garner.

The 1860 census listed the number of inhabitants of Hancock County as 179. By 1880, the population had grown to 3,453. It consisted of natives of Germany, Ireland, France, and Bohemia (now part of Czechoslovakia). It also included Americans from other parts of the United States and a few Scandinavians, Scots, and English. The American settlers emigrated mainly from the New England States, New York, Pennsylvania, Ohio, Illinois, and Wisconsin. Although these early settlers were poor, they bought land at low prices, making small payments over long periods of time, and through hard work became successful farmers and businessmen.

The population of the county grew rapidly after 1880, and reached 13,752 in 1900. The growth of the county during this period was not in towns but on farms. The towns grew and expanded but lagged behind the development of the county as a whole.

Since 1900, the population has increased slightly to 13,833 in 1980. Garner, the county seat, is the largest town and has a population of 2,908. Britt has a population of 2,185 and is next largest.

Transportation Facilities

Transportation facilities generally are adequate for the economic enterprises in the county. Every farm is served by a graded and surfaced road. Most of the roads are surfaced with gravel. The main farm-to-market roads are surfaced with bituminous material. Federal and state highways are concrete or concrete surfaced with bituminous material.

U.S. Highway 69 generally runs north and south across the eastern part of the county. U.S. Highway 18 generally runs east and west. It intersects with U.S. Highway 69 in the east-central part of the county. State Highway 111 connects the towns of Woden, Crystal Lake, Britt, and Kanawha; and State Highway 17 runs along the border between Hancock and Kossuth Counties.

Of the two railroads that serve the county, one crosses the eastern part and serves the towns of Goodell, Klemme, Garner, Miller, and Forest City. The other runs from east to west in the center of the county and serves Garner, Britt, and Hutchins. Corwith, Crystal Lake, Hayfield, Kanawha, and Woden do not have railroad service.

Bus transportation is available to towns along the U.S. highways. A regional bus system serves the county. Every trading center is served by motor freight lines. A small airport is located near Forest City.

Business and Industry

Industry provides markets for farm products in the county. Nearly every town has a grain elevator, a feed mill, and a fertilizer plant. Organized livestock auctions are held in Forest City and Garner. Several towns have frozen food locker plants.

Businesses that sell and service farm machinery and supplies operate in several towns in the county. Veterinarian services are readily available. Industry provides several hundred jobs in Forest City and Garner, as well as many jobs at Britt and, to a lesser extent, at Kanawha.

Relief and Drainage

Hancock County has been influenced by four distinct geologic characteristics. The Altamont end moraine dominates the central and south-central parts of the county. It is characterized by nearly level to steep terrain and contains areas, especially in the south-central part of the county, that have the strongest relief and roughest land surface of the county. In the north-central part of the county, glacial outwash is characterized by level to gently sloping terrain that has numerous small depressions and potholes and a few large depressions of muck. The Algona end moraine, extending across the northwestern part of the county, has a physiographic pattern much like that in the south-central part of the county. The rest, and majority, of the county is dominated by a ground moraine that has many small depressions and potholes and a level to strongly sloping landscape pattern.

The south part of Hancock County is drained by the east and west forks of the Iowa River and by the Boone River and its tributaries. Otter Creek, West Otter Creek, and the middle and east branches of the Boone River also drain the southwest part of the county to the south.

Buffalo Creek, Lindner Creek, and Plum Creek drain the northwestern part of the county and flow southwest. The Winnebago River and its tributaries drain the northeast corner of the county and flow east.

In places, the channels of some of these streams have been straightened and deepened. In addition, manmade ditches provide surface drainage and outlets for underground artificial drainage systems.

Natural Resources

Agricultural land is the primary natural resource in Hancock County. Other natural resources include water, sand and gravel, decomposed peat, wildlife, and, to a minor extent, trees.

Hancock County has a good supply of underground water. Wells that are properly drilled rarely fail because of a seasonal lack of water or during periods of drought. Some wells are less than 100 feet deep, but many are as deep as 300 feet or more. Shallow wells and sand points are dependable sources of water in a few areas where the substratum is gravelly. Water quality generally is good, but a few wells have higher than desirable nitrate levels.

Several thousand acres have potential for irrigation. A few shallow wells in an outwash area currently provide water for irrigation on a limited basis. The best potential for irrigation is in areas south of Crystal Lake and southwest of Forest City. These areas have soils that are seasonally droughty.

A few springs, seepy areas, and artesian wells are in the county. A few of these wells have been developed as a source of water for livestock on pasture, as well as for recreation uses. Eagle Lake, Twin Lake, Elrod Sherwood County Park, and areas adjacent to Pilot Knob State Park have been developed as wildlife areas. Smaller, marshy areas are throughout the county. The marshy areas provide many opportunities for hunting and trapping. A few manmade farm ponds, several gravel pits, the Winnebago River, and the Iowa River provide opportunities for fishing.

State parks are located at Eagle Lake and Pilot Knob. Other parks have been developed at points along the Iowa River. Elrod Sherwood Park, in the southeastern part of the county, is developed around a small manmade lake. The parks generally provide facilities for camping, fishing, and picnicking.

Native oak and other trees are harvested on a very limited basis in the county. A decomposed peat is mined and processed for potting soil and horticultural uses from a bog southwest of Garner. A few sand and gravel pits are mined in glacial outwash areas. The sand and gravel are used extensively as road-surfacing material and as concrete aggregate.

Opportunities for hunting, fishing, and trapping are available throughout the county. Migratory waterfowl, deer, rabbit, squirrel, pheasant, and partridge are commonly hunted. Muskrat, raccoon, and mink are among the species commonly trapped.

Farming

In 1983, Hancock County had 332,200 acres of farmland *(10)*. Of this land, 309,800 acres was used for row crops, small grain, or hay. The rest was used for permanent pasture, woods, lots, buildings, or roads or was idle land. Corn was planted on 102,000 acres. It yielded an average of 99.6 bushels per acre. Soybeans were planted on 127,000 acres and yielded an average of 36.7 bushels per acre. Oats were harvested on 4,300 acres. The yield was 60.2 bushels per acre. About 9,800 acres was used for hay of all types *(10)*.

Beef cattle and hogs are the most extensively raised livestock in the county. In 1984, about 12,400 grain-fed cattle and 301,000 hogs were sold. In the same year, 28,200 sows were farrowed. Beef cows totaled 4,600 and milk cows, 1,700. The county had a few sheep and lambs and 37,000 laying hens *(10)*.

In recent years, the number of people living on farms and the number of farms have declined. Farm size has increased. In 1984, the county had 1,150 farms, and the average size farm was 304 acres *(9, 10)*.

Most farms are cash-grain enterprises. Farmers derive most of their income from the sale of corn and soybeans. Many, however, derive a large part of their income from the sale of livestock, especially hogs and beef cattle.

Dairying is a major enterprise on a few farms. The number of dairy farms has been decreasing in recent years, but the size of herds has increased. Some poultry is raised in the county. A recent trend has been toward fewer, but larger, poultry enterprises, mainly those that raise laying hens. Commercial broiler and turkey production is minimal. Sheep are raised on a few farms, but their numbers have declined in recent years. In 1984, the number of sheep was 3,500 head.

Climate

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

Hancock County is cold in winter and is quite hot and has occasional cool spells in summer. Precipitation in winter frequently occurs as snowstorms, and during the warm months it is chiefly showers, often heavy, when warm moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Britt in the period 1951 to 1984. 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 19 degrees F, and the average daily minimum temperature is 9 degrees. The lowest temperature on record, which occurred at Britton January 21, 1970, is -31 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred on August 21, 1955, is 101 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 31.65 inches. Of this, 22 inches, or 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 8.60 inches at Britt on June 18, 1954. Thunderstorms occur on about 43 days each year.

The average seasonal snowfall is about 42 inches. The greatest snow depth at any one time during the period of record was 23 inches. On the average, 12 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration and result in sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

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

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

General Soil Map Units

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

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

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

Soil Descriptions

1. Lester-Kilkenny-Webster Association

Nearly level to steep, well drained and poorly drained, loamy soils that formed in glacial till, in lacustrine sediments and the underlying glacial till, and in glacial till or reworked till; on uplands

This association consists of soils on rolling to steep knobs and side slopes that have nearly level to moderately sloping ridgetops and that are dissected by upland drainageways. Numerous large depressions also are throughout the landscape. Steep knobs and side slopes are dotted with native oaks. Slopes range from 0 to 25 percent.

This association makes up about 3 percent of the county. It is about 37 percent Lester soils, 16 percent Kilkenny soils, 11 percent Webster soils, and 36 percent soils of minor extent (fig. 2).

The well drained Lester soils are on gently sloping and moderately sloping, convex knobs and ridgetops and strongly sloping to steep side slopes. The well drained Kilkenny soils are on gently sloping and moderately sloping, convex knobs and ridgetops and strongly sloping to moderately steep side slopes. Most of the steep areas remain in native hardwoods or are in permanent pasture. The poorly drained Webster soils are mostly in nearly level swales between the knobs and ridges.

Typically, in cultivated areas, the surface layer of the Lester soils is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable and about 31 inches thick. The upper part is brown clay loam, the next part is dark yellowish brown clay loam, and the lower part is dark yellowish brown loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam.

Typically, in cultivated areas, the surface layer of the Kilkenny soils is very dark gray, friable clay loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is firm and about 35 inches thick. The upper part is brown clay; the next part is olive brown clay and light olive brown, mottled clay; and the lower part is light olive brown, mottled clay loam. The substratum to a depth of about 60 inches is mottled grayish brown and light olive brown, calcareous clay loam in the upper part and mottled grayish brown and light olive brown, calcareous loam in the lower part.

Typically, the surface layer of the Webster soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 12 inches thick. The upper part is black, and the lower part is black with mottles. The subsoil is friable and about 21 inches thick. The upper part is dark gray and olive gray, mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

The minor soils in this association are the Collinwood, Houghton, Nicollet, Okoboji, Storden, and

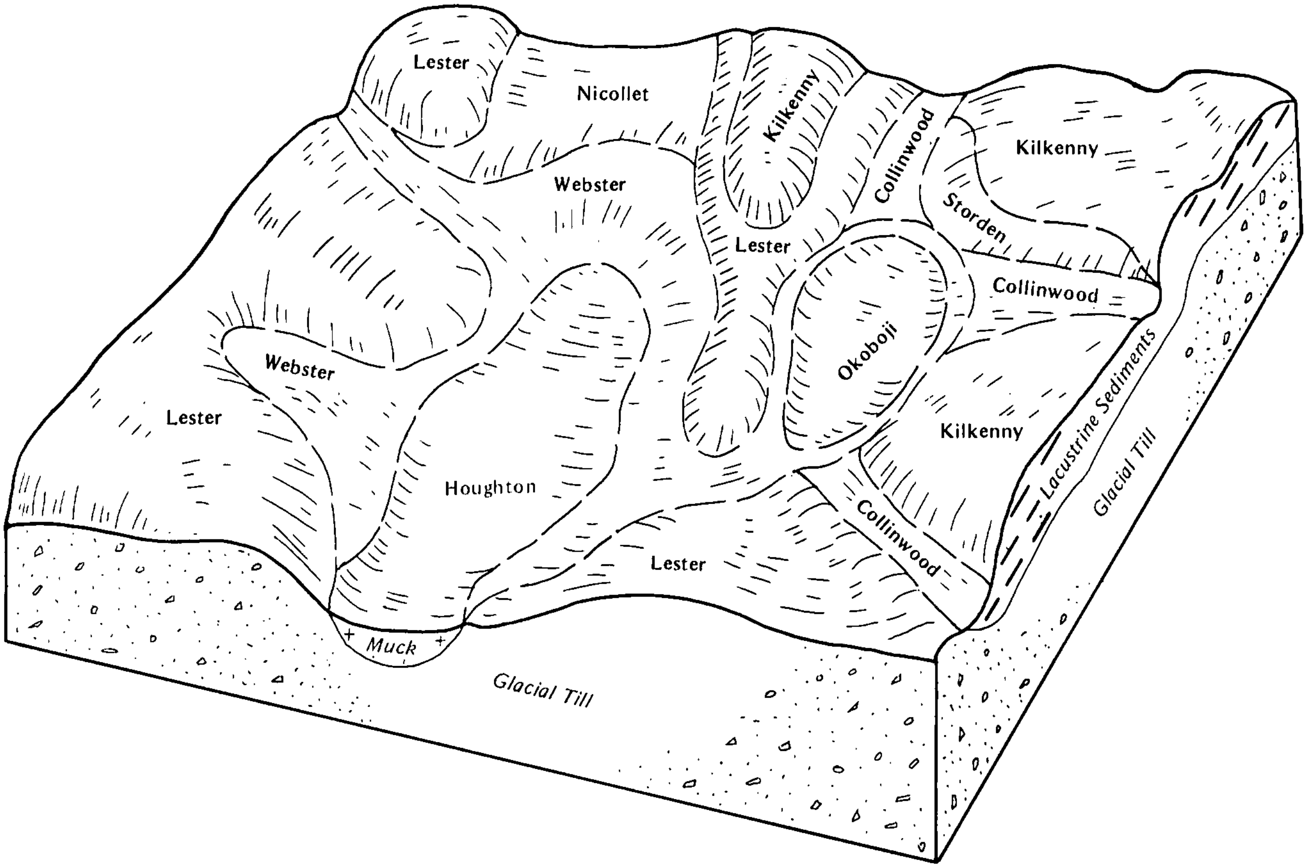

Figure 2.—Typical pattern of soils and parent material in the Lester-Kilkenny-Webster association.

Waldorf soils. The somewhat poorly drained Collinwood soils formed in thick lacustrine sediments and are on low rises on ridgetops and concave side slopes. The very poorly drained Houghton soils formed in thick organic deposits in large depressions. The somewhat poorly drained Nicollet soils formed in glacial till and are on very gently sloping, slightly convex to concave slopes. The very poorly drained Okoboji soils formed in sediments derived from glacial till, have a thick, dark colored surface layer, and are in depressions. The well drained, calcareous Storden soils are on the steepest part of the slope adjacent to the Lester and Kilkenny soils. The poorly drained Waldorf soils formed in clayey, lacustrine sediments and are in concave swales between the Lester and Kilkenny soils.

This association is used mainly for general farming. It ranges from well suited to unsuited for cultivated crops. Suitability for cultivated crops is dependent mainly on the degree of slope. The nearly level soils, except for the Houghton and Okoboji soils, and the gently sloping soils are only moderately suited to cultivated crops. The rest of the soils are moderately suited to unsuited to cultivated crops, depending on the degree of slope. Those areas that are too steep for crops are used as hayland or pasture or are left in trees. Corn and soybeans are the main crops, but oats and hay and pasture crops are frequently grown. Most of the Lester and Kilkenny soils on steep slopes remain in trees, mainly oak. The Lester and Kilkenny soils are moderate in content of organic matter. The available water capacity is high in most of the soils, but it is very high in Houghton soils. However, this capacity may not be reached on the more sloping soils because of rapid runoff.

The main management needs are water erosion control, drainage improvement, and maintenance of tilth. Water erosion is a serious hazard in this association. Steep, complex slopes, low organic matter content, and reduced infiltration because of the finer textured Kilkenny soils increase the rate of runoff. As a result, immediate control of water erosion to prevent lasting damage is a greater need on these soils than on soils in other associations. Additional water erosion control practices are needed to slow runoff and allow increased infiltration. These include terracing, contouring, constructing grassed waterways, and applying a system of conservation tillage that leaves crop residue on the surface. All these practices are suitable to use in this association, but in places terracing and contouring are difficult because of short, complex slopes. Also, some slopes are too steep for these practices. Maintaining tilth is a problem, especially on the finer textured Kilkenny soils if they are tilled when wet. Drainage is adequate in most places in this area, although in Houghton soils maintaining and improving drainage and finding suitable tile outlets are problems. Potential is good for improving wildlife habitat for both upland and wetland species in this association.

2. Canisteo-Webster-Nicollet Association

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

This association consists of soils on convex slopes and nearly level to slightly concave slopes. The landscape is nearly level to gently undulating. Slopes range from 0 to 3 percent.

This association makes up about 16 percent of the county. It is about 30 percent Canisteo soils, 25 percent Webster soils, 23 percent Nicollet soils, and 22 percent soils of minor extent.

The poorly drained Canisteo and Webster soils are in nearly level areas and swales on uplands. The Canisteo soils are calcareous, and the Webster soils are in slightly higher positions than the Canisteo soils. The Nicollet soils are somewhat poorly drained and are on very gently sloping rises and concave side slopes on uplands.

Typically, the surface layer of the Canisteo soils is black, friable, calcareous clay loam about 8 inches thick. The subsurface layer is friable, calcareous clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and has mottles. The subsoil is friable and calcareous and is about 22 inches thick. The upper part is dark gray mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Webster soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 12 inches thick. The upper part is black, and the lower part is black and has mottles. The subsoil is friable and about 21 inches thick. The upper part is olive gray and dark gray, mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Nicollet soils is black, friable loam about 9 inches thick. The subsurface layer is friable clay loam about 11 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is friable and about 21 inches thick. The upper part is dark grayish brown and olive brown clay loam; the next part is dark grayish brown, mottled loam; and the lower part is dark grayish brown and grayish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is mottled, light olive brown and grayish brown, calcareous loam.

The minor soils in this association are the Clarion, Harps, and Okoboji soils. Clarion soils are well drained and are on convex knolls, ridges, and side slopes on uplands. The poorly drained Harps soils are highly calcareous and are on rims surrounding depressional areas. The very poorly drained Okoboji soils formed in sediments derived from glacial till, have a thick, dark surface layer, and are in depressional areas.

This association is well suited to cultivated crops, and most of the acreage is used as cropland. Corn and soybeans are the main crops. Some oats and crops for rotation hay and as pasture, including alfalfa and alfalfa-grass mixtures, are also grown. Organic matter content and available water capacity are high. Crops respond well to fertilization.

The main concerns of management are drainage, soil blowing, water erosion, and maintaining fertility. Water erosion is a hazard in a few areas of the minor Clarion soils. Flooding and ponding are common on some of the minor soils in late winter and early spring and following heavy rains. On the Harps soils, low fertility and herbicide carry-over from year to year are management concerns. Most areas are tile drained, but in places additional tile is needed. In areas where large tracts are fall plowed and the surface is left bare, soil blowing is a management concern.

3. Canisteo-Nicollet-Clarion Association

Nearly level to strongly sloping, poorly drained,

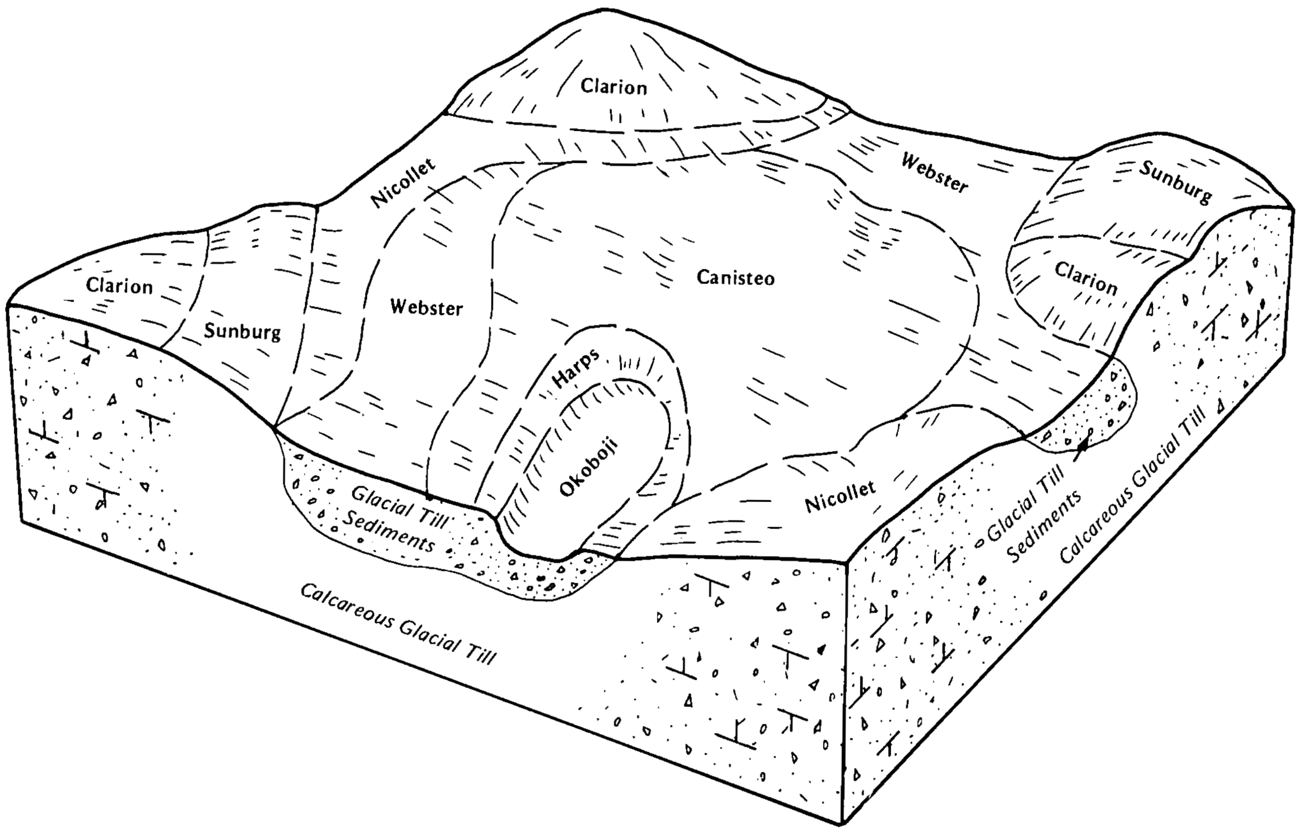

Figure 3.—Typical pattern of soils and parent material in the Canisteo-Nicollet-Clarion association.

somewhat poorly drained, and well drained, loamy soils that formed in glacial till or reworked till; on uplands

This association consists of soils on convex knolls and ridges and on slightly convex to nearly level and slightly concave slopes. The landscape is nearly level to rolling. Slopes range from 0 to 14 percent.

This association makes up about 54 percent of the county. It is about 30 percent Canisteo soils, 20 percent Nicollet soils, 16 percent Clarion soils, and 34 percent soils of minor extent (fig. 3).

The poorly drained, nearly level Canisteo soils are on upland flats and swales. The somewhat poorly drained, very gently sloping Nicollet soils are on low rises and concave side slopes on uplands. The well drained, gently sloping to strongly sloping Clarion soils are on convex knolls, ridges, and side slopes on uplands.

Typically, the surface layer of the Canisteo soils is black, friable, calcareous clay loam about 8 inches thick. The subsurface layer is friable, calcareous clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and has mottles. The subsoil is friable and calcareous, and is about 22 inches thick. The upper part is dark gray, mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Nicollet soils is black, friable loam about 9 inches thick. The subsurface layer is friable clay loam about 11 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is friable and about 21 inches thick. The upper part is dark grayish brown, and olive brown clay loam; the next part is dark grayish brown, mottled loam; and the lower part is dark grayish brown and grayish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is mottled, light olive brown and grayish brown, calcareous loam.

Typically, the surface layer of the Clarion soils is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 13 inches thick. The upper part is very dark brown and the lower part is very dark grayish brown. The subsoil is friable loam about 24 inches thick. The upper part is brown and dark yellowish brown, and the lower part is dark yellowish brown and yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

The minor soils in this association are the Crippin, Harps, Okoboji, Sunburg, and Webster soils. The somewhat poorly drained Crippin soils are calcareous throughout and are on low rises within large areas of the Canisteo soils. The poorly drained Harps soils are highly calcareous and are on rims surrounding depressional areas. The very poorly drained Okoboji soils formed in sediments derived from glacial till, have a thick dark surface soil, and are in depressional areas. Sunburg soils are calcareous throughout and typically are upslope or adjacent to the Clarion soils on the more convex parts of slopes. Webster soils do not have free carbonates in the solum and are on upland flats and swales.

This association is well suited to crops, and most of the acreage is used as cropland. Corn and soybeans are the main crops. Some oats and crops for rotation hay and pasture, including alfalfa and alfalfa-grass mixtures, are also grown. Organic matter content is moderate or high, and available water capacity is high. Crops respond well to fertilization.

The more sloping soils of this association need protection from water erosion. In places contour tillage and terracing are somewhat difficult because of the irregular pattern of slopes. In areas where large tracts are fall plowed and the surface is left bare, soil blowing is a hazard. The nearly level, poorly drained soils and the very poorly drained soils in depressions generally are tile drained to provide best crop production. Maintaining fertility and tilth are other important management concerns in this association. On the Harps and Sunburg soils, low fertility and herbicide carry-over are management concerns.

4. Fieldon-Harcot-Ridgeport Association

Nearly level to gently sloping, poorly drained and somewhat excessively drained, loamy soils that formed in loamy sediments that overlie sand or sand and gravel; on outwash plains and stream terraces

This association consists of soils that are nearly level to undulating. Slopes range from 0 to 5 percent.

This association makes up about 10 percent of the county. It is about 22 percent Fieldon and similar soils, 18 percent Harcot and similar soils, 15 percent Ridgeport and similar soils, and 45 percent soils of minor extent (fig. 4).

The poorly drained, nearly level Fieldon soils are in broad, flat areas. The poorly drained, nearly level Harcot soils are on the rims of depressions. The somewhat excessively drained, nearly level and gently sloping Ridgeport soils are on slightly convex slopes. In places they are the highest soils on the landscape.

Typically, the surface layer of the Fieldon soils is black, friable, calcareous loam about 7 inches thick. The subsurface layer is friable, calcareous sandy clay loam about 14 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is very friable, calcareous fine sandy loam that has mottles. It is about 15 inches thick. The upper part is olive gray, and the lower part is olive gray and pale olive. The substratum to a depth of about 60 inches is mottled, olive gray and light olive brown, calcareous loamy fine sand.

Typically, the surface layer of the Harcot soils is black, friable, calcareous clay loam about 9 inches thick. The subsurface layer is friable and calcareous, and is about 11 inches thick. The upper part is black loam, and the lower part is very dark gray sandy loam. The subsoil is olive gray, mottled, very friable, calcareous sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is olive gray and olive, calcareous fine sand.

Typically, the surface layer of the Ridgeport soils is black, very friable sandy loam about 10 inches thick. The subsurface layer is very dark gray, very friable sandy loam about 9 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 10 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous, gravelly loamy sand.

The minor soils in this association are the Biscay, Fostoria, Linder, Okoboji, and Palms soils. The poorly drained Biscay soils are not calcareous in the solum and are nearly level in outwash areas. The somewhat poorly drained Fostoria soils formed in glacial lacustrine sediments or glacial drift and are on slight rises that have a silty substratum. The somewhat poorly drained Linder soils are on slight rises that formed in loamy alluvium. The very poorly drained Okoboji soils have a deep, dark, surface soil. The very poorly drained Palms soils formed in organic deposits. Okoboji and Palms soils are in depressions.

This association is used mainly for cultivated crops. It ranges from well suited to moderately suited for row crops. Corn and soybeans are the main crops. Some oats and crops for rotation hay and pasture, including

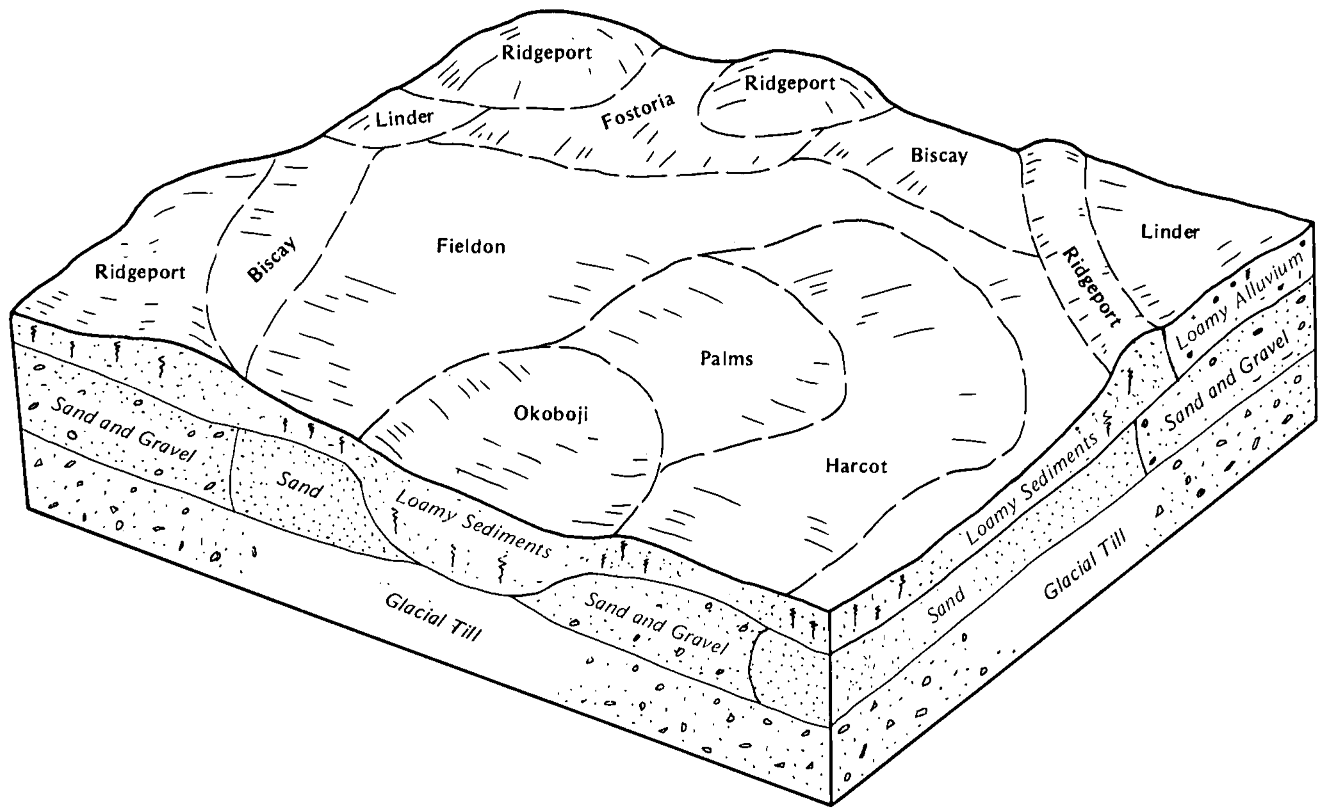

Figure 4.—Typical pattern of soils and parent material in the Fieldon-Harcot-Ridgeport association.

alfalfa and alfalfa-grass mixtures, are also grown. Organic matter content is moderate or high, and available water capacity is moderate.

The main concerns of management are droughtiness, drainage, water erosion, soil blowing, and maintaining tilth and fertility. Some areas tend to be droughty, especially in years when rainfall is below average or when rains are not timely. A system of conservation tillage that leaves most of the crop residue on or mixed in the soil surface is effective in reducing erosion, conserving soil moisture, and maintaining tilth. Most areas are drained, but in some places additional drainage is needed. Ponding is common on some soils during periods of heavy rain, especially in early spring. Low fertility and herbicide sensitivity and carry-over are management concerns on the Harcot soils.

5. Truman-Estherville-Webster Association

Nearly level to strongly sloping, well drained, somewhat excessively drained, and poorly drained, silty and loamy soils that formed in reworked glacial till and the underlying glacial outwash, in glacial outwash, and in glacial till or reworked till; on uplands, outwash plains, and stream terraces

This association consists of soils on nearly level to gently undulating slopes and on interwoven, concave drainageways. In a few places the landscape relief is interrupted by nearly level to undulating ridgetops. The ridgetops have gently rolling or rolling side slopes and are adjacent to large upland depressions containing organic deposits. In places depth to sandy material is quite variable within short distances. Slopes range from 0 to 14 percent.

This association makes up about 3 percent of the county. It is about 32 percent Truman and similar soils, 15 percent Estherville soils, 13 percent Webster and similar soils, and 40 percent soils of minor extent (fig. 5).

The well drained Truman soils are on nearly level or gently sloping, convex slopes. The somewhat excessively drained Estherville soils are on nearly level to strongly sloping, convex side slopes and knolls. The

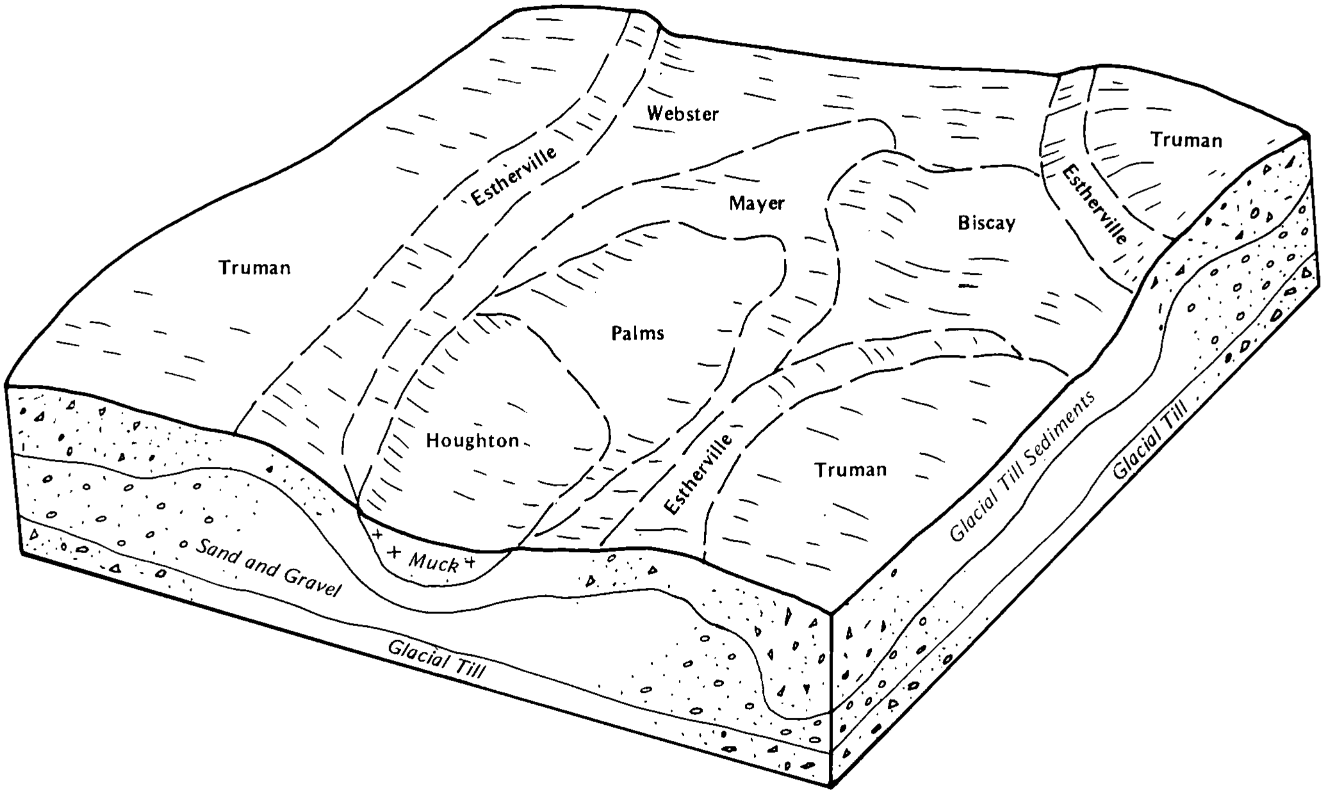

Figure 5.—Typical pattern of soils and parent material in the Truman-Estherville-Webster association.

poorly drained Webster soils are on nearly level slopes and in concave drainageways.

Typically, the surface layer of the Truman soils is black, friable silty clay loam about 9 inches thick. The subsurface layer is friable silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown. The subsoil is friable and about 28 inches thick. The upper part is brown silty clay loam; the next part is dark yellowish brown, mottled silty clay loam; and the lower part is dark yellowish brown, mottled loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown, mottled fine sandy loam.

Typically, the surface layer of the Estherville soils is very dark gray, friable loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable loam about 5 inches thick. The subsoil is about 12 inches thick. The upper part is brown, friable sandy loam; and the lower part is dark yellowish brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown, calcareous sand.

Typically, the surface layer of the Webster soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 12 inches thick. The upper part is black, and the lower part is black and has mottles. The subsoil is friable and about 21 inches thick. The upper part is olive gray and dark gray, mottled clay; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

The minor soils in this association are the Biscay, Houghton, Mayer, and Palms soils. The calcareous Mayer soils formed in glacial outwash in nearly level positions. The very poorly drained Houghton and Palms soils are in large depressions and formed in thick or moderately thick organic deposits.

This association is used mainly for cultivated crops. It ranges from well suited to poorly suited for cultivated crops. Corn and soybeans are the main crops. Some of the steeper areas are better suited to small grains and to grasses and legumes for hay or pasture. Organic matter content and available water capacity range from high to low.

The main concerns of management in this association are droughtiness, water erosion control, and drainage. Some areas tend to be droughty, especially in years when rainfall is below average or when rains are untimely. Water erosion is a severe hazard in the steeper areas in the association. Soil blowing is a common hazard because of the rapid drying of the surface soil after tillage. Blowing sand may sometimes damage young plants. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing, and conserves moisture for crop use. Drainage improvement is needed in major soils and in some areas of minor soils. Existing tile lines do not have the capacity needed during periods of high rainfall. Suitable outlets are not always available on Houghton and Palms soils. In places, the substratum of some poorly drained soils contains a high amount of fine sand, which becomes unstable during periods of high rainfall. In larger field tile, this instability may cause "back-fall." This instability may allow larger field tile to move out of position, which reduces the capacity of the tile line to carry water.

6. Ridgeport-Coland-Truman Association

Nearly level to gently sloping, somewhat excessively drained, poorly drained, and well drained, loamy and silty soils that formed in loamy sediments and the underlying sand and gravel, in alluvium, and in reworked glacial till and the underlying glacial outwash; on outwash plains, bottom land, and stream terraces

This association consists of soils on bottom land, in broad outwash areas, and on broad stream terraces. In some areas the bottom land soils are covered with grasses or marsh-type vegetation. In places are a few scattered trees. Many areas are cut by meandering channels and oxbows. Slopes range from 0 to 5 percent.

This association makes up about 3 percent of the county. It is about 27 percent Ridgeport and similar soils, 18 percent Coland soils, 17 percent Truman soils, and 38 percent soils of minor extent.

The somewhat excessively drained Ridgeport soils are on nearly level, gently sloping rises on stream terraces and outwash plains. The poorly drained Coland soils are in nearly level positions on bottom land. The well drained Truman soils are on nearly level, gently sloping rises on stream terraces.

Typically, the surface layer of the Ridgeport soils is black, very friable sandy loam about 9 inches thick. The subsurface layer is very dark gray, very friable sandy loam about 10 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous, gravelly loamy sand.

Typically, the surface layer of the Coland soils is black, friable clay loam about 8 inches thick. The subsurface layer is black, friable clay loam about 37 inches thick. The substratum to a depth of about 60 inches is black clay loam.

Typically, the surface layer of the Truman soils is black, friable silty clay loam about 9 inches thick. The subsurface layer is friable silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown. The subsoil is friable and about 28 inches thick. The upper part is brown silty clay loam; the next part is dark yellowish brown, mottled silty clay loam; and the lower part is dark yellowish brown, mottled loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown, mottled fine sandy loam.

The minor soils in this association are the Biscay, Calco, Linder, and Mayer soils. The poorly drained Biscay soils contain sand and gravel in the substratum and are on nearly level stream terraces and in outwash areas. The calcareous Calco soils have a thick, dark surface soil and are on bottom land. The somewhat poorly drained Linder soils are on slightly convex rises in outwash areas and on stream terraces. The poorly drained, calcareous Mayer soils contain sand and gravel in the substratum and are in nearly level outwash areas and stream terraces.

Most areas of this association are used for cultivated crops, hay, and pasture, but a few areas are used as permanent pasture, wasteland, or wildlife habitat. Most of the soils in outwash areas are used for corn, soybeans, oats, hay, and rotation pasture. About half of the areas of Coland soils are used for cultivated crops, but the rest are used as pasture. In places the Coland soils are cut by meandering channels, are subject to frequent flooding, and remain flooded long enough for crop production to be impossible. Some areas that are low lying and wet are managed as wildlife habitat. Coland and Calco soils formed in alluvium, have a high content of organic matter, and are high in available water holding capacity. In outwash areas and on stream terraces, the soils mostly have low to moderate content of organic matter and generally are low or moderate in available water capacity. Crop growth and yields are variable, but in most years they are only moderate or, at best, moderately high because of droughtiness of the soils.

On Coland soils flooding is a management concern. On Ridgeport soils water erosion, soil blowing, and droughtiness are management problems. At present, management alternatives are few on the Coland soils. On the Ridgeport soils, a system of conservation tillage that leaves crop residue on or mixed on the surface helps to control soil blowing and water erosion and helps to conserve available water.

7. Bode-Collinwood-Waldorf Association

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

This association consists of soils on nearly level, high, almost circular ridgetops or hummocks with moderately sloping and strongly sloping side slopes. Concave swales and upland drainageways wind between the hummocks. In nearly level, high areas the soils formed in lacustrine sediments. On side slopes the soils formed dominantly in glacial sediments overlying glacial till. In the concave areas the soils formed in lacustrine sediments, glacial sediments, or the underlying glacial till. Slopes range from 0 to 18 percent.

This association makes up about 8 percent of the county. It is about 32 percent Bode and similar soils, 22 percent Collinwood and similar soils, 15 percent Waldorf and similar soils, and 31 percent soils of minor extent (fig. 6).

The well drained Bode soils are on gently sloping to moderately steep, convex side slopes and knolls on uplands. The somewhat poorly drained Collinwood soils are on low rises on ridgetops and concave side slopes on uplands. The poorly drained Waldorf soils are in nearly level swales and flats on uplands.

Typically, the surface layer of the Bode soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 9 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil is friable clay loam about 22 inches thick. The upper part is brown, and the lower part is dark yellowish brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

Typically, the surface layer of the Collinwood soils is black, firm silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay about 9 inches thick. The subsoil is firm silty clay about 19 inches thick. The upper part is dark grayish brown, the next layer is dark grayish brown and mottled, and the lower part is grayish brown and mottled. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Typically, the surface layer of the Waldorf soils is black, firm silty clay about 8 inches thick. The subsurface layer is firm silty clay about 13 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is olive gray, mottled, firm silty clay about 16 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam.

The minor soils in this association are the Canisteo, Harps, Nicollet, Okoboji, and Storden soils. The poorly drained, calcareous Canisteo soils formed in glacial till or sediments and are on upland flats and swales. The poorly drained Harps soils are highly calcareous and are on rims surrounding depressions. The somewhat poorly drained Nicollet soils are on low rises and slightly concave side slopes on uplands. The very poorly drained Okoboji soils are in slightly depressional areas and are very near Waldorf and Canisteo soils. The well drained, calcareous Storden soils are on the most convex parts of slopes, generally adjacent to Bode soils.

This association is used mainly for general farming. The soils range from well suited to poorly suited for cultivated crops. They are nearly level to gently sloping and generally are well suited to cultivated crops. The rest of the soils are moderately suited or poorly suited, depending on steepness of slope. In a few areas, slopes are too steep for cropping and are generally used as pasture. Corn and soybeans are the main crops. Oats and crops for hay and pasture are frequently grown on a significant acreage. Organic matter content is high in the major soils and most minor soils. Available water capacity is high, but this capacity may not be reached in some years on the more sloping soils because of runoff.

Management needs mainly are erosion control, maintenance of tilth, and, in some areas, drainage improvement. Additional fertility management is a concern in areas of Storden soils. Wind erosion and especially water erosion are serious hazards. Steep slopes and reduced infiltration because of the fine textured soils cause a greater rate of runoff than on soils in some other associations. Erosion control practices, such as terracing, contouring, and applying a system of conservation tillage that leaves crop residue

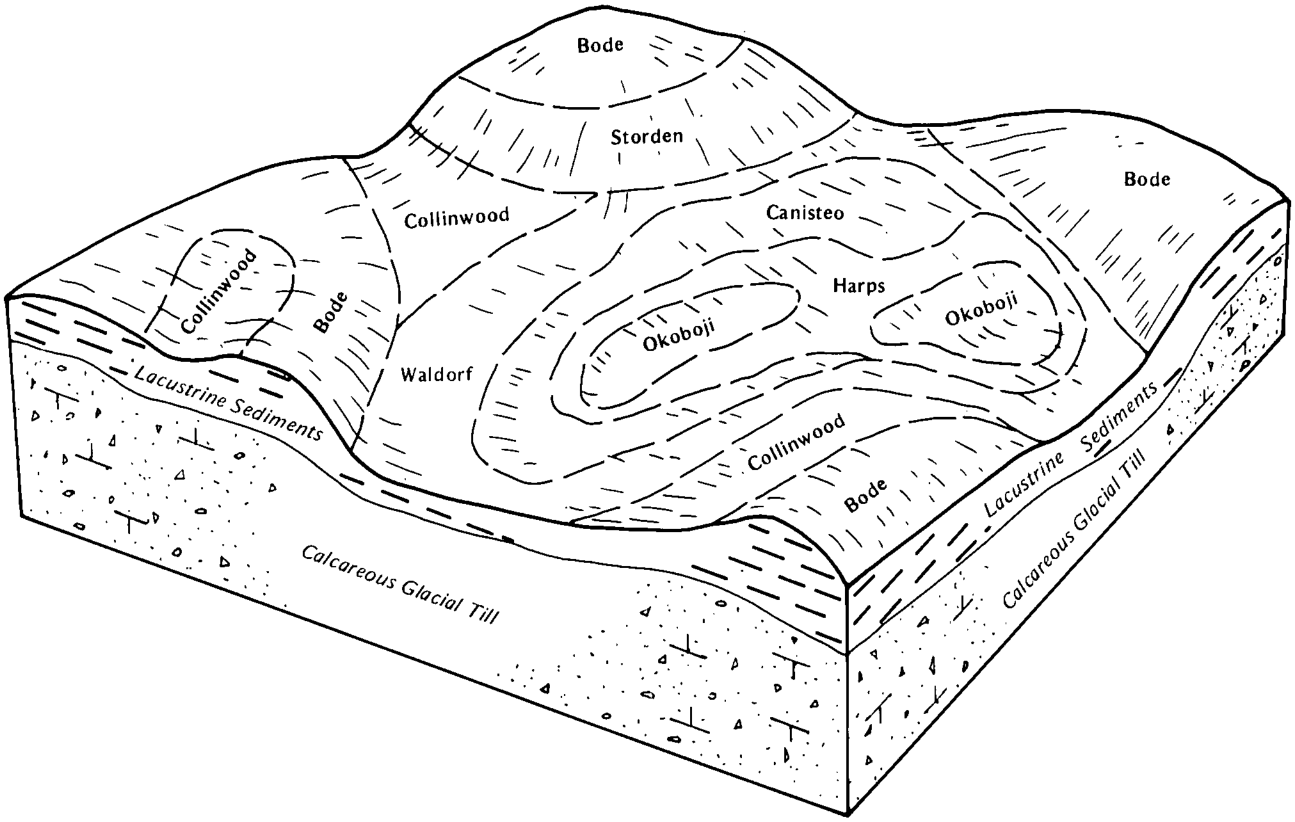

Figure 6.—Typical pattern of soils and parent material in the Bode-Collinwood-Waldorf association.

on the surface, are needed to reduce runoff and to increase the infiltration rate. These practices are suitable on these soils, but in places contouring and terracing are difficult because of a complex pattern of slopes. These soils are slower to dry and more difficult to till than other soils because of the higher clay content. Conservation tillage and terrace channels that retard waterflow tend to further delay drying, which puts additional stress on management, especially timely seedbed preparation and planting.

Maintenance of tilth is a problem. These soils need to be tilled at the best moisture content. If worked when too wet, they dry out cloddy and hard; when tilled too dry, they are hard and difficult to work. Areas of poorly drained soils within the association generally have been drained, but tile drains work more slowly and closer spacing is required because of the high clay content of these soils.

8. Bode-Kossuth-Ottosen Association

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

This association consists of broad, nearly level areas that have many slight convex rises. Relief on this association generally is less than 10 feet, but along the fringes, where it is gently rolling, it ranges from 15 to 20 feet. The landscape generally does not have depressions. Most parts of this association do not have a natural drainage pattern but are extensively drained by underground drainage systems. Drainage ditches and streams provide outlets for most of these drains. Slopes range from 0 to 9 percent.

This association makes up about 3 percent of the county. It is about 23 percent Bode soils, 19 percent

Kossuth soils, 19 percent Ottosen soils, and 39 percent soils of minor extent.

The well drained Bode soils are on gently sloping and moderately sloping, convex ridges or knobs and side slopes. The poorly drained Kossuth soils are in swales and nearly level positions. The somewhat poorly drained Ottosen soils are in very gently sloping, convex and concave positions. The Kossuth and Ottosen soils are in lower landscape positions than Bode soils.

Typically, the surface layer of the Bode soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 9 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil is friable clay loam about 22 inches thick. The upper part is brown, and the lower part is yellowish brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

Typically, the surface layer of the Kossuth soils is black, firm silty clay loam about 7 inches thick. The subsurface layer is firm silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is about 19 inches thick. The upper part is olive gray, mottled, firm silty clay loam; and the lower part is olive gray, mottled, friable, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Ottosen soils is black, friable clay loam about 8 inches thick. The subsurface layer is friable and about 11 inches thick. The upper part is black clay loam, and the lower part is very dark grayish brown silty clay loam. The subsoil is friable and about 16 inches thick. The upper part is dark grayish brown silty clay loam; and the lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is mottled, olive gray and olive brown, calcareous loam.

The minor soils in this association are the Canisteo, Clarion, Harps, Nicollet, and Okoboji soils. The poorly drained Canisteo soils are calcareous, are in swales and nearly level areas, and formed in glacial till or sediments. Canisteo soils are in similar landscape positions as Kossuth soils. The well drained Clarion soils are on convex knobs, hills, and side slopes. The poorly drained Harps soils are highly calcareous and are on the rims of depressions. The somewhat poorly drained Nicollet soils are on low rises and slightly concave side slopes adjacent to Clarion soils. The very poorly drained Okoboji soils are in depressions.

This association is well suited to crops, and nearly all of its acreage is used as cropland. Corn and soybeans are the main crops. Some oats and crops for rotation hay and pasture, including alfalfa and alfalfa-grass mixtures, are also grown. A few areas of this association, mostly along farmsteads, are used for permanent pasture. Organic matter content is moderate or high, and available water capacity is high. Crops respond well to fertilization.

The main concerns of cropland management are maintaining and improving drainage and maintaining tilth and fertility. Flooding and ponding are common on some of the minor and major soils of this association in late winter, early spring, and after heavy rains. In a few areas of Bode and Clarion soils, particularly those adjacent to drainageways, water erosion control practices are needed. Soil blowing is a concern in areas where large tracts are fall plowed and the surface is left bare. On Harps soils, particular attention to fertility needs is necessary for best yields. Most areas are drained, but in some places additional drainage is needed. Because of the high clay content and low sand content, the soils in this association remain wet and sticky for long periods following rains. If worked when too wet, they dry out cloddy and hard; if tilled when too dry, they are hard and difficult to work.

Detailed Soil Map Units

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

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

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

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

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

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

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

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

Soil Descriptions

6—Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in shallow upland depressions (fig. 7). It is subject to ponding. Individual areas are circular. They mainly range from 2 to 25 acres in size, but some are as large as 40 acres.

Typically, the surface layer is black, firm silty clay loam about 9 inches thick. The subsurface layer is black and firm, and about 27 inches thick. The upper part is silty clay loam, and the lower part is silty clay. The subsoil is mottled and firm, and is about 10 inches thick. The upper part is very dark gray silty clay, and the lower part is olive gray silty clay loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In places the surface layer contains more sand.

Included with this soil in mapping are a few small areas of Harps soils. Harps soils are on rims of depressions, are poorly drained, and are highly

Figure 7.—Small depression, or pothole, in an area of Okoboji silty clay loam, 0 to 1 percent slopes. This soil is frequently ponded after rains, and crops are often damaged.

calcareous. They make up less than 5 percent of the map unit.

Permeability of this Okoboji soil is moderately slow, and runoff is slow to ponded. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 9 to 12 percent in the surface layer. The subsurface layer generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. The seasonal high water table is the main limitation. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Timely tillage operations are needed to maintain tilth in the surface layer. Chisel plowing makes the surface more pervious to water and increases the infiltration rate. Cultivating when the soil is too wet causes surface compaction and cloddiness.

This soil is poorly suited to some legumes, especially alfalfa. Ponding and soil heaving in winter frequently drown out or kill crops. If this soil is used as pasture, grasses and legumes that tolerate excessive wetness should be grown. Grazing when the soil is wet causes surface compaction and poorer tilth. Some areas are suitable for use as wildlife habitat (fig. 8).

The land capability classification is IIIw.

28—Dickman sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is mainly on uplands and outwash plains. Individual areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown, very friable sandy loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown, very friable sandy loam about 8 inches thick. The subsoil is loamy sand about 20 inches thick. The upper part is dark brown and very friable, the next part is dark brown and brown and very friable, and the lower part is dark yellowish brown and loose. The substratum to a depth of about 60 inches is yellowish brown sand. In places the surface layer is thicker than 24 inches. In some places a loamy substratum is at a depth of more than 42 inches.

Included with this soil in mapping are a few small areas of low-lying, slightly concave, wetter soils. They make up less than 5 percent of the map unit.

Permeability of this Dickman soil is moderately rapid in the upper part of the solum and rapid in the lower part. Runoff is slow. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Figure 8.—Dug pond, in an undrained area of Okoboji silty clay loam, 0 to 1 percent slopes. This pond is valuable for livestock production and wildlife habitat.

Most areas are cultivated because they are small and generally near soils that are better suited to cultivation. This soil is poorly suited to cultivated crops. The low available water capacity is the main limitation. If the soil is used for cultivated crops, water erosion and soil blowing are hazards. This soil is better suited to small grain than to row crops because of the low available water capacity. Soil blowing is a hazard because the surface dries out quickly after tillage. In some years windblown sand damages young plants. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to maintain tilth, and improve available water capacity.

The use of this soil as pastureland is effective in controlling water erosion. Overgrazing, however, increases runoff and exposes the surface layer to soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extremely dry periods help to keep the pasture in good condition.

The land capability classification is IIIs.

28B—Dickman sandy loam, 2 to 5 percent slopes. This gently sloping, well drained soil is mainly on uplands and outwash plains. Individual areas range from 2 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown, very friable sandy loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown, very friable sandy loam about 8 inches thick. The subsoil is loamy sand about 18 inches thick. The upper part is dark brown and very friable, the next part is dark brown and brown and very friable, and the lower part is dark yellowish brown and loose. The substratum to a depth of about 60 inches is yellowish brown sand. In a few places the surface layer is less than 10 inches thick. In some places a loamy substratum is at a depth of more than 42 inches.

Included with this soil in mapping are a few small areas of Salida soils. The excessively drained Salida soils are on the steeper parts of slopes. They make up less than 5 percent of the map unit.

Permeability of this Dickman soil is moderately rapid in the upper part of the solum and rapid in the lower part. Runoff is slow. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated because they are small and generally near soils that are better suited to cultivation. This soil is poorly suited to cultivated crops. If it is used for cultivated crops, water erosion and soil blowing are hazards. This soil is better suited to small grain than to row crops because of the low available water capacity. Soil blowing is a hazard because the surface dries out quickly after tillage. In some years windblown sand damages young plants. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to maintain tilth, and improve available water capacity.

The use of this soil as pasture is effective in controlling erosion. Overgrazing, however, increases runoff and exposes the surface layer to soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extremely dry periods help to keep the pasture in good condition.

The land capability classification is IIIe.

28D2—Dickman sandy loam, 5 to 14 percent slopes, moderately eroded. This moderately sloping and strongly sloping, well drained soil is mainly on uplands and outwash plains. Individual areas range from 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable sandy loam about 6 inches thick. Plowing has mixed some streaks and pockets of dark brown subsoil material into the surface layer. The subsoil is about 25 inches thick. The upper part is dark brown, very friable sandy loam; the next part is dark brown and brown, very friable loamy sand; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is yellowish brown sand. In a few places the surface layer is thicker.

Included with this soil in mapping are a few small areas of Salida soils. The excessively drained Salida soils are on the steeper parts of slopes. They make up less than 5 percent of the map unit.

Permeability of this Dickman soil is moderately rapid in the upper part of the solum and rapid in the lower part. Runoff is medium. Available water capacity is low. The content of organic matter is less than 0.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has poor tilth.

Most areas are cultivated because they are small and generally near soils that are better suited to cultivation. A few larger areas are managed separately. This soil is poorly suited to cultivated crops. If it is used for cultivated crops, further water erosion is a hazard.

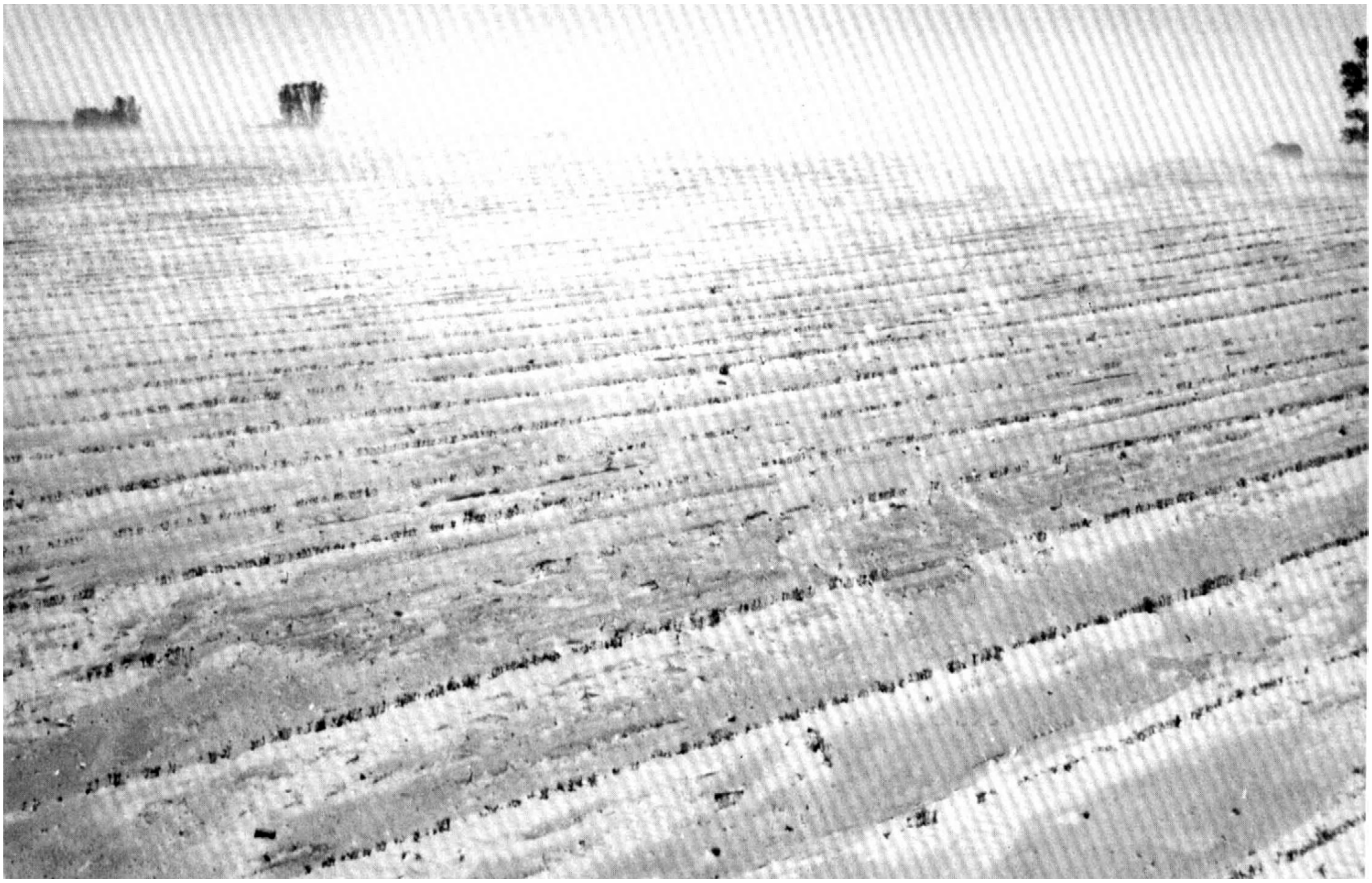

Figure 9.—Windblown sand on Dickman sandy loam, 5 to 14 percent slopes, moderately eroded, damages soybean seedlings.

This soil is better suited to small grain than to row crops because of the low available water capacity. Soil blowing is a hazard because the surface dries out quickly after tillage. In some years windblown sand damages young plants (fig. 9). A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil blowing. Applying mechanical erosion-control practices, such as terracing, is difficult because the soil is unstable. Also, deep cuts may expose the sandy subsoil, which is low in organic matter and fertility. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to maintain tilth, and increase available water capacity.

The use of this soil as pasture is effective in controlling water erosion and soil blowing. Overgrazing, however, increases runoff and exposes the surface layer to soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extremely dry periods help to keep the pasture in good condition.

The land capability classification is IVe.

52B—Bode clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on upland knolls. Areas range from 5 to 10 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 9 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil is friable clay loam about 22 inches thick. The upper part is brown, and the lower part is dark yellowish brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

Included with this soil in mapping are a few small areas of well drained Storden soils. Storden soils do not have a subsoil, are calcareous throughout the profile, and are in similar landscape positions. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing (fig. 10) are practical in some areas but are not feasible in undulating areas where slopes are short. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and prevent surface crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling water erosion. Overgrazing or grazing when the soil is too wet, however, results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The land capability classification is IIe.

52C2—Bode clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes on uplands. Slopes typically are short. Areas range from 5 to 15 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable clay loam about 6 inches thick. Plowing has mixed some streaks and pockets of brown subsoil into the surface layer. The subsoil is friable clay loam about 24 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is mottled light olive brown and grayish brown, calcareous clay loam. In places the surface layer is thicker.

Included with this soil in mapping are a few small areas of well drained Storden soils. Storden soils are calcareous throughout the profile and are in similar landscape positions. They make up about 5 to 10 percent of the map unit.

Permeability of this Bode soil is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 2.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, terracing, contour farming, and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas, but are not feasible in undulating areas where slopes are short. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and prevent surface crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIe.

52D2—Bode clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on knolls and convex side slopes on uplands. Individual areas range from 5 to 10 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable clay loam about 21 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is mottled light olive brown and grayish brown, calcareous clay loam. In a few places the surface layer is thicker.

Included with this soil in mapping are a few areas of well drained Storden soils. Storden soils are calcareous throughout the profile and are on the steeper parts of slopes. They make up about 10 percent of the map unit.

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

Figure 10.—Terraces help to reduce runoff and control erosion on Bode clay loam, 2 to 5 percent slopes.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, terracing, contour farming, and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas, but are not feasible in undulating areas where slopes are short and steep. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and prevent surface crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIe.

52E2—Bode clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on knolls and convex side slopes on uplands. Individual areas range from 5 to 15 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable clay loam about 24 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is mottled light olive brown and grayish brown, calcareous clay loam.

Included with this soil in mapping are a few areas of well drained Storden soils. Storden soils are calcareous throughout the solum and are on the steeper parts of slopes. They make up about 10 percent of the map unit.

Permeability of this Bode soil is moderate, and runoff is rapid. Available water capacity is high, although this potential may not be reached because of rapid runoff. The content of organic matter is about 0.5 to 1 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is poorly suited to corn and soybeans. It is better suited to small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. Because of the higher clay content, the rate of infiltration is slower and the rates of runoff are increased during rainy periods. A system of conservation tillage that leaves crop residue on the surface, terracing, contour farming, and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contouring and terracing, is difficult because of the irregular topography and the short, steep slopes. In many areas, however, these measures are suitable.

The use of this soil as pasture is effective in controlling water erosion and promoting better tilth. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IVe.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on low rises and slightly convex side slopes on uplands. Individual areas range from 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 9 inches thick. The subsurface layer is friable clay loam about 11 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is friable and about 21 inches thick. The upper part is dark grayish brown and olive brown clay loam; the next part is dark grayish brown, mottled loam; and the lower part is dark grayish brown and grayish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is mottled, light olive brown and grayish brown, calcareous loam. In some places the surface layer dries out to a lighter color and is thinner.

Included with this soil in mapping are small areas of Clarion and Webster soils. Clarion soils are well drained and are on the more convex parts of slopes. Webster soils are poorly drained and are in the more level areas. Included soils make up about 5 to 10 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Water erosion generally is not a problem on this soil, but soil blowing may occur if the soil is fall plowed. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss from soil blowing. Returning crop residue to the soil and delaying tillage when the soil is wet help to maintain good tilth. This soil generally is not drained, but in some areas artificial drainage will improve the timeliness of operations.

If this soil is used as pasture, overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

72—Estherville loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on uplands and glacial outwash plains. Individual areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable loam about 7 inches thick. The subsoil is about 13 inches thick. The upper part is brown, friable sandy loam; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown, calcareous sand. In a few places the surface layer is sandy clay loam.

Included with this soil in mapping are a few small areas of Dickman soils. Dickman soils have a higher sand content in the solum, coarse fragments, and are in similar landscape positions. They make up about 2 to 5 percent of the map unit.

Permeability of this Estherville soil is moderately rapid in the upper part of the solum and very rapid in the lower part. Runoff is slow. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. The soil is moderately suited to row crops but is better suited to small grain and to grasses and legumes for hay or pasture. The main limitation is low available water capacity. This soil tends to be droughty, especially in years when rainfall is below average or not timely. Soil blowing is a common hazard because of the rapid drying of the surface after tillage. In places, blown sand sometimes damages young plants. A system of conservation tillage that leaves crop residue on the surface helps to prevent or reduce soil blowing and conserves available water for crop use. Returning crop residue to the soil and regularly adding other organic material improve available water capacity, slow surface drying, and help to maintain tilth.

The use of this soil as pasture is effective in controlling soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extreme periods of wetness help to keep the pasture in good condition.

The land capability classification is IIIs.

72B—Estherville loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on uplands and glacial outwash plains. Individual areas range from 2 to 25 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable loam about 5 inches thick. The subsoil is about 12 inches thick. The upper part is brown, friable sandy loam; and the lower part is dark yellowish brown, very friable loamy sand. The substratum to a depth of about 60 inches is brown, calcareous sand. In a few places the surface layer is sandy clay loam.

Included with this soil in mapping are a few small areas of Clarion and Dickman soils. Clarion soils have a higher clay content in the solum and do not have a sandy substratum. Dickman soils have a higher sand content in the upper part of the solum. These included soils are in similar landscape positions. They make up about 2 to 5 percent of the map unit.

Permeability of this Estherville soil is moderately rapid in the upper part of the solum and very rapid in the lower part. Runoff is medium. Available water capacity is low. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. The soil is poorly suited to row crops but is better suited to small grain and to grasses and legumes for hay or pasture. The main limitation is low available water capacity. This soil tends to be droughty, especially in years when rainfall is below average or not timely. When tilled, the surface layer dries rapidly. Also, the tilled areas are highly susceptible to soil blowing, which damages young seedlings. A system of conservation tillage that leaves crop residue on the surface helps to prevent soil blowing and water erosion and conserves moisture for crop use. Returning crop residue to the soil and regularly adding other organic material improve available water capacity, slow surface drying, and help to maintain tilth.

The use of this soil as pasture is effective in controlling soil blowing and water erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extreme periods of wetness help to keep the pasture in good condition.

The land capability classification is IIIs.

72C2—Estherville loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, somewhat excessively drained soil is on uplands and glacial outwash plains. Individual areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 12 inches thick. The upper part is brown, friable sandy loam; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown, calcareous sand.

Included with this soil in mapping are a few small areas of Clarion and Dickman soils. Clarion soils have a higher content of clay in the solum and do not have a sandy substratum. Dickman soils have a higher sand content in the solum. These included soils are in similar landscape positions. They make up about 5 percent of the map unit.

Permeability of this Estherville soil is moderately rapid in the upper part of the solum and very rapid in the lower part. Runoff is medium. Available water capacity is low. The content of organic matter is about 1.5 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is poorly suited to corn and soybeans and is better suited to small grain and to grasses and legumes for hay or pasture. The main limitation is low available water capacity. This soil tends to be droughty, especially in years when rainfall is below average or not timely. If this soil is used for cultivated crops, water erosion and soil blowing are hazards. When tilled, the surface layer dries rapidly. Also the tilled areas are highly susceptible to soil blowing, which often damages young seedlings. A system of conservation tillage that leaves crop residue on the surface helps to control water erosion and soil blowing and conserves moisture for crop use. Returning crop residue to the soil and regularly adding other organic material improve available water capacity, slow surface drying, and help to maintain tilth. Some areas have slopes that can be farmed on the contour. Terraces ordinarily are not constructed on this soil because of the hazard of exposing the sandy substratum.

The use of this soil as pasture is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extreme periods of wetness help to keep the pasture in good condition.

The land capability classification is IVs.

72D2—Estherville loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, somewhat excessively drained soil is on uplands and glacial outwash plains. Individual areas range from 2 to 5 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 6 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 12 inches thick. The upper part is brown, friable sandy loam; and the lower part is dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown, calcareous sand.

Included with this soil in mapping are a few small areas of Clarion and Dickman soils. Clarion soils have a higher content of clay in the solum and do not have a sandy substratum. Dickman soils have a higher sand content in the solum. These included soils are in similar landscape positions. They make up about 5 percent of the map unit.

Permeability of this Estherville soil is moderately rapid in the upper part of the solum and very rapid in the lower part. Runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 1.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas of this soil are cultivated. This soil is poorly suited to corn and soybeans and is better suited to small grain and to grasses and legumes for hay or pasture. The main limitation is low available water capacity. This soil tends to be droughty, especially in years when rainfall is below average or not timely. If this soil is used for cultivated crops, further water erosion is a hazard. When tilled, the surface layer dries rapidly. Also, the tilled areas are highly susceptible to soil blowing, which often damages young seedlings. A system of conservation tillage that leaves crop residue on the surface helps to prevent water erosion and soil blowing and conserves moisture for crop use. Returning crop residue to the soil and regularly adding other organic material improve available water capacity, help to maintain tilth, and slow surface drying. In some areas slopes can be farmed on the contour. Terraces ordinarily are not constructed on this soil because of the danger of exposing the sandy substratum.

The use of this soil as pasture is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during extreme periods of wetness help to keep the pasture in good condition.

The land capability classification is IVs.

73C2—Salida gravelly sandy loam, 2 to 9 percent slopes, moderately eroded. This moderately sloping, excessively drained, calcareous soil is on upland knolls and outwash plains. Individual areas range from about 2 to 8 acres in size. On uplands they generally are small and irregularly shaped. On outwash plains they generally are long and narrow.

Typically, the surface layer is very dark grayish brown, very friable, calcareous gravelly sandy loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown, loose, calcareous gravelly loamy coarse sand about 8 inches thick. The substratum to a depth of about 60 inches is multicolored, calcareous very gravelly coarse sand. In a few places the surface layer is loam.

Permeability of this Salida soil is very rapid, and runoff is slow. Available water capacity is very low. The content of organic matter is about 0.5 to 1 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has poor tilth.

Most areas are cultivated, but other areas are near steeper soils and are used as pasture. This soil is poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The main limitation is low available water capacity. This soil is droughty in years when rainfall is below average or untimely. Many areas are used for cultivated crops because they are in small, irregularly shaped areas with other soils that are better suited to crops. In cultivated areas of this soil stones and gravel on the surface hinder tillage operations. If this soil is used for cultivated crops, further water erosion is a hazard. Soil blowing can be severe when this soil is tilled and the surface layer is left bare. A system of conservation tillage that leaves crop residue on the surface reduces the hazard of erosion and helps to conserve water. Row crops can be planted on the contour. In cultivated fields, a few areas commonly are left in grass, which is grazed in fall along with residue from row crops. These areas also provide habitat for wildlife.

Larger areas are left idle or are used as pasture. These areas can be improved for forage production and wildlife by planting desirable species that tolerate drought. If pastures are properly managed, native bluestem grasses eventually move onto this soil. Controlled grazing and harvesting are essential to maintain desirable plant species and satisfactory forage production.

The land capability classification is IVs.

90—Okoboji mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained mucky soil is in shallow upland depressions. It is subject to ponding. Individual areas are circular. They mainly range from 10 to 20 acres in size, but some are as large as 40 acres.

Typically, the surface layer is black, friable mucky silt loam about 9 inches thick. The subsurface layer is black, firm silty clay loam about 20 inches thick. The subsoil is very dark gray, mottled, firm silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In places the upper part of the solum is calcareous.

Included with this soil in mapping are a few small areas of Harps and Palms soils. Harps soils are on rims of potholes, are poorly drained, and are highly calcareous. Palms soils developed in organic material and are in similar landscape positions. Included soils make up less than 5 percent of the map unit.

Permeability of this Okoboji soil is moderately slow, and runoff is slow to ponded. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 12 to 18 percent in the surface layer. The subsurface layer has a very low supply of available phosphorus and potassium. This soil has good tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Most of the acreage is artificially drained or partly drained and is cultivated. Surface intakes, shallow ditches, and underground drains are used. In places outlets are difficult to find that are deep enough for these drains to function adequately. Many areas are ponded in spring and after heavy rains. In some years water ponds long enough to drown out crops. If ponding occurs early in the season, the land can be tilled and replanted. Even where artificial drainage is adequate for good crop growth, tillage is delayed after heavy rains.

Because this soil is in low-lying areas and has a high organic matter content, it is slow to warm in spring and loses heat rapidly from the surface. Consequently, crops are subject to frost damage in late spring and early fall. The use of early maturing varieties helps to reduce crop losses because of late planting or early frost. The surface layer is less dense and compacted than in other Okoboji soils, making preparation of a desirable seedbed easier. Fall plowing should be avoided in large areas because soil blowing is a hazard if the surface layer is not protected. Production can be improved in many areas by improving the drainage system. On this soil the application rate of some herbicides should be increased compared to the rate used for surrounding soils and other Okoboji soils because the higher organic matter content of this soil reduces the effectiveness of some herbicides.

This soil is poorly suited to some legumes, especially alfalfa. Ponding water and soil heaving in winter frequently kill crops. If this soil is used as pasture, grasses and legumes that tolerate wetness should be substituted for those more commonly grown. Grazing when the soil is wet should be avoided to prevent crop damage. Productivity in most areas can be increased by improving drainage and planting more desirable grasses that tolerate wetness and periods of ponding. This soil generally is managed in conjunction with adjacent soils, but some larger areas are managed separately.

The land capability classification is IIIw.

95—Harps loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on convex rims that border depressions on uplands. Individual areas range from 5 to about 25 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, mottled, friable, calcareous loam about 8 inches thick. The subsoil is olive gray, mottled, friable, calcareous loam about 24 inches thick. The substratum to a depth of about 60 inches is mottled, olive gray and light olive brown, calcareous loam. In a few places strata of silt loam and very fine sand are below a depth of 30 inches.

Included with this soil in mapping are small areas of Crippin and Okoboji soils. Crippin soils are somewhat poorly drained and are in slightly higher landscape positions. Okoboji soils tend to pond water after rains and are in depressions. Included soils make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. If this soil is used for cultivated crops, adequate drainage is needed to reduce wetness and to provide proper aeration for plants that require a deep root zone. Underground drains work well, but in some places providing adequate outlets is a problem. Because of an excess of calcium carbonate in this soil, larger fertilizer applications are needed. Carry-over and sensitivity of some herbicides can be problems. Special fertilization and careful selection of herbicides may be needed. Soybeans grown on this soil can show dramatic visual evidence of iron deficiency. Soybean varieties that tolerate high lime conditions should be selected. In years of excessive rainfall, crops may be lost in areas of this soil because of ponding on the adjacent Palms muck and Okoboji soils. Excessive tillage readily destroys the weak soil structure, and this soil is subject to soil blowing if the surface is left bare and becomes dry. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material help to improve structure and control soil blowing.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition. Because most areas are narrow, they are managed with the surrounding Canisteo soils and the adjacent Palms, Okoboji, Houghton, and Blue Earth soils.

The land capability classification is IIw.

107—Webster clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on upland flats and in swales. Individual areas range from 5 to 120 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 12 inches thick. The upper part is black, and the lower part is black and mottled. The subsoil is friable and about 21 inches thick. The upper part is olive gray and dark gray, mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places the surface layer is more than 24 inches, and depth to free carbonates is shallower. A few places have more clay in the upper part of the solum.

Included with this soil in mapping are small areas of Clarion, Harps, Nicollet, Okoboji, and Rolfe soils. The well drained Clarion soils and the somewhat poorly drained Nicollet soils are in higher landscape positions. Harps soils are highly calcareous and are on rims of depressions. Okoboji and Rolfe soils are very poorly drained and are in depressions that tend to pond water after rains. Included soils make up about 10 percent of the map unit.

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

Most areas are cultivated. Wetness is the main limitation. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Tile drains remove excess water. Special care generally is needed to maintain good tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. When fall plowed, soil blowing is a hazard. Returning crop residue to the soil and regularly adding other organic material help to control soil blowing and prevent surface crusting and increase the rate of water infiltration.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

135—Coland clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. It is subject to occasional flooding. Individual areas mainly range from 20 to 160 acres in size and are long and narrow, paralleling streams.

Typically, the surface layer is black, friable clay loam about 8 inches thick. The subsurface layer is black, friable clay loam about 37 inches thick. The substratum to a depth of about 60 inches is black clay loam. In a few places the sand content is lower and free carbonates are throughout the solum.

Permeability of this Coland soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is moderate. The content of organic matter is about 5 to 7 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated. A few areas that are flooded too frequently or that are not adequately drained are used as pasture. This soil is well suited to corn, soybeans, and small grain and to grasses for hay or pasture. Wetness is the main limitation. Adequate drainage and protection from flooding should be provided for best crop growth. Underground drains work well, but in some places adequate outlets are difficult to find because of shallowness of the stream channel.

This soil is suited to pasture. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

138B—Clarion loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex knolls, ridges, and side slopes on uplands. Slopes typically are short and irregular. Individual areas range from 4 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 13 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil is friable loam about 24 inches thick. The upper part is brown and dark yellowish brown, and the lower part is dark yellowish brown and yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are some areas of Sunburg soils. Sunburg soils are calcareous throughout, are lower in organic matter content, and mainly are on the most convex parts of slopes. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and regularly adding other organic material improve fertility, help to control erosion and maintain tilth, and increase the rate of water infiltration. In some areas applying mechanical erosion-control practices, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these practices are suitable.

The use of this soil as pasture is effective in controlling erosion. Overgrazing, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

138C2—Clarion loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex knolls, ridgetops, and side slopes on uplands. Slopes typically are short and irregular. Areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is friable loam about 23 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are some small areas of Sunburg soils. Sunburg soils are calcareous, are lower in organic matter, and generally are on the most convex part of the slope. They make up about 5 percent of the map unit.

Permeability of this Clarion soil is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 2.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. The soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, contour farming, and terracing prevent excessive soil loss. In some areas applying mechanical erosion-control practices, such as contouring and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable.

The use of this soil as pasture is effective in controlling water erosion. Overgrazing, however, results in surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex knolls, ridgetops, and side slopes on uplands. Slopes typically are short and irregular. Individual areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 6 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is friable loam about 20 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are some small areas of Sunburg soils. Sunburg soils are calcareous throughout the profile, contain less organic matter, and generally are on the more convex part of the slope. They make up less than 10 percent of the map unit.

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

Most areas are cultivated. It is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, contour farming, and terracing help to prevent excessive soil loss. In some areas applying mechanical erosion-control practices, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable.

The use of this soil for pasture is effective in controlling water erosion. Overgrazing, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

174—Bolan loam, 0 to 2 percent slopes. This nearly level, well drained soil is on level to slightly convex slopes on uplands and stream benches. Individual areas range from 2 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 14 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is about 24 inches thick. The upper part is brown, friable loam; the next part is brown, very friable fine sandy loam; and the lower part is dark yellowish brown, very friable loamy fine sand. The substratum to a depth of about 60 inches is dark yellowish brown fine sand. In a few places the upper part of the solum is sandy loam.

Included with this soil in mapping are a few small areas of Dickman and Wadena soils. Dickman soils have more sand and less clay in the solum. Wadena soils have calcareous coarse sand and gravel in the substratum. These included soils are in similar landscape positions. They make up less than 5 percent of the map unit.

Permeability of this Bolan soil is moderate in the upper part and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter is 3 or 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Moderate available water capacity is the main limitation. In years when rainfall is below average or untimely, a lack of available water may limit crop growth, resulting in reduced yields. Small grain and legumes for hay or pasture generally do better than row crops. If this soil is fall plowed or if the soil surface is left bare, soil blowing can be a hazard. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve fertility, conserve moisture, and help to control soil blowing.

If this soil is used as pasture, overgrazing or grazing when the soil is wet causes surface compaction and results in poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIs.

174B—Bolan loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on slightly convex slopes on uplands and on stream terraces. Individual areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is friable loam about 14 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is about 20 inches thick. The upper part is brown, friable loam; the next part is brown, very friable fine sandy loam; and the lower part is dark yellowish brown, very friable loamy fine sand. The substratum to a depth of about 60 inches is dark yellowish brown fine sand. In a few places the upper part of the solum is sandy loam.

Included with this soil in mapping are a few small areas of Dickman soils. Dickman soils have less clay and more sand in the solum and are in similar landscape positions. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The main management problem is water erosion. In years when rainfall is below average or untimely, a lack of available water may limit crop growth, resulting in reduced yields. Small grain and legumes for hay or pasture generally do better than row crops. If this soil is fall plowed or the soil surface is left bare, soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve fertility, conserve moisture, and help to control soil blowing and water erosion. In some areas slopes can be farmed on the contour. Terraces are not ordinarily constructed on this soil because of the hazard of exposing the sand substratum.

The use of this soil as pasture is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

221—Palms muck, 0 to 1 percent slopes. This level, very poorly drained organic soil is in upland depressions that formerly contained water much of the time. It is subject to ponding. Individual areas range from 15 to 50 acres in size, but some are as large as 160 acres. They are circular or irregularly shaped.

Typically, the surface layer is black, slightly sticky sapric material about 10 inches thick. The subsurface layer is black, slightly sticky sapric material about 22 inches thick. The substratum to a depth of about 60 inches is black, dark gray, and olive gray, mottled silty clay loam. In places depth to the mucky material is more than 50 inches. In a few places the substratum is black to a depth of 60 inches or more.

Permeability of this Palms soil is moderately slow to moderately rapid in the organic material and moderate in the substratum. Runoff is very slow. The soil has a seasonal high water table. Available water capacity is very high. The content of organic matter is more than 20 percent in the surface layer. The substratum has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. Wetness is the main limitation. If adequately drained, the soil is moderately suited to row crops. Surface intakes and shallow ditches are used in addition to underground drains. In places outlets deep enough for drains to function adequately are difficult to find. Runoff from adjacent slopes readily pond on this soil, and in periods of excessive rainfall crops are sometimes damaged or destroyed before the drains can remove the excess water. If this occurs early in the season, the land can be tilled and replanted. This soil is slow to warm in spring, and planting may be delayed. Because this soil is in low-lying areas and loses heat rapidly from the surface, frost often injures crops in late spring and early fall. Using early maturing varieties helps to reduce crop losses caused by late planting and early frost. Row crops grow fairly well where this soil is adequately drained and fertilized and otherwise well managed. This soil can be tilled within a wide range of moisture content. Fall plowing should be avoided because, if left unprotected, the surface readily blows when dry. The application rate of some herbicides should be increased on this soil because its high organic matter content causes herbicides to be less effective.

Partially drained areas of this soil are suited to permanent pasture consisting of bluegrass, bromegrass, and reed canarygrass. Undrained areas generally are suited to wildlife habitat.

The land capability classification is IIIw.

224—Linder sandy loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces and upland outwash areas. Individual areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable sandy loam about 9 inches thick. The subsurface layer is black and very dark grayish brown, friable sandy loam about 12 inches thick. The subsoil is very friable and about 15 inches thick. The upper part is dark grayish brown sandy loam; and the lower part is grayish brown and very dark grayish brown, mottled loamy sand. The upper part of the substratum is dark grayish brown, mottled loamy sand; the next part is dark grayish brown and light olive brown, calcareous loamy sand and gravel; and the lower part to a depth of about 60 inches is grayish brown and light olive brown, calcareous gravelly loamy sand. In places the depth to the substratum is less than 24 inches. In a few places the solum is calcareous.

Permeability of this Linder soil is moderately rapid in the upper part and very rapid in the underlying sand and gravel. Runoff is slow. The soil has a seasonal high water table. Available water capacity is low to moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. It is better suited to small grain and to grasses and legumes than to cultivated crops because available water is not sufficient during parts of most growing seasons. Water erosion generally is not a problem on this soil. When plowed or tilled, the surface layer dries rapidly and commonly is subject to soil blowing. Windblown sand damages or destroys seedlings. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil blowing. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture helps to control erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIs.

236B—Lester loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on ridgetops and convex side slopes on uplands. Individual areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil is friable and about 31 inches thick. The upper part is brown clay loam, the next part is dark yellowish brown clay loam, and the lower part is dark yellowish brown loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam. In places the subsoil contains less clay and more sand.

Included with this soil in mapping are a few small areas of Rolfe soils. Rolfe soils are very poorly drained and are in depressions. They make up less than 5 percent of the map unit.

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

Most areas are cultivated, but some areas are used as pasture or left in timber. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees, and a few small areas remain in native hardwoods. New stands of trees survive and grow well if species are selected and managed properly.

The land capability classification is IIe.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on upland ridgetops and convex side slopes. Individual areas typically range from 3 to 15 acres in size, but some are as large as 30 acres. They are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable and about 31 inches thick. The upper part is brown clay loam, the next part is dark yellowish brown clay loam, and the lower part is dark yellowish brown loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam. In places the subsoil contains less clay and more sand.

Included with this soil in mapping are a few small areas of Sunburg soils. The Sunburg soils are calcareous and on the steepest, most convex part of slopes. They make up about 5 percent of the map unit.

Permeability of this Lester soil is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 1 or 2 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated, but some areas are used as pasture or remain in timber. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the short slopes and the irregular topography. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees, and a few small areas remain in native hardwoods. New stands of trees survive and grow well if species are selected and managed properly.

The land capability classification is IIIe.

236D2—Lester loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes on uplands. Individual areas are irregularly shaped. They typically range from 3 to 15 acres in size, but some are as large as 30 acres.

Typically, the surface layer is very dark grayish brown, friable loam about 6 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable and about 28 inches thick. The upper part is brown clay loam, the next part is dark yellowish brown clay loam, and the lower part is dark yellowish brown loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous sandy loam. In places the subsoil contains less clay and more sand.

Included with this soil in mapping are a few small areas of Sunburg soils. The calcareous Sunburg soils are on the steepest, most convex part of slopes. They make up less than 10 percent of the map unit.

Permeability of this Lester soil is moderate, and runoff is rapid. Available water capacity is high. The content of organic matter is about 1.0 to 2.0 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated, but some are used as pasture or left in timber. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical water erosion-control measures, such as contour farming and terracing, is difficult because of the short slopes and the irregular topography. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is moderately suited to trees, and a few small areas remain in native hardwoods. Careful site selection is needed when laying out logging trails or roads on this soil to reduce the hazard of erosion. Laying out trails or roads on or nearly on the contour will help to control erosion. The slope makes the operation of equipment somewhat hazardous. Special equipment and caution in its use are needed. Seedlings survive and grow well.

The land capability classification is IIIe.

236F—Lester loam, 14 to 25 percent slopes. This moderately steep and steep, well drained soil is on convex side slopes on uplands. Individual areas typically range from 4 to 20 acres in size, but some are as large as 150 acres. The areas are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil is friable and about 27 inches thick. The upper part is brown clay loam, the next part is dark yellowish brown clay loam, and the lower part is dark yellowish brown loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous sandy loam. In places the subsoil contains less clay and more sand. In a few places the surface layer is thinner.

Included with this soil in mapping are small areas of Spillville and Sunburg soils. Spillville soils are on foot slopes and in small, concave drainageways that extend into uplands. Sunburg soils are on the steepest, most convex part of slopes. Included soils make up about 10 percent of the map unit.

Permeability of this Lester soil is moderate, and runoff is rapid. Available water capacity is high, but commonly this potential is not reached because of the rapid runoff and reduced surface infiltration. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Most areas are used as pasture or left in timber, but a few are cultivated. This soil is unsuited to cultivated crops because of the steep slopes and the severe hazard of water erosion. It is best suited to pasture or timber. Major management concerns are the hazard of water erosion, water management, and fertility. The amount of water available for plant growth is commonly low because of rapid runoff. Management should maintain an adequate vegetative cover, help to prevent excessive soil loss, and improve the water supply capacity of the soil by reducing runoff and the rate of drying. Growth of vegetation, except for trees, generally is poor and total production is low.

If this soil is used as pasture, proper stocking rates, timely deferment of grazing, and planned, uniform rotation grazing help to keep the pasture in good condition. Grazing can damage trees and seedlings, and reduce their value as timber and as habitat for wildlife. This soil is well suited to use as wildlife habitat because many areas have returned to their natural state.

This soil is moderately suited to trees, and a few areas remain in native hardwoods. Careful site selection is needed when laying out logging trails and roads on this soil to reduce the hazard of erosion. Laying out the trails or roads on or nearly on the contour will help to control erosion. Because of the slope the operation of equipment is hazardous. Special equipment and caution in its use are needed. Seedlings survive and grow well.

The land capability classification is VIe.

259—Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil is on glacial outwash plains and stream terraces. Individual areas typically range from 4 to 15 acres in size, but some are as large as 25 acres. They are irregularly shaped.

Typically, the surface layer is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is friable and about 18 inches thick. The upper and middle parts are olive gray, mottled clay loam; and the lower part is olive gray, mottled sandy loam. The substratum to a depth of about 60 inches is dark grayish brown, mottled, calcareous gravelly loamy sand. In a few places the depth to sand and gravel is less than 32 inches, and the surface layer and the subsoil contain more sand and less clay.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is essential for best crop production.

Drainage can be improved by installing underground drains. These drains function well, but in some places the instability of the substratum makes installation difficult. This soil not only is seasonally wet but also is droughty, especially if rainfall is below average or untimely. This soil is subject to soil blowing if it is plowed in fall or if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and to conserve moisture. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

274—Rolfe silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in shallow depressions on uplands and stream terraces. It is subject to ponding. Individual areas are circular. They range from 2 to 5 acres in size, although a few are as large as 25 acres.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsurface layer is friable silt loam about 12 inches thick and is mottled. The upper part is very dark gray, and the lower part is dark gray. The subsoil is about 39 inches thick, and is mottled. The upper and middle parts are olive gray, firm silty clay loam; and the lower part is olive gray, friable sandy clay loam.

Permeability of this Rolfe soil is slow, and runoff is very slow. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 3.5 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated. Wetness is the main limitation. If adequately drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses for pasture. It is poorly suited to legumes for hay. Most areas of this soil are within areas of other soils that are well suited to row cropping, and adequate drainage is needed for best yields. Most areas, however, are ponded in spring and after heavy rains. Underground drains do not remove water adequately because the subsoil is high in clay and is slowly permeable. Drains need to be more closely spaced in this soil than in other depressional soils in the county. Shallow surface ditches and surface intakes for underground drains are needed to remove excess surface water and to reduce ponding. Even when drainage is improved, this soil is slower to dry than surrounding soils, and tillage is often delayed in spring and after heavy rains. Crop growth is only moderate, and winterkill and drowning out of legumes are common.

Hay and pasture crops that tolerate wetness and short periods of ponding are needed on this soil. This soil generally is managed with the surrounding soils.

The land capability classification is IIIw.

288—Ottosen clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on gentle, convex slopes or in slightly concave positions on uplands. It formed in loamy glacial or lacustrine sediments and the underlying glacial till. Individual areas range from 4 to 45 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable clay loam about 8 inches thick. The subsurface layer is friable and about 11 inches thick. The upper part is black clay loam, and the lower part is very dark grayish brown silty clay loam. The subsoil is friable and about 16 inches thick. The upper part is dark grayish brown silty clay loam, and the lower part is grayish brown, mottled clay loam. The substratum to a depth of about 60 inches is mottled olive gray and olive brown, calcareous loam.

Included with this soil in mapping are small areas of Kossuth soils. Kossuth soils are poorly drained and are in the more level areas. They make up about 5 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Erosion generally is not a problem on this soil. However, if the soil is fall plowed, the surface layer is subject to soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss from soil blowing. Returning crop residue to the soil and delaying tillage when the soil is wet help to maintain good tilth. This soil generally is not drained, but in areas where it borders Kossuth or Canisteo soils it is wet in years of above-normal rainfall. Drainage in these areas improves timeliness of fieldwork.

If this soil is used as pasture, overgrazing or grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

308—Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is on slightly convex slopes in upland glacial outwash areas and on stream terraces. Individual areas range from 5 to 60 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 10 inches thick. The subsurface layer is black and very dark grayish brown, friable loam about 8 inches thick. The subsoil is friable loam about 15 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown and brown, calcareous gravelly coarse sand. In some places the subsoil is sandy loam. In a few places the surface layer is more than 24 inches.

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

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. A lack of available water frequently limits crop growth in parts of most growing seasons, especially in years when rainfall is below average or untimely. Small grain and legumes for hay or pasture generally do better than row crops. When tilled, the surface layer dries rapidly, and commonly is subject to soil blowing, especially if fall plowed or if the surface layer is left bare. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve fertility, conserve moisture, and help to control soil blowing.

The use of this soil as pasture is effective in controlling soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIs.

308B—Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex slopes in upland glacial outwash areas and on stream terraces. Individual areas range from 5 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 10 inches thick. The subsurface layer is black and very dark grayish brown, friable loam about 7 inches thick. The subsoil is friable loam about 16 inches thick. The upper part is brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown and brown, calcareous gravelly coarse sand. In a few places the B horizon is sandy loam. In places the sand and gravel are at a depth of less than 32 inches.

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

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. A lack of available water frequently limits crop growth in parts of most growing seasons, especially in years when rainfall is below average or untimely. Small grain and legumes for hay and pasture generally do better than row crops. Water erosion and soil blowing are hazards if this soil is fall plowed or if the surface layer is left bare. A system of conservation tillage that leaves crop residue on the surface slows drying and helps to control erosion. In some areas slopes can be farmed on the contour. Terraces generally are not constructed on this soil because of the hazard of exposing the sand and gravel substratum.

The use of this soil as pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

335—Harcot clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on low-lying, glacial outwash areas. Some areas are on narrow, convex rims surrounding slight depressions. Individual areas are irregularly shaped. They typically range from 5 to 30 acres in size, but some are as large as 180 acres.

Typically, the surface layer is black, friable, calcareous clay loam about 9 inches thick. The subsurface layer is friable and calcareous, and is about 11 inches thick. The upper part is black loam, and the lower part is very dark gray sandy loam. The subsoil is olive gray, mottled, very friable, calcareous sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is olive gray and olive, calcareous fine sand. In a few places sand is at a depth of less than 24 inches.

Included with this soil in mapping are a few small areas of Biscay soils. Biscay soils are very poorly drained and are in depressions. They make up less than 5 percent of the map unit.

Permeability of this Harcot soil is moderate in the solum and very rapid in the substratum. Runoff is slow, and in some places the soil is ponded. The soil has a seasonal high water table. Available water capacity is moderate. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. The supply of available iron also is seriously deficient, and some minor elements are likely to be in short supply. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. If this soil is used for cultivated crops, adequate drainage is needed to reduce wetness and to provide proper aeration and a deep root zone for plants. Underground drains work well, but installing them can be difficult because of the instability of the substratum. Because of an excess of calcium carbonate in this soil, applying larger amounts of fertilizer is needed. Carry-over and sensitivity of some herbicides are problems. Special fertilization and careful selection of herbicides are needed. In some years of excessive rainfall, crops may be lost in some areas of this soil because of ponding of the adjacent depressions. Excessive tillage readily destroys the weak soil structure. Also, the tilled areas are highly susceptible to soil blowing when the surface layer dries and is left bare. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve the soil structure and help to control soil blowing.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

348—Fieldon loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on glacial outwash plains and upland flats. Individual areas range from 5 to 120 acres and are irregularly shaped. A few areas are as large as 400 acres or more.

Typically, the surface layer is black, friable, calcareous loam about 7 inches thick. The subsurface layer is friable, calcareous sandy clay loam about 14 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is very friable, calcareous fine sandy loam, and is mottled. It is about 15 inches thick. The upper part is olive gray, and the lower part is olive gray and pale olive. The substratum to a depth of about 60 inches is mottled olive gray and light olive brown, calcareous loamy fine sand. In some places the surface layer is more than 24 inches thick.

Included with this soil in mapping are small areas of Harcot, Harpster, and Okoboji soils. Harcot soils are highly calcareous. Harpster soils have more silt and less sand in the solum and the substratum. In addition, Harcot and Harpster soils have a distinctly lighter surface color when dry and are on narrow rims next to depressions. Okoboji soils are very poorly drained and are in slight depressions. Okoboji soils are wetter and are subject to ponding after rains. Included soils make up about 5 to 10 percent of the map unit.

Permeability of this Fieldon soil is moderate in the solum and rapid in the substratum. Runoff is slow. The soil has a seasonal high water table. Available water capacity is moderate. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are drained and cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is essential for best crop production. Underground drains function well in the soil, but installing them may be difficult because of the instability of the substratum. Because of an excess of calcium carbonate in this soil, applying fertilizer in larger amounts is needed. Carry-over and sensitivity of herbicides are problems on this soil. This soil is subject to soil blowing if it is plowed in the fall and if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing, improves fertility, and maintains tilth.

This soil is suited to use as pasture. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

384—Collinwood silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on low rises on ridgetops on uplands. Individual areas range from 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, firm silty clay loam about 8 inches thick. The subsurface layer is black, firm silty clay about 9 inches thick. The subsoil is firm silty clay about 19 inches thick. The upper part is dark grayish brown, the next part is dark grayish brown and mottled, and the lower part is grayish brown and mottled. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous silty clay loam.

Included with this soil in mapping are a few small areas of Vinje soils. Vinje soils are better drained and are more sloping than Collinwood soils. They make up less than 5 percent of the map unit.

Permeability of this Collinwood soil is moderately slow or slow, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. This soil has a seasonal high water table, and most areas are artificially drained to improve the timeliness of field operations. Tile drains do not always function well, and will need closer spacing than on soils that have less clay in the subsoil. The surface layer typically needs special care to maintain tilth. If worked when too wet, the surface layer becomes hard and cloddy upon drying. It is highly susceptible to soil blowing, especially if the soil is plowed in fall or if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface and regular addition of other organic material help to control erosion, increase the rate of water infiltration, and improve tilth and fertility.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, reduces infiltration, and increases runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

384B—Collinwood silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on low rises on ridgetops and on slightly concave side slopes on uplands. Individual areas range from 5 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black, firm silty clay loam about 8 inches thick. The subsurface layer is firm and about 14 inches thick. The upper part is black silty clay loam, and the lower part is black and very dark gray silty clay. The subsoil is firm silty clay about 16 inches thick. The upper part is dark grayish brown, and the lower part is olive brown and mottled. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous silty clay loam.

Included with this soil in mapping are a few small areas of Vinje soils. Vinje soils are better drained and are in slightly higher landscape positions. They make up less than 5 percent of the map unit.

Permeability of this Collinwood soil is moderately slow or slow, and runoff is medium. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 5 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, the hazard of water erosion is greater on this soil than on some soils on similar slopes. On this soil, the higher clay content reduces the rate of infiltration and increases runoff. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the undulating topography and the short slopes. In many areas, however, these measures are suitable. This soil is susceptible to soil blowing, especially if it is fall plowed or if the surface is left bare. The surface layer typically needs special care to maintain tilth. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material help to reduce runoff, increase the rate of water infiltration, help to control erosion, and improve fertility.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, reduces infiltration, and increases runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIe.

388—Kossuth silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or nearly level areas on uplands. Most areas range from 5 to 40 acres in size, and a few areas are as large as 160 acres in size. They are irregularly shaped, but some areas in drainageways are long and narrow.

Typically, the surface layer is black, firm silty clay loam about 7 inches thick. The subsurface layer is firm silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is about 19 inches thick. The upper part is olive gray, mottled, firm silty clay loam; and the lower part is olive gray, mottled, friable, calcareous loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Included with this soil in mapping are small areas of Okoboji soils in depressions. Okoboji soils are very poorly drained and are in small depressions. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. The soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The main limitation is wetness. Installation of underground drains is essential for best crop production. These drains function more slowly in this soil because the fine textured subsoil restricts water movement. Drains must be more closely spaced in this soil to adequately remove excess water. Special care is needed to maintain tilth in the surface layer. Cultivation when the soil is too wet causes surface compaction and cloddiness. The surface layer is susceptible to soil blowing, especially if it is plowed in the fall and left bare. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and improves fertility.

If this soil is used as pasture, overgrazing or grazing when the soil is wet damages forage plants and causes surface compaction, which results in poorer tilth and a reduction in the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

390—Waldorf silty clay, 0 to 2 percent slopes. This nearly level, poorly drained soil is on upland flats and in swales. Individual areas range from 5 to 30 acres in size and are irregularly shaped. A few areas are as large as 120 acres in size.

Typically, the surface layer is black, firm silty clay about 8 inches thick. The subsurface layer is firm silty clay about 13 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is olive gray, mottled, firm silty clay about 16 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In a few places the surface layer is more than 24 inches thick. In places glacial till is above a depth of 40 inches.

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

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Installation of underground drains is essential for best crop production. Underground drains function more slowly in this soil than in most others in the county. Drains must be more closely spaced in this soil to remove excess water. Special care is needed to maintain tilth in the surface layer. Cultivation when the soil is too wet causes surface compaction and cloddiness. Soil heaving commonly damages legumes, and in some areas the legumes are drowned out by ponding. This soil is susceptible to soil blowing, especially if large areas are plowed in the fall and the soil surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing.

If this soil is used as pasture, overgrazing or grazing when the soil is too wet causes surface compaction and poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

485B—Spillville loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on upland foot slopes. Individual areas range from 4 to 10 acres in size, but some are as large as 35 acres. They are long and narrow.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is black, friable loam about 41 inches thick. The next layer to a depth of about 60 inches is very dark grayish brown, mottled, friable loam. In a few places the surface layer is thinner. In places the surface layer is sandy loam.

Included with this soil in mapping are some areas of Clarion soils. Clarion soils have a thinner surface layer and are in higher landscape positions. They make up about 2 to 5 percent of the map unit.

Permeability of this Spillville soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The subsurface generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated, but some areas adjacent to steep slopes are used as pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Diversion terraces installed upslope of Spillville soils help to reduce runoff. Gullies may form in shallow drainageways. These areas can be shaped and seeded and used as waterways. This soil generally is managed with surrounding soils.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIe.

506—Wacousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in shallow upland depressions. It is subject to ponding. Individual areas range from 5 to 40 acres in size and are circular.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 6 inches thick. The subsoil is olive gray, mottled, friable, calcareous silty clay loam about 9 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silt loam. In a few places the surface layer is thicker. In places the solum is calcareous.

Included with this soil in mapping are a few small areas of Harps soils. Harps soils are highly calcareous and are on small rises. They make up less than 5 percent of the map unit.

Permeability of this Wacousta soil is moderate, and runoff is slow or ponded. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 8 to 10 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Drainage is the main limitation. Because ponding often drowns out legumes and delays planting, drainage is essential for crop production. Underground drainage works well. In some areas drainage needs to be supplemented by shallow surface ditches, surface intakes to the underground drainage system, or a combination of both. Special care is needed to maintain tilth in the surface layer. If this soil is worked when too wet, the surface layer puddles and becomes hard and cloddy when dry.

Areas in which drainage cannot be improved to make crop yields dependable can be used as pasture. However, forage species that tolerate wetness and ponding are needed. If this soil is used as pasture, grazing when the soil is too wet causes surface compaction and damages crops. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIw.

507—Canisteo clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on upland flats and in swales. Areas range from 5 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable, calcareous clay loam about 8 inches thick. The subsurface layer is friable, calcareous clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and mottled. The subsoil is friable and calcareous, and is about 22 inches thick. The upper part is dark gray, mottled clay loam; the next part is olive gray, mottled clay loam; and the lower part is olive gray, mottled loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In places the surface layer is more than 24 inches thick.

Included with this soil in mapping are some small areas of Crippin, Harps, and Okoboji soils. Crippin soils are somewhat poorly drained and are in higher landscape positions. The highly calcareous Harps soils are located around the rims of depressions. The very poorly drained Okoboji soils tend to pond water after rains and are in small depressions. Included soils make up less than 5 percent of the map unit.

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

Most areas are cultivated. Wetness is the main limitation. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Tile drains are needed to remove excess subsurface water. Special care is needed to maintain tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. This soil is susceptible to soil blowing, especially if it is fall plowed or the surface is left bare. Returning crop residue to the soil and regularly adding other organic material help to control soil blowing and to prevent surface crusting and increase the rate of water infiltration. Because of the high content of calcium carbonate in the soil, larger applications of fertilizer are needed because of the lower availability of plant nutrients. Carry-over and sensitivity of some herbicides are problems on this soil. In areas where soybeans are grown, varieties should be selected that tolerate high-lime soils.

This soil is also suited to use as pasture. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

511—Blue Earth mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained, highly calcareous soil is in depressions that formerly contained water much of the time. It is subject to ponding. Some areas are in former shallow lakebeds that have been drained. Individual areas range from about 10 to 60 acres in size and are circular.

Typically, the surface layer is black, calcareous mucky silt loam about 7 inches thick. The layer below that, to a depth of about 60 inches, is very dark gray, mottled, calcareous mucky silt loam. In places the surface layer does not have free carbonates. In a few places the substratum has a texture of loamy fine sand below a depth of 30 inches.

Permeability of this Blue Earth soil is moderate, and runoff is slow or ponded. The soil has a seasonal high water table. Available water capacity is very high. The content of organic matter is more than 15 percent in the surface layer. The surface layer has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

This soil is moderately suited to cultivated crops. Drainage is the main limitation. Ponding after excessive rainfall sometimes damages or destroys crops before tile drains can remove excess water. Because of very low availability of some plant nutrients, high organic matter content, and the high concentration of calcium carbonate, special emphasis of the fertility program is needed for best crop yields. If drainage is adequate and the soil is fertilized and managed correctly, row crops grow fairly well. Small grain, however, tends to lodge badly and to produce harvests of poor quality. The soil is slow to warm in spring, and planting is often delayed. Frost will often injure crops in late spring and early fall. The use of early maturing varieties helps to reduce loss as a result of late planting and early frost. Soil blowing can be a problem if the surface is left bare, especially when larger areas are fall plowed. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing.

Partially drained areas of this soil are suitable for permanent pasture consisting of species, such as reed canarygrass, that tolerate excess wetness. Legumes for hay grow poorly on this soil and are often winterkilled. Undrained areas generally are well suited to use as wildlife habitat.

The land capability classification is IIIw.

524—Linder sandy loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in upland outwash areas and on stream terraces. Individual areas range from 2 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 10 inches thick. The subsurface layer is very friable sandy loam about 11 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil is very friable sandy loam about 18 inches thick. The upper part is dark grayish brown, the next part is dark grayish brown and mottled, and the lower part is grayish brown and mottled. The substratum to a depth of about 60 inches is dark grayish brown, calcareous loamy coarse sand in the upper part and dark grayish brown and grayish brown, calcareous coarse sand in the lower part.

Included with this soil in mapping are a few small areas of Biscay soils. Biscay soils are poorly drained and are lower on the landscape. They make up about 5 percent of the map unit.

Permeability of this Linder soil is moderately rapid in the solum and very rapid in the underlying sand and gravel. Runoff is slow. The soil has a seasonal high water table. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Water erosion generally is not a problem on this soil. When tilled, the surface layer dries out quickly and commonly is highly susceptible to soil blowing. Windblown sand damages or destroys young seedlings. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and to conserve moisture. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIs.

562D2—Storden clay loam, 5 to 14 percent slopes, moderately eroded. This moderately sloping and strongly sloping, well drained, calcareous soil is on short, convex side slopes and on sharply convex knolls and ridges on uplands. Individual areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown, friable, calcareous clay loam about 7 inches thick. Plowing has mixed streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous clay loam. The upper part is yellowish brown, and the lower part is mottled olive brown. In a few places strata of silt are present in the substratum. In places the surface layer is darker in color.

Included with this soil in mapping are some small areas of Bode and Vinje soils. Bode soils have a thicker surface soil and do not have carbonates in the solum. Vinje soils contain more silt and less sand in the solum and have a thicker surface soil. These included soils are on the less steeper part of the slope. They make up about 5 to 10 percent of the map unit.

Permeability of this Storden soil is moderate, and runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated, but some are used as pasture. This soil is poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a severe hazard. This soil is highly susceptible to soil blowing if it is tilled and if the soil surface is left bare. A system of conservation tillage that leaves crop residue on or mixed into the surface layer and grassed waterways help to prevent excessive soil loss. In places applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Because the excess calcium carbonate in this soil restricts the availability of plant nutrients, larger than normal applications of fertilizers are needed. Carry-over and sensitivity of some herbicides are problems. The supply of available iron is sometimes deficient in this soil, and in places other available minor elements may be low. Returning crop residue to the soil and regularly adding other organic material increase organic matter content, improve fertility, and help to maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

562E2—Storden clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on convex side slopes, knolls, and ridges on uplands. Individual areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown, friable clay loam about 7 inches thick. Plowing has mixed streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous clay loam. The upper part is yellowish brown, and the lower part is light olive brown and mottled. In a few places stratified silt is in the substratum. In places the light-colored substratum is exposed.

Included with this soil in mapping are small areas of Bode soils. Bode soils have a thicker surface soil and do not have carbonates in the solum. They are on the less steep parts of slopes and make up about 5 to 10 percent of the map unit.

Permeability of this Storden soil is moderate, and runoff is rapid. Available water capacity is high, but often the potential is not reached because of rapid runoff and reduced surface infiltration. The content of organic matter is about 0.5 to 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated, but some are used as pasture. This soil is poorly suited to corn and soybeans and is better suited to small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion and soil blowing are severe hazards. Practices that control runoff and allow more water to enter the soil help to prevent excessive soil loss and to improve pasture and crop growth. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent soil loss. In places applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short, steep slopes. In many areas, however, these measures are suitable. Because of the excess calcium carbonate in this soil, larger than normal applications of fertilizer are needed because of low availability of plant nutrients. Carry-over and sensitivity of some herbicides are problems. The supply of available iron is sometimes deficient, and in places other available minor elements may be low. Returning crop residue to the soil and regularly adding other organic material increase organic matter content, improve fertility, and help to maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IVe.

562F2—Storden clay loam, 18 to 25 percent slopes, moderately eroded. This steep, well drained, calcareous soil is on convex side slopes on uplands. A few areas are on steep hills and ridges and side slopes on uplands. Individual areas range from 4 to 12 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown, friable clay loam about 5 inches thick. Plowing has mixed streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous clay loam. The upper part is yellowish brown, and the lower part is olive brown and mottled. In a few places stratified silt is present in the substratum. In places the light-colored substratum is exposed.

Permeability of this Storden soil is moderate, and runoff is rapid. Available water capacity is high, but often this potential is not reached because of rapid runoff and reduced surface infiltration. The content of organic matter is about 0.5 to 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated, but some are used as pasture or are left idle. This soil is unsuited to corn, soybeans, and small grain but is better suited to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion and soil blowing are severe hazards. Practices that improve fertility, control runoff, and allow more water to enter the soil help to prevent excessive soil loss and are management concerns. Adding fertilizer dramatically increases plant growth for hay or pasture because of very low fertility. During periods of low rainfall, crops often do not have enough water for best yields, because of rapid runoff. Returning crop residue to the soil and regularly adding other organic material increase organic matter content, improve fertility, and help to maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing and overstocking the pasture reduces the protective vegetative cover and causes deterioration of grasses. Under these conditions, weeds invade and compete with grasses for available water and plant nutrients. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is VIe.

621—Houghton muck, 0 to 1 percent slopes. This level, very poorly drained, organic soil is in upland depressions that formerly contained water much of the time. This soil is subject to ponding. Individual areas are circular. They range from 15 to 30 acres in size, and some areas are as large as 160 acres.

Typically, the organic surface layer is black, slightly sticky sapric material about 10 inches thick. The subsurface is black, slightly sticky sapric material about 50 inches thick.

Permeability of this Houghton soil is moderately slow to moderately rapid, and runoff is very slow or ponded. The soil has a seasonal high water table. Available water capacity is very high. The content of organic matter is more than 20 percent in the surface layer. The surface soil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

In most areas this soil is cultivated. It is poorly suited to row crops. Drainage is the main limitation. Runoff from adjacent slopes readily ponds on this soil, and periods of excessive rainfall sometimes damage or destroy crops before tile drains can remove the excess water. If this occurs early in the season, the land can be tilled and replanted. This soil is slow to warm in spring, and planting may be delayed. Because this soil is in low-lying areas and loses heat rapidly from the surface, frost often injures crops in late spring and early fall. Using early maturing varieties helps to reduce crop losses caused by late planting and early frost. This soil can be tilled within a wide range of moisture content. Fall plowing should be avoided on this soil because the surface layer dries quickly. Also, this soil is highly susceptible to soil blowing if it is not protected. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Because of the high organic matter content, herbicides are less effective on this soil unless the application rates are increased. Small grain tends to lodge badly and to produce harvests of poor quality. Legumes for hay grow poorly on this soil and are often winterkilled.

Partially drained areas of this soil are suited to permanent pasture consisting of bluegrass, bromegrass, and reed canarygrass. Undrained areas generally are suited to use as wildlife habitat.

The land capability classification is IIIw.

640C2—Sunburg sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained, calcareous soil is on knolls and sharply convex side slopes on uplands. Slopes generally are short. Individual areas range from 2 to 10 acres in size and are irregularly shaped. A few areas on side slopes adjacent to streams and drainageways range to about 20 acres in size and are long and narrow.

Typically, the surface layer is brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is yellowish brown, calcareous sandy loam in the upper part and light olive brown, mottled, calcareous sandy loam in the lower part. In a few places where the soil has not been plowed, the surface layer is darker and thicker. Also, in places the surface layer has been severely eroded, exposing the substratum.

Included with this soil in mapping are small areas of Clarion and Salida soils. Clarion soils are deeper to carbonates, contain more organic matter in the surface layer, and are on the flatter parts of slopes. Salida soils contain more sand and coarse fragments in the solum. They are in similar landscape positions. The included soils make up about 10 percent of the map unit.

Permeability of this Sunburg soil is moderately rapid, and runoff is medium. Available water capacity is moderate or high. The content of organic matter is about 1 to 1.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Many areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a severe hazard. This soil is highly susceptible to soil blowing if it is tilled and the soil is left bare. A system of conservation tillage that leaves crop residue on the surface, terraces, and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Because of the excess of calcium carbonate in this soil, larger than normal applications of fertilizer are needed. Carry-over and sensitivity of some herbicides are problems. The supply of available iron is sometimes deficient in this soil, and in places other available minor elements may be low. Returning crop residue to the soil and regularly adding other organic material increase organic matter, improve fertility, and help to maintain tilth. Special fertilization and careful selection of herbicides generally are needed.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases surface runoff, and results in poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

640D2—Sunburg sandy loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained, calcareous soil is on short convex side slopes and on sharply convex knolls and ridges in the rolling to hilly uplands throughout most of the county. Individual areas of this soil range from 5 to 10 acres in size and are irregularly shaped. Some areas on side slopes adjacent to streams and drainageways may be as much as 20 acres in size and are long and narrow.

Typically, the surface layer is brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is yellowish brown, and the lower part is light olive brown and mottled. In a few places that have not been plowed, the surface layer commonly is darker and thicker. Also, in places severe erosion has exposed the light-colored substratum.

Included with this soil in mapping are small areas of Clarion and Salida soils. Clarion soils have more organic matter in the surface layer, are deeper to carbonates, and are on the flatter parts of slopes. Salida soils contain more sand and coarse fragments. They are in similar landscape positions. Included soils make up about 10 percent of the map unit.

Permeability of this Sunburg soil is moderately rapid, and runoff is medium. Available water capacity is moderate or high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. The soil generally has fair tilth.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further erosion is a hazard. This soil is highly susceptible to soil blowing if it is tilled and if the soil surface is left bare. A system of conservation tillage that leaves crop residue on the surface, terraces, and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Because of an excess of calcium carbonate, larger applications of fertilizer are needed. Carry-over and sensitivity of some herbicides are problems. The supply of available iron is sometimes deficient in this soil, and in places other available minor elements may be low. Special fertilization and careful herbicide selection generally are needed. Returning crop residue to the soil and regularly adding other organic material increase organic matter, improve fertility, and help to maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIe.

640E2—Sunburg sandy loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on hills and ridges on uplands and on slopes along drainageways and small streams. Individual areas range from 3 to 8 acres in size and are irregularly shaped. Some areas on side slopes adjacent to streams and drainageways are as large as 15 acres in size and are long and narrow.

Typically, the surface layer is brown and dark brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is brown, and the middle and lower parts are light olive brown and mottled. In many places erosion has exposed the light-colored substratum.

Included with this soil in mapping are a few small areas of Clarion and Salida soils. Clarion soils have more organic matter in the surface layer, are deeper to carbonates, and are on the flatter parts of slopes. Salida soils contain more sand, are droughtier, and erode more easily. They commonly are on the more sharply convex parts of slopes. Included soils make up less than 10 percent of the map unit.

Permeability of this Sunburg soil is moderately rapid, and runoff is rapid. Available water capacity is moderate or high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are used for cultivated crops because they are associated with soils that are better suited to this use. This soil is poorly suited to corn and soybeans. It is better suited to small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further erosion is a severe hazard. This soil is highly susceptible to soil blowing if it is tilled and if the soil is left bare. Practices that control runoff and allow more water to enter the soil help to prevent excessive soil loss and to improve pasture and crop growth. A system of conservation tillage that leaves crop residue on the surface, terraces, and grassed waterways help to prevent excessive soil loss.

In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short, steep slopes. In many areas, however, these measures are suitable. Because of an excess of calcium carbonate in this soil, larger applications of fertilizer are needed. Carry-over and sensitivity of some herbicides are problems. The supply of available iron is sometimes deficient, and in places other available minor elements may be low. Returning crop residue to the soil and regularly adding other organic material increase organic matter, improve fertility, and help to maintain tilth. Special fertilization and careful selection of herbicides generally are needed.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The land capability classification is IVe.

640F2—Sunburg sandy loam, 18 to 25 percent slopes, moderately eroded. This steep, well drained, calcareous soil is mostly on convex side slopes adjacent to drainageways and streams throughout the county. Individual areas range from 5 to 15 acres in size. Areas along drainageways and streams are long and narrow, and other areas are irregularly shaped.

Typically, the surface layer is brown, friable sandy loam about 7 inches thick. In areas that are cultivated, plowing has mixed some streaks and pockets of brown substratum material into the surface layer. The substratum to a depth of about 60 inches is mottled brown, calcareous sandy loam in the upper part and light olive brown, mottled, calcareous sandy loam in the middle and lower parts. In places erosion has exposed the light-colored substratum on the soil surface. In some places the slope is steeper.

Included with this soil in mapping are small areas of Salida soils. Salida soils contain more sand and coarse fragments in the solum. They are in similar landscape positions and make up less than 5 percent of the map unit.

Permeability of this Sunburg soil is moderately rapid, and runoff is rapid. Available water capacity is moderate or high. The content of organic matter is about 0.5 to 1 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Almost all the acreage of this soil is used as pasture. This soil is unsuited to cultivated crops because of the steep slopes and the severe hazard of further erosion. This soil is best suited to pasture. Further water erosion is a hazard, and low fertility limits plant growth. Crops often do not have enough water during periods of low rainfall because of rapid runoff. Conservation practices, such as improving fertility and controlling runoff so that more water can enter the soil, will improve plant growth. Overstocking and overgrazing the pasture reduces the protective vegetative cover and causes deterioration of the grasses. Under these conditions, weeds invade and compete with the grasses for available water and plant nutrients. Proper stocking rates, uniform grazing, timely deferment of grazing, and use of a planned grazing system help to keep the pasture and the soil in good condition. Ungrazed areas provide habitat for some species of wildlife. Applying fertilizer increases pasture dramatically. But fertilizer, together with renovation to establish more desirable and productive plant species, achieves more uniform and greater total production. An excess of calcium carbonate in this soil adversely affects the response of plants to fertilizer.

The land capability classification is VIe.

641B—Clarion-Sunburg complex, 2 to 5 percent slopes. These gently sloping, well drained soils are on knolls, ridges, and side slopes on uplands. The Clarion soil is on knolls and ridges and the lower parts of side slopes. The Sunburg soil is on knolls and the steepest part of side slopes. The two soils are in areas so intricately mixed or so small in size that mapping them separately is impractical. Individual areas range from 2 to 8 acres in size and are irregularly shaped. They are about 60 percent Clarion soil and 40 percent Sunburg soil.

Typically, the surface layer of the Clarion soil is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 13 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil is friable loam about 24 inches thick. The upper part is brown and dark yellowish brown, and the middle and lower parts are dark yellowish brown and yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the surface layer of the Sunburg soil is brown, friable, calcareous sandy loam about 8 inches thick. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is yellowish brown, and the lower part is grayish brown and mottled. In a few places where the soil has not been plowed, the surface layer commonly is darker.

Permeability is moderate in the Clarion soil and moderately rapid in the Sunburg soil. Runoff is medium. Available water capacity is high in the Clarion soil and moderate or high in the Sunburg soil. The content of organic matter is about 1 to 4 percent in the surface layer of these soils. The subsoil in these soils generally has a very low supply of available phosphorus and potassium. Tilth generally is good in the Clarion soil and fair in the Sunburg soil.

Most areas are cultivated. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. The Sunburg soil is susceptible to soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In most places applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In a few places, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and help to control erosion and maintain tilth.

The use of these soils as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, results in poor tilth, and reduces production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

641C2—Clarion-Sunburg complex, 5 to 9 percent slopes, moderately eroded. These moderately sloping, well drained soils are mostly on knolls, ridges, and convex side slopes on uplands. Slopes typically are short and irregular. The Clarion soil is on ridges and the lower parts of side slopes. The Sunburg soil is on knolls and the steepest parts of side slopes. Individual areas range from 4 to 10 acres in size, but a few are as large as 15 acres and are irregularly shaped. They are about 60 percent Clarion soil and 40 percent Sunburg soil. The two soils are in areas so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is friable loam about 23 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the surface layer of the Sunburg soil is brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is yellowish brown, calcareous sandy loam in the upper part and light olive brown, mottled, calcareous sandy loam in the lower part. In places the surface layer has been severely eroded, exposing the substratum.

Permeability is moderate in the Clarion soil and moderately rapid in the Sunburg soil. Runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 2.5 percent in the surface layer of these soils. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is good in the Clarion soil and fair in the Sunburg soil.

In most areas these soils are cultivated. They are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. The Sunburg soil is susceptible to soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and help to control erosion and maintain tilth.

The use of these soils as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, results in poor tilth and reduces production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

641D2—Clarion-Sunburg complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on knolls, ridgetops, and side slopes on uplands. Slopes typically are short and irregular. The Clarion soil is on ridges and the lower parts of side slopes. The Sunburg soil is on steep knolls and the steepest parts of side slopes. Individual areas range from 4 to 20 acres in size and are irregularly shaped. They are about 55 percent Clarion soil and 45 percent Sunburg soil. Areas are so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is friable loam about 20 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the surface layer of the Sunburg soil is brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is yellowish brown, and the lower part is light olive brown and mottled. In places the surface layer has been severely eroded, and the substratum has been exposed.

Permeability is moderate in the Clarion soil and moderately rapid in the Sunburg soil. Runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 2 percent in the surface layer of these soils. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is fair in both the Clarion and Sunburg soils.

Most areas are cultivated. These soils are poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a severe hazard. The Sunburg soil is susceptible to soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas these measures are not suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility and help to control erosion and maintain tilth.

The use of these soils as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, results in poor tilth and reduces production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

641E2—Clarion-Sunburg complex, 14 to 18 percent slopes, moderately eroded. These moderately steep, well drained soils are on knolls, ridgetops, and side slopes on uplands. Slopes typically are short and irregular. The Clarion soil is on ridges and the lower parts of side slopes. The Sunburg soil is on steep knolls and the steepest part of side slopes. Individual areas range from 4 to 20 acres in size and are long and narrow. They are about 55 percent Clarion soil and 45 percent Sunburg soil. Areas are so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Clarion soil is very dark grayish brown, friable loam about 7 inches thick. Plowing has mixed streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is friable loam about 19 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the surface layer of the Sunburg soil is brown and dark brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed streaks and pockets of brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is brown, and the middle and lower parts are light olive brown and mottled.

Permeability is moderate in the Clarion soil and moderately rapid in the Sunburg soil. Runoff is medium on the Clarion soil and rapid on the Sunburg soil. Available water capacity is high, but often this potential is not reached because of the rapid runoff and reduced surface infiltration. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of these soils. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is fair in both the Clarion and Sunburg soils.

In most areas these soils are cultivated. They are poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a severe hazard. The Sunburg soil is susceptible to soil blowing. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In most areas, however, these practices are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility and help to control erosion and maintain good tilth.

The use of these soils as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, results in poor tilth and reduces production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IVe.

642D2—Sunburg-Salida complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained and excessively drained soils are on convex upland ridges and side slopes. The Sunburg soil generally is on the lower parts of convex side slopes and the broader parts of ridgetops. The Salida soil generally is on high, narrow ridges and the upper parts of side slopes and commonly has gravel on the surface. Individual areas range from 3 to 10 acres in size and are irregularly shaped. They are about 55 percent Sunburg soil and 45 percent Salida soil. Areas are so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Sunburg soil is brown, friable, calcareous sandy loam about 7 inches thick. Plowing has mixed some streaks and pockets of yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is calcareous sandy loam. The upper part is yellowish brown, and the lower part is olive brown and mottled. In places the surface layer has been severely eroded, exposing the substratum.

Typically, the surface layer of the Salida soil is very dark grayish brown, very friable, calcareous gravelly sandy loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is brown, loose, calcareous gravelly loamy coarse sand about 8 inches thick. The substratum to a depth of about 60 inches is multicolored, calcareous, very gravelly coarse sand.

Included with these soils in mapping are a few small areas of Clarion soils. Clarion soils have a thicker solum, and are not calcareous in the solum. They are on the lower parts of side slopes and dips on the lower level ridgetops. They make up about 2 to 5 percent of the map unit.

Permeability is moderately rapid in the Sunburg soil and very rapid in the Salida soil. Runoff is rapid on the Sunburg soil and slow on the Salida soil. Available water capacity is moderate or high on the Sunburg soil and very low on the Salida soil. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of these soils. The substratum of the Sunburg soil and the subsoil of the Salida soil generally have a very low supply of available phosphorus and potassium. Tilth generally is fair in the Sunburg soil and poor in the Salida soil.

In most areas these soils are used as cropland or are left idle. They are unsuited to row crops because of the steep slopes. They are better suited to grasses as pasture. Major management concerns are the hazard of further water erosion, low fertility, and the very low available water capacity. Maintaining an adequate vegetative cover helps to prevent excessive soil loss and improves the available water capacity by reducing runoff and the rate of drying. Adding fertilizer improves plant growth, but applications should be made in the fall or in very early spring before droughtiness limits growth.

If pastures are properly managed, native bluestem grasses eventually move onto this soil. Proper stocking rates, timely deferment of grazing, and use of a planned, uniform rotational grazing system are needed to help maintain desirable plant species and to keep the pasture in good condition. If properly managed, these soils are well suited to use as wildlife habitat.

The land capability classification is VIs.

654—Corwith loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained, calcareous soil is on low rises in upland, glacial outwash areas. Individual areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable, calcareous loam about 9 inches thick. The subsurface layer is very dark gray, friable loam about 8 inches thick. The subsoil is calcareous, friable, and about 13 inches thick. The upper part is dark grayish brown loam, and the lower part is dark grayish brown and light olive brown silt loam and mottled. The substratum to a depth of about 60 inches is mottled, light brownish gray and light olive brown, calcareous silt loam.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Water erosion generally is not a problem. However, this soil is susceptible to soil blowing if the soil is fall plowed or if the soil surface is left bare. A system of conservation tillage that leaves crop residue on the surface and the regular addition of organic material help to control soil blowing and to maintain tilth and productivity. This soil generally is not artificially drained, but in some areas artificial drainage will improve timeliness of operations.

The use of this soil as pasture is effective in controlling soil blowing. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increased runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

655—Crippin loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained, calcareous soil is on low rises on uplands. Individual areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable, calcareous loam about 9 inches thick. The subsurface layer is friable, calcareous, and about 10 inches thick. The upper part is black clay loam, and the lower part is very dark gray loam. The subsoil is friable, calcareous loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is light olive brown and mottled. The substratum to a depth of about 60 inches is light olive brown and grayish brown, mottled, calcareous loam. In places the surface layer is thinner.

Included with this soil in mapping are some small areas of Clarion soils. Clarion soils are well drained and are on higher, more convex slopes. They make up about 5 percent of the map unit.

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

In most areas this soil is cultivated. It is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Erosion generally is not a problem on this soil. However, it is highly susceptible to soil blowing if it is fall plowed and if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. These soils generally are not drained, but in some areas artificial drainage will improve timeliness of operations.

The use of this soil as pasture is effective in controlling soil blowing. Overgrazing or grazing when the soil is wet causes surface compaction and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

658—Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on stream terraces and in upland glacial outwash areas. Individual areas range from about 5 to 40 acres in size, but some are as large as 100 acres. They are irregularly shaped.

Typically, the surface layer is black, friable, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, friable, calcareous loam about 7 inches thick. The subsoil is calcareous and about 11 inches thick. The upper part is olive gray, mottled, friable loam; and the lower part is olive gray, mottled, very friable sandy loam. The substratum to a depth of about 60 inches is calcareous gravelly coarse sand. It is olive in the upper part and brown and dark grayish brown in the lower part. In places the solum contains more clay. In some places the sand and gravel substratum is at a depth of less than 24 inches.

Included with this soil in mapping are small areas of Biscay, ponded, and Harcot soils. Biscay, ponded, soils are very poorly drained and are subject to ponding after rains. Harcot soils have a higher calcium carbonate content throughout and are in landscape positions similar to those of the Mayer soil. Included soils make up about 5 to 10 percent of the map unit.

Permeability of this Mayer soil is moderate in the solum and rapid in the substratum. Runoff is slow. This soil has a seasonal high water table. Available water capacity is moderate. Root development and available water capacity are somewhat limited by the underlying calcareous sand and gravel. The content of organic matter is about 4 to 6 percent in the surface layer. The subsoil generally has a very low supply of available potassium and phosphorus. The soil generally has fair tilth.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is needed for best crop production. Drainage can be improved by the installation of underground drains. These drains function well, but in some places installation is difficult because of instability of the substratum. Care should be taken to avoid overdrainage. In years when rainfall is below average or when rains are untimely, sufficient water for best crop growth will be limited because of the low or moderate available water capacity. This soil is subject to soil blowing, especially if it is plowed in the fall and if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to prevent soil blowing and conserves moisture.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to maintain desirable plant species and keep the pasture in good condition.

The land capability classification is IIw.

659—Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on stream terraces and in upland glacial outwash areas. Individual areas range from 5 to 60 acres in size, although some are as large as 100 acres. They are irregularly shaped.

Typically, the surface layer is black, friable, calcareous loam about 10 inches thick. The subsurface layer is friable, calcareous loam about 11 inches thick. The upper part is black, and the lower part is very dark gray. The calcareous subsoil is mottled and friable and is about 16 inches thick. The upper part is grayish brown sandy clay loam, and the lower part is olive gray sandy loam. The substratum to a depth of about 60 inches is olive gray, calcareous gravelly coarse sand. In places the depth to the sand and gravel substratum is less than 32 inches.

Included with this soil in mapping are a few small areas of Biscay, ponded, and Harcot soils. Biscay, ponded, soils are wetter and are subject to ponding after rains. Harcot soils have a higher calcium carbonate content throughout and are in landscape positions similar to those of the Mayer soil. Included soils make up about 5 to 10 percent of the map unit.

Permeability of this Mayer soil is moderate in the solum and rapid in the substratum. Runoff is slow to ponded. The soil has a seasonal high water table. Available water capacity is moderate. The content of organic matter is about 4 to 6 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is needed for best crop production. Drainage can be improved by the installation of underground drains. These drains function well, but in some places installation is difficult because of instability of the substratum. Care should be taken to avoid overdrainage. In years when rainfall is below average or when rains are untimely, sufficient water for best crop growth may be limited because of moderate available water capacity. This soil is subject to soil blowing, especially if it is fall plowed and if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to prevent soil blowing and to conserve moisture.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to maintain desirable plant species and keep the pasture in good condition.

The land capability classification is IIw.

787B—Vinje silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex knolls on uplands. Areas range from 5 to 15 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, firm silty clay loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown, firm silty clay about 11 inches thick. The subsoil is about 26 inches thick. The upper part is brown, firm silty clay; the next part is brown and light olive brown, mottled, firm silty clay loam; and the lower part is light olive brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is mottled light olive brown and grayish brown, calcareous loam.

Included with this soil in mapping are a few small areas of somewhat poorly drained Collinwood soils on the flatter parts of the slope. These soils make up about 5 percent of the map unit.

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

Most areas are cultivated. If water erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Soil blowing can be severe on this soil if it is tilled and if the soil is left bare. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and prevent surface crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIe.

787C2—Vinje silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes on uplands. Slopes typically are short. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown silty clay loam subsoil material into the surface layer. The subsoil is firm silty clay loam about 28 inches thick. The upper part is brown, and the lower part is yellowish brown. The substratum to a depth of about 60 inches is mottled light olive brown, calcareous clay loam. In a few places the surface layer is more than 10 inches thick.

Included with this soil in mapping are a few areas of well drained Storden soils. Storden soils are calcareous and are in landscape positions similar to those of the Vinje soil. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a hazard. Soil blowing can be severe on this soil if it is tilled and if the soil is left bare. A system of conservation tillage that leaves crop residue on the surface, terracing, contour farming, and grassed waterways help to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the undulating areas and the short slopes. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and to prevent surface crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIe.

811—Muskego muck, 0 to 1 percent slopes. This level, very poorly drained, organic soil is in depressions on uplands. It is subject to ponding. Individual areas range from 10 to 80 acres in size and are circular.

Typically, the organic surface layer is about 28 inches thick. The upper part is black, nonsticky, sapric material, and the lower part is black, slightly sticky, sapric material. Underlying the surface soil is calcareous, coprogenous material that is mainly black and extends to a depth of 60 inches or more. In a few places this soil is calcareous throughout the solum.

Permeability of this Muskego soil is moderate or moderately rapid in the sapric material and slow in the coprogenous earth. Runoff is very slow or ponded. The soil has a seasonal high water table at or near the surface. Available water capacity is very high. The content of organic matter is more than 20 percent in the surface layer. The surface soil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas have been artificially drained and are used for row crops. Even where drainage is adequate, this soil is poorly suited to corn, soybeans, and small grain. It is poorly suited to legumes for hay or pasture. During periods of excessive rainfall, crops are sometimes damaged or destroyed before tile drains can remove the excess water. If this happens to crops early in the season, this soil can be tilled and replanted. Early frost often injures crops in late spring and early fall on this low-lying soil, which loses heat rapidly from the surface. If drainage is adequate and if the soil is fertilized and well managed, row crops will grow fairly well. Small grain, however, tends to lodge badly and produce poor quality grain. Growth of all crops generally is better in years of somewhat limited rainfall than in years of above average rainfall. This soil can be tilled throughout a wide range of moisture content. Fall plowing should be avoided on this soil because soil blowing is a severe hazard if the surface layer is left unprotected. Herbicide selection and application rates need careful attention because of the high organic matter content, which causes many herbicides to be less effective.

Legumes for hay production or as pasture do poorly on this soil and are highly susceptible to winterkill. Partially drained areas are often used as pasture. Many grasses are well suited to and are productive on this soil, although such species as reed canarygrass, which tolerate wetness, are generally more productive and easier to manage. Rotational grazing and avoiding grazing when the soils are too wet help to keep the pasture in good condition. Areas that are not drained sufficiently for use as pasture or cropland provide good habitat for wildlife.

The land capability classification is IVw.

823—Ridgeport sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on upland glacial outwash plains and stream terraces. Individual areas range from 4 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 9 inches thick. The subsurface layer is very dark gray, very friable sandy loam about 10 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 12 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous gravelly loamy sand.

Permeability of this Ridgeport soil is moderately rapid in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The main limitation is the low available water capacity. Growth of crops is limited during parts of most growing seasons, especially in years when rainfall is below average or if rains are untimely. Small grain and grasses and legumes for hay or pasture generally do better than row crops. This soil warms up quickly in spring and can be worked soon after rains. When tilled or plowed, the surface layer dries rapidly and commonly is subject to soil blowing. Windblown sand damages or destroys young seedlings. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve fertility, conserve moisture, and help to control erosion.

The use of this soil as pasture is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIs.

823B—Ridgeport sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on upland glacial outwash plains and stream terraces. Individual areas range from 4 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 10 inches thick. The subsurface layer is very dark gray, very friable sandy loam about 9 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 10 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous gravelly loamy sand.

Permeability of this Ridgeport soil is moderately rapid in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. In parts of some seasons it is commonly seasonally droughty because the gravelly substratum limits available water capacity. Growth of crops is limited in parts of most growing seasons, especially in years when rainfall is below average or if rains are untimely. Small grain and grasses and legumes for hay or pasture generally do better than row crops. This soil warms up quickly in spring and can be worked soon after rains. The surface tends to dry quickly after tillage, and soil blowing is a hazard. In some years windblown sand may damage young plants. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve fertility, conserve moisture, and help to control erosion. In some areas slopes can be farmed on the contour. Terraces generally are not constructed on this soil because of the danger of exposing the sand and gravel substratum.

The use of this soil as pasture is effective in controlling water erosion and soil blowing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

836B—Kilkenny clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex knolls and ridges on uplands. Individual areas range from 3 to 5 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable clay loam about 9 inches thick. The subsoil is firm and about 36 inches thick. The upper part is brown clay; the next part is olive brown and light olive brown clay; and the lower part is light olive brown, mottled clay loam.

The substratum to a depth of about 60 inches is grayish brown, calcareous, and mottled. The upper part is clay loam and the lower part is loam.

Permeability of this Kilkenny soil is moderately slow, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is cultivated, water erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. In some areas applying mechanical erosion-control measures, such as contour farming and terracing, is difficult because of the irregular topography and the short slopes. In many areas, however, these measures are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility, reduce crusting, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees, and a few small areas remain in native hardwoods. New stands of trees survive and grow well if species are selected and managed properly.

The land capability classification is IIe.

836C2—Kilkenny clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex knolls and side slopes on uplands. Individual areas range from 3 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable clay loam about 7 inches thick. Plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is firm and about 35 inches thick. The upper part is brown clay; the next part is olive brown and light olive brown, mottled clay; and the lower part is light olive brown, mottled clay loam. The substratum to a depth of about 60 inches is grayish brown and light olive brown, calcareous, and mottled. The upper part is clay loam and the lower part is loam.

Included with this soil in mapping are a few small areas of Storden soils. Storden soils have less clay and more sand, are calcareous throughout, and are on the steeper parts of slopes. They make up about 2 to 5 percent of the map unit.

Permeability of this Kilkenny soil is moderately slow, and runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay or pasture. If this soil is cultivated, further water erosion is a severe hazard. A system of conservation tillage that leaves crop residue on the surface, grassed waterways, and crop rotations that include grass help to control erosion. In some areas, where the slopes are long enough and smooth, mechanical erosion-control practices, such as contour farming and terracing, are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility and help to control erosion and maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is well suited to trees and a few small areas remain in native hardwoods. New stands of trees survive and grow well if species are selected and managed properly.

The land capability classification is IIIe.

836E2—Kilkenny clay loam, 9 to 18 percent slopes, moderately eroded. This strongly sloping and moderately steep, well drained soil is on convex knolls, ridges, and side slopes on uplands. Individual areas typically range from 3 to 40 acres in size, and a few areas are as much as 80 acres. They are irregularly shaped.

Typically, the surface layer is very dark gray, friable clay loam about 7 inches thick. The subsoil is firm and about 28 inches thick. The upper part is brown clay; the next part is olive brown and light olive brown, mottled clay; and the lower part is light olive brown, mottled clay loam. The substratum to a depth of about 60 inches is grayish brown and light olive brown, mottled clay loam. The upper part is clay loam and the lower part is loam.

Included with this soil in mapping are a few small areas of Storden soils. Storden soils have less clay and more sand, are calcareous throughout, and are on the steeper part of slopes. They make up about 5 percent of the map unit.

Permeability of this Kilkenny soil is moderately slow, and runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated, but some are used as pasture or are in native hardwoods. This soil is poorly suited to corn and soybeans. It is better suited to small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, further water erosion is a severe hazard. Major management concerns are related to the hazard of water erosion, water management, and fertility. The amount of water available for plant growth may be low because of rapid runoff. In some areas, where slopes are long enough and smooth, mechanical erosion-control practices, such as contour farming and terracing, are suitable. Returning crop residue to the soil and regularly adding other organic material improve fertility and help to control erosion and maintain tilth.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, increases runoff, and results in poorer tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IVe.

879—Fostoria loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is mainly on slightly convex or concave slopes on upland glacial outwash plains. Individual areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable loam about 10 inches thick. The subsurface layer is friable and about 10 inches thick. The upper part is black loam, and the lower part is black and very dark gray clay loam. The subsoil is friable and about 23 inches thick. The upper part is dark grayish brown loam; the next part is light olive brown and olive brown, mottled clay loam; and the lower part is light olive brown, mottled, calcareous silt loam. The substratum to a depth of about 60 inches is mottled, grayish brown and light olive brown, calcareous silt loam. In places thin layers of sand and gravel are in the lower part of the substratum.

Included with this soil in mapping are small areas of Truman soils. Truman soils are well drained and in slightly higher landscape positions. They make up about 2 to 5 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Soil blowing may be a hazard on this soil if it is fall plowed or if the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil blowing. This soil generally is not artificially drained, but in some areas artificial drainage will improve timeliness of operations.

The use of this soil as pasture is effective in preventing soil blowing. If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

956—Harps-Okoboji complex, 0 to 2 percent slopes. These level to nearly level, poorly drained and very poorly drained soils are in depressions and on their adjacent rims on uplands. The poorly drained, calcareous Harps soil is on convex rims surrounding the very poorly drained, depressional Okoboji soil. The Okoboji soil is subject to ponding. Individual areas range from 10 to 40 acres in size, although some areas are as large as 120 acres. The Okoboji soil is generally circular, and the Harps soil is irregularly shaped. It is about 60 percent Harps soil and 40 percent Okoboji soil. Areas are so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Harps soil is black, friable, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, mottled, friable, calcareous loam about 8 inches thick. The subsoil is olive gray, mottled, friable, calcareous loam about 24 inches thick. The substratum to a depth of about 60 inches is mottled, olive gray and light olive brown, calcareous loam.

Typically, the surface layer of the Okoboji soil is black, firm silty clay loam about 9 inches thick. The subsurface layer is black, firm, and about 27 inches thick. The upper part is silty clay loam, and the lower part is silty clay. The subsoil is mottled and firm and is about 10 inches thick. The upper part is very dark gray silty clay, and the lower part is olive gray silty clay loam. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam. In places the surface layer contains more sand.

Permeability is moderate for the Harps soil and moderately slow for Okoboji soil. Runoff is slow on the Harps soil and slow or ponded on the Okoboji soil. These soils have a seasonal high water table. Shrink-swell potential is high in the Okoboji soil. The content of organic matter is about 4.5 to 12 percent in the surface layer of these soils. The subsoil of the Harps soil and the subsurface layer of the Okoboji soil generally have a very low supply of available phosphorus and potassium. Both Harps and Okoboji soils generally have fair tilth.

Most areas are cultivated. These soils are moderately suited to corn, soybeans, and small grain. Harps soils are moderately suited to grasses and legumes for hay or pasture. The Okoboji soil is poorly suited to some legumes, especially alfalfa. Drainage is the main limitation. Drainage is essential for best crop production on these soils, especially the Okoboji soil, which tend to pond water in the spring and after heavy rains. Underground drains function well on these soils, but in some places it is difficult to find outlets deep enough for these drains to function adequately. If these soils are fall plowed and if surface layer is left bare, soil blowing is a hazard, especially on the Harps soil. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material improve soil structure and help to reduce soil blowing. Because of the excess calcium carbonate in the Harps soil, larger applications of fertilizers are needed because of lower availability of plant nutrients. Herbicide carry-over and sensitivity are problems in areas of the Harps soil. On both soils, the supply of available iron is sometimes deficient, and in places on the Harps soil the availability of other minor elements also may be low. Soybeans can show dramatic visual evidence of iron deficiency when grown on the Harps soil. Soybean varieties that tolerate high-lime conditions should be selected.

If these soils are used as pasture, grasses and legumes that tolerate excessive wetness should be considered, especially on the Okoboji soil. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIw.

1032—Spicer silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on slightly concave to slightly convex slopes on upland outwash and lake plains. Individual areas range from 10 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable, calcareous silty clay loam about 10 inches thick. The subsurface layer is black, mottled, friable, calcareous silty clay loam about 9 inches thick. The subsoil is olive gray, mottled, friable, calcareous, and about 21 inches thick. The upper part is silty clay loam, and the lower part is silt loam. The substratum to a depth of about 60 inches is mottled olive gray and strong brown, calcareous silt loam. In a few places the lower part of the subsoil and the substratum are fine sandy loam.

Included with this soil in mapping are Harpster and Okoboji soils. Harpster soils have a higher calcium carbonate content and are in similar landscape positions. Okoboji soils are very poorly drained and are in depressions. Included soils make up about 5 to 10 percent of the map unit.

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

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is essential for best crop production. Underground drainage systems work well. This soil is subject to soil blowing. A system of conservation tillage that leaves crop residue on the surface and the regular addition of other organic material help to prevent soil blowing and maintain fertility. Because of the high concentration of calcium carbonate in this soil, larger applications of fertilizers are needed because of lower availability of plant nutrients. Carry-over and sensitivity of some herbicides are problems on this soil. Also, available iron may be low because of the excess lime.

The use of this soil as pasture is effective in preventing soil blowing. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, poorer tilth, and a lower water infiltration rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

1052B—Bode-Kamrar clay loams, 2 to 5 percent slopes. These gently sloping, well drained soils are on upland knolls. Individual areas range from 4 to 10 acres in size and are long and irregularly shaped. They are about 60 percent Bode soil and 40 percent Kamrar soil. Areas are so intricately mixed or so small that mapping them separately is impractical.

Typically, the surface layer of the Bode soil is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 9 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The subsoil is friable clay loam about 22 inches thick. The upper part is brown, and the lower part is dark yellowish brown and calcareous. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

Typically, the surface layer of the Kamrar soil is black, friable clay loam about 9 inches thick. The subsurface layer is firm clay loam about 11 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is about 20 inches thick. The upper part is brown, firm clay loam; the next part is yellowish brown, firm clay; and the lower part is light olive brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam.

Included with these soils in mapping are a few small areas of well drained Storden soils. Storden soils do not have a subsoil, are calcareous in the surface layer, and are in landscape positions similar to those of the Bode and Kamrar soils. They make up about 5 percent of the map unit.

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

Most areas are cultivated. Water erosion is the limiting factor. If water erosion is controlled, this soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. A system of conservation tillage that leaves crop residue on the surface (fig. 11) and grassed waterways help to prevent excessive soil loss. Contour farming and terracing are practical in some areas but are not feasible in undulating areas where slopes are short. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to control erosion and prevent surface crusting, and increase the rate of water infiltration.

The use of these soils as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, results in poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIe.

1135—Coland clay loam, channeled, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom lands adjacent to major streams and rivers in the county. This soil is subject to flooding. Areas of this soil are dissected by oxbows and meandering stream channels, and these areas are among the first to flood whenever streams overflow. Some areas are long and narrow, paralleling the streams. Oxbows are numerous throughout. Individual areas of this soil are wide and range from 40 to 100 acres in size, but some are as large as 160 acres.

Typically, the surface layer is black, friable clay loam about 8 inches thick. The subsurface layer is black, friable clay loam about 40 inches thick. The substratum to a depth of about 60 inches is black clay loam. In a few places the sand content is higher. In places the surface layer has loamy overwash about 10 inches thick.

Permeability of this Coland soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 5 to 7 percent in the surface layer. The subsurface layer generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Flooding is a severe hazard on this soil; therefore, most areas remain in cool-season grasses or are left idle. Idle areas contain trees, brush, or native grasses, which provide good wildlife habitat. Areas of cool-season grasses are used as pastureland. This soil is not suited to cultivated crops or hayland. If the flooding is controlled, old stream channels are filled, trees and brush are cleared, and adequate drainage is provided, this soil is well suited to row crops.

This soil is suited to pasture. Areas that are used as pasture provide good grazing for livestock. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is Vw.

Figure 11.—Cornstalks provide a protective cover for no-till soybeans on Bode-Kamrar clay loams, 2 to 5 percent slopes.

1221—Palms muck, ponded, 0 to 1 percent slopes. This very poorly drained soil is in depressional areas on bottom lands and low terraces adjacent to the major streams and rivers and in shallow depressional areas on uplands. It is subject to ponding. Individual areas range from 3 to 40 acres in size and are circular, although a few areas are irregularly shaped.

Typically, the surface layer is black sapric material about 40 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. In places the substratum is loamy sand or sand. In a few places the sapric material is deeper.

Permeability of this Palms soil is moderately slow to moderately rapid in the organic material and moderate in the substratum. Available water capacity generally is very high. In most areas either small ponds are evident or the water table is at or near the surface throughout the year. The content of organic matter is more than 25 percent in the surface layer. The subsoil generally has a very low supply of phosphorus and potassium. This soil generally has good tilth.

Most areas are left idle or are used as wildlife habitat. These soils generally are well suited to wetland wildlife habitat but are not suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Providing adequate drainage on this soil is very difficult because suitable outlets are not available.

The land capability classification is Vw.

1259—Biscay clay loam, ponded, 32 to 40 inches to sand and gravel, 0 to 1 percent slopes. This level, very poorly drained soil is in shallow depressions on upland glacial outwash plains. It is subject to ponding. Individual areas are circular. They range from 2 to 10 acres in size, although some are as large as 20 acres.

Typically, the surface layer is black, friable clay loam about 7 inches thick. The subsurface layer is friable clay loam about 15 inches thick and mottled. The upper part is black, and the lower part is very dark gray. The friable subsoil is olive gray, mottled, and about 13 inches thick. The upper part is clay loam, and the lower part is sandy loam. The substratum to a depth of about 60 inches is olive gray, calcareous, loamy coarse sand and gravel in the upper part and dark gray and gray, calcareous, fine sand in the lower part. In places the surface layer is thicker.

Permeability of this Biscay soil is moderate in the solum and rapid in the substratum. Runoff is very slow or ponded. The soil has a seasonal high water table at or near the surface. Available water capacity is moderate. The content of organic matter is about 6 to 8 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Drainage is essential for best crop production because many areas are ponded in the spring and after heavy rains. Underground drains function well on this soil, but in some areas the instability of the substratum makes installation difficult. This soil is not only seasonally wet but also is droughty, especially if rainfall is below average or if rains are not timely. If this soil is fall plowed and if the surface is left bare, soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent soil blowing and conserves moisture.

If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to maintain desirable plant species and keep the pasture in good condition.

The land capability classification is IIIw.

1339—Truman silty clay loam, stratified substratum, 0 to 2 percent slopes. This nearly level, well drained soil is on uplands and stream terraces. Individual areas are irregularly shaped. They range from 10 to 60 acres in size, and a few areas are as large as 220 acres.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsurface layer is friable silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown. The subsoil is friable and about 28 inches thick. The upper part is brown silty clay loam; the next part is dark yellowish brown, mottled silty clay loam; and the lower part is dark yellowish brown, mottled loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown, mottled fine sandy loam. In places the surface layer is more than 24 inches thick.

Permeability of this Truman soil is moderate, and runoff is slow. Available water capacity is high. The content of organic matter is about 3 to 5 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has good tilth.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is fall plowed and the surface is left bare, soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to maintain good tilth, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling soil blowing. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is I.

1339B—Truman silty clay loam, stratified substratum, 2 to 5 percent slopes. This gently sloping, well drained soil is on slightly convex slopes on uplands and stream terraces. Individual areas range from 5 to 15 acres in size and generally are elongated, although a few are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. The subsoil is friable and about 28 inches thick. The upper part is brown silty clay loam; the next part is dark yellowish brown silty clay loam; and the lower part is yellowish brown, mottled loam. The substratum to a depth of about 60 inches is brown, mottled fine sandy loam. In a few places the solum is loam.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If this soil is used for cultivated crops, water erosion is a hazard. Soil blowing is a hazard on this soil if areas are fall plowed and the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil and regularly adding other organic material improve fertility, help to maintain good tilth, and increase the rate of water infiltration.

The use of this soil as pasture is effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIe.

1506—Wacousta silty clay loam, stratified substratum, 0 to 1 percent slopes. This level, very poorly drained soil is in a depression adjacent to a stream. It is subject to flooding. This individual area is about 514 acres in size and is elongated.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The subsurface layer is black, friable silty clay loam about 10 inches thick. The subsoil is olive gray, friable, calcareous silt loam about 4 inches thick and mottled. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous, silt loam, loam, fine sandy loam, and loamy fine sand.

Permeability of this Wacousta soil is moderate, and runoff is slow or ponded. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 8 to 10 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Drainage is essential for best crop production on this soil because of flooding, which often drowns out legumes and delays planting. Underground drainage systems work well on this soil, but installation may be difficult in places because of the instability of the substratum. Drainage in some areas needs to be supplemented by shallow surface ditches, surface intakes to the underground drainage system, or a combination of both.

Areas in which drainage cannot be improved to make crop yields dependable can be used as pasture. However, crops selected for pasture and hay should tolerate wetness as well as ponding. If this soil is used for pasture, grazing when the soil is too wet causes surface compaction and damages crops. Proper stocking rates, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIIw.

1507—Brownton silty clay loam, 0 to 2 percent slopes. This nearly level, calcareous, poorly drained, slowly permeable soil is on flats and swales on uplands. Individual areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black, firm, calcareous silty clay loam about 8 inches thick. The subsurface layer is very dark gray, firm, calcareous silty clay loam about 9 inches thick. The subsoil is calcareous, about 22 inches thick, and mottled. The upper part is olive gray and dark gray, firm silty clay loam; the next part is olive gray, firm silty clay loam; and the lower part is olive gray, firm silty clay. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous clay. In places the surface layer is leached, and in other places it is thicker.

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

Permeability of this Brownton soil is slow, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 6 or 7 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has fair tilth.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The main limitation is wetness. The root zone is deep, but in wet seasons it is restricted by a high water table in areas that are inadequately drained. Underground drains function more slowly in this soil than in most others in the county and must be more closely spaced. If this soil is tilled when too wet, the surface layer puddles easily and becomes cloddy and hard when dry. Soil blowing is a hazard on this soil, especially if large areas are plowed in the fall and the surface is left bare. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and improves fertility. Because of the excess calcium carbonate in this soil, larger applications of fertilizers are needed because of lower availability of plant nutrients. Carry-over and sensitivity of some herbicides are problems on this soil.

This soil is also suited to use as pasture. If this soil is used as pasture, proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

1595—Harpster silty clay loam, 0 to 2 percent slopes. This nearly level, highly calcareous, poorly drained soil is on rims of depressions and in lower-lying areas on upland glacial outwash plains. Individual areas are irregularly shaped. They range from 10 to 50 acres in size, but some are as large as 160 acres.

Typically, the surface layer is black, friable, calcareous silty clay loam about 9 inches thick. The subsurface layer is very dark gray, friable, calcareous silty clay loam about 12 inches thick. The subsoil is mottled, friable, calcareous, and about 19 inches thick. The upper part is dark grayish brown silty clay loam; the next part is grayish brown silt loam; and the lower part is light grayish brown silt loam. The substratum to a depth of about 60 inches is light grayish brown, mottled, calcareous silt loam. In a few places the surface layer is loam.

Included with this soil in mapping are a few small areas of Okoboji soils. Okoboji soils are very poorly drained and in depressions. They make up less than 5 percent of the map unit.

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

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Wetness is the main limitation. Drainage is essential for best crop production, and underground drainage systems function well. Most of the acreage of this soil is tilled in fall, but if the surface is left bare or unprotected soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the soil surface and the regular addition of other organic material help to improve structure and reduce soil blowing. Because of the excess concentration of calcium carbonate in this soil, larger applications of fertilizer are needed because of lower availability of plant nutrients. Carry-over and sensitivity of some herbicides are problems on this soil. The supply of available iron is sometimes deficient, and in places the availability of minor elements may be low. Soybeans may show visual evidence of iron deficiency when grown on this soil. Soybean varieties that tolerate high-lime conditions should be selected.

Using this soil as pasture is effective in preventing soil blowing. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, poor tilth, and a lower water infiltration rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is IIw.

1733—Calco silty clay loam, frequently flooded, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on bottom land. It is subject to flooding. Individual areas are long and narrow and parallel the sides of small streams. They range from 10 to 25 acres in size, but some are as large as 35 acres.

Typically, the surface layer is black, friable silty clay loam about 16 inches thick. The subsurface layer is silty clay loam about 32 inches thick. The upper part is black and friable; the next part is black and firm; and the lower part is black and very dark gray, mottled, and firm. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. This soil is calcareous throughout. In places the surface does not have carbonates. In a few places the texture of the solum is clay loam.

Permeability of this Calco soil is moderate, and runoff is slow. Runoff is also received from adjacent soils. The soil has a seasonal high water table. Available water capacity is high. Shrink-swell potential is high. The content of organic matter is about 5 to 7 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. This soil generally has fair tilth.

Flooding is a severe hazard on this soil; consequently, most areas remain in cool-season grasses or are left idle. Areas of cool-season grasses are used as pasture. Idle areas provide good habitat for some species of wildlife. This soil is not suited to cultivated crops and hay. If flooding is controlled, old stream channels filled, and a drainage system installed, this soil is well suited to row crops and hay. These practices may be too expensive to install.

This soil is suited to pasture. Areas that are used as pasture provide good grazing for livestock. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, rotational grazing, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability classification is Vw.

2222—Adrian muck, 0 to 1 percent slopes. This level, very poorly drained, organic soil is in upland depressions within outwash plains. It is subject to ponding. Individual areas range from 10 to 160 acres in size. Most are irregularly shaped, but some are circular.

Typically, the surface layer is black, slightly sticky sapric material about 7 inches thick. The subsurface layer is black, slightly sticky sapric material about 27 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is olive gray, mottled loamy sand. In other places a layer of mineral material is less than 5 inches thick and is between the organic layer and the underlying sandy material.

Permeability of this Adrian soil is moderately slow to moderately rapid in the organic material and rapid in the substratum. Runoff is very slow. The soil has a seasonal high water table. Available water capacity is very high. The content of organic matter is more than 20 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. This soil generally has good tilth.

Most areas are artificially drained and are used for row crops. This soil is poorly suited to row crops even if adequately drained. Drainage is essential for best crop production. In addition to underground drains, surface intakes are used, although in places outlets are difficult to find that are deep enough for drains to function adequately. Also, installation of underground drains may be difficult in places because of the instability of the substratum. During periods of excessive rainfall, crops are sometimes damaged or destroyed before tile drains can remove the excess water. If this crop damage occurs early in the season, the land can be replanted. This soil is slow to warm in spring, and planting is delayed. This soil is in low-lying areas; consequently, the surface will lose heat rapidly and frost will often injure crops in late spring and early fall. Using early maturing varieties helps to reduce crop losses caused by late planting and early frost. This soil can be tilled within a wide range of moisture content. Fall plowing should be avoided on this soil because the surface is subject to soil blowing when dry and unprotected. The application rates of some herbicides should be increased on this soil because of the high organic matter content, which causes herbicides to be less effective. Small grain tends to lodge badly and to produce harvests of poor quality. Legumes for hay grow poorly on this soil and are often winterkilled.

In partially drained areas this soil is suited to permanent pasture consisting of bluegrass, bromegrass, and reed canarygrass. Undrained areas generally are suited to use as habitat for wildlife.

The land capability classification is IVw.

4000—Urban land. This map unit is on nearly level and gently sloping uplands south of the town of Forest City. The area is about 360 acres in size and is rectangular.

This map unit is covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification of the soils is not feasible. In many areas the structures are built on loamy or clayey fill material that ranges from 24 to 60 inches or more in thickness. Most areas are drained by surface drains, sewer systems, and gutters.

No land capability classification is assigned.

5010—Pits, sand and gravel. This map unit dominantly is on outwash plains on uplands. Most pits are still active. The pits range from less than 1 acre to more than 40 acres in size and commonly are square or rectangular.

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

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

No land capability classification is assigned.

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

Typically, the uppermost 60 inches is yellowish brown, friable sandy loam. In many places cobbles and pebbles are common on the surface. In some places the texture is loam. The surface color ranges from very dark gray to dark brown.

Included with these soils in mapping are a few small areas of sand. Also included are a few areas that were once dumps or landfills and have now been covered.

Permeability in Orthents, loamy, varies with texture and density. Runoff is slow to rapid. Available water capacity is moderate or low. These soils, because they were 3 to 20 feet or more beneath the surface, have less pore space and a higher density than the original surface layer. They have not been appreciably affected by the processes of soil formation, such as freezing and thawing. The content of organic matter in these soils is very low unless the topsoil has been redistributed throughout the area. As a result, preparing a good seedbed is difficult and drought is a hazard. In most areas these soils have a very low supply of available phosphorus and potassium.

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

No land capability classification is assigned.

Prime Farmland

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

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

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

About 280,000 acres in the survey area, or nearly 76 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are throughout the county. About 270,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for about 80 percent of the county's total agricultural income each year.

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

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

Soils that have limitations or hazards, such as a seasonal high water table, frequent flooding during the growing season, or inadequate rainfall, qualify for prime farmland only in areas where these limitations or hazards have been overcome by such measures as drainage, flood control, or irrigation. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

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

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

In 1983, about 332,200 acres in Hancock County was used for agricultural purposes. Of this total, approximately 229,000 acres was used for corn and soybeans, 4,300 acres for oats, and 9,800 acres for hay. Field crops suited to the soils and climate in the county include many that are not commonly grown. The main crops are corn and soybeans. Grain sorghum, sunflowers, sugar beets, sweet corn, popcorn, and canning peas are among the crops that can be grown if economic and other conditions are favorable. Oats is the most common close-growing crop. Wheat, barley, rye, and flax can be grown. A variety of forage crops can also be grown, and seed can be produced from these crops.

Specialty crops are not commonly grown in the county, but a small acreage is used for sweet corn. Most of the upland soils are suited to a variety of specialty crops, including orchard crops. Some of the organic soils are suited to potatoes. The rest are used for pasture, woodland, farmsteads, roads, or miscellaneous crops or are left idle.

The paragraphs that follow describe the major concerns in managing the soils in the county for crops and pasture. These concerns are water erosion and soil blowing, drainage, fertility, and tilth.

Water erosion is a major problem on about 157,000 acres, or 43 percent, of the cropland and pasture in the county. If the slope is 3 percent or more, water erosion is a hazard. Measures that control erosion are needed on Bode, Bolan, Clarion, Collinwood, Dickman, Estherville, Kilkenny, Lester, Ridgeport, Salida, Storden, Sunburg, and Vinje soils.

Loss of the surface layer through erosion reduces the productivity of soils and results in sedimentation of streams and lakes. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on Clarion and other soils that have a subsurface layer that is very low in fertility. On soils that have a fine textured subsoil, such as Collinwood, Kilkenny, and Vinje soils, erosion exposes soil material in which fertility and the infiltration rate are lower and tilth is poor. Thus, preparing a good seedbed is much more difficult and erosion is greatly accelerated. Erosion also reduces the productivity of soils that tend to be droughty, such as Bolan, Dickman, Estherville, Ridgeport, Salida, and Wadena soils. Control of erosion helps to maintain the productivity of soils. It minimizes the pollution of streams and lakes, and it also improves the quality of water for municipal use, for recreation, and for fish and other wildlife.

Erosion control practices provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a vegetative cover on the soil for extended periods can hold soil losses to an amount that will not reduce the productive capacity of the soils. On livestock farms, including forage crops of grasses and legumes in the cropping sequence not only helps to control erosion on sloping land but also provides nitrogen and improves tilth for the following crop.

Certain methods of conservation tillage that leave a protective amount of crop residue on the surface are effective in controlling erosion. In no-till, the seedbed is prepared and the seed is planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on about 90 percent of the surface. In strip-till and ridge planting, the seedbed is prepared and the seed is planted in one operation. Tillage is limited to a strip not wider than one third of the total area. A protective cover of crop residue is left on two-thirds of the surface. In mulch-till, the soil is tilled throughout the field and part of the crop residue is incorporated into the soil. Preparing the seedbed and planting may be combined or separate operations.

Terraces reduce the length of slopes and thus the runoff rate and the risk of water erosion. They are most practical on deep, well drained soils that have long, uniform slopes. In Hancock County, the slopes commonly are not very uniform, but many soils are suitable for terracing. Examples of these are Bode, Clarion, Lester, and Storden soils. Other soils, such as Kilkenny and Vinje soils, are less suited because of a fine textured subsoil. Terracing generally is not practical on soils that have a coarse or moderately coarse texture in the surface layer or that are shallow to such textures. Examples of these are Bolan, Dickman, Estherville, Ridgeport, Salida, and Wadena soils.

In some areas gully-control structures and grassed waterways are needed. Grassed waterways slow runoff, trap sediments, and help to prevent gullying.

Soil blowing is a serious hazard on Dickman, Ridgeport, and Sunburg soils, and is a somewhat lesser hazard on Harcot, Harps, Harpster, Mayer, and Linder soils. The sandy soils tend to dry quickly, and are highly susceptible to soil blowing. Harcot, Harps, and Harpster soils are susceptible because they are calcareous and have a weak grade of structure in the surface layer. In a few hours windblown sand can damage young plants if winds are strong and the surface is left bare. Soil blowing also is a serious hazard in bare areas of the organic Adrian, Blue Earth, Houghton, Muskego, and Palms soils. These soils are particularly susceptible if they are tilled in the fall. Soil blowing can be controlled by a good plant cover, surface mulch, or tillage methods that keep the surface rough. Windbreaks of suitable trees and shrubs also help to control soil blowing.

Drainage is a management concern on 201,795 acres, or 55 percent of the cropland and pasture in the county. The very poorly drained Adrian, Biscay, ponded, Blue Earth, Houghton, Muskego, Okoboji, Palms, Rolfe, Wacousta, and Wacousta, stratified substratum, soils are naturally so wet that the production of crops commonly grown in the county generally is not possible. These soils make up 35,569 acres in the county. Most of the acreage of these soils has been artificially drained and is cropped. In extremely wet years, however, many areas are flooded and crops are destroyed or are not planted.

Unless they are drained, the poorly drained Biscay, Brownton, Calco, Canisteo, Coland, Fieldon, Harcot, Harps, Harpster, Kossuth, Mayer, Spicer, Waldorf, and Webster soils are so wet that crops are damaged in most years. These soils make up about 45 percent of the county. They are more productive and more easily managed if they are drained. All of these soils, except for some Calco and Coland soils, have been drained, but measures that improve drainage are needed in some areas.

The design of both surface and subsurface drainage systems varies with the kind of soil. If the very poorly drained soils are intensively row cropped, a combination of tile drainage and surface intakes generally is needed. In some areas a surface drainage system is also needed. Tile drains generally are adequate in the poorly drained soils. The drains should be more closely spaced in slowly permeable or very slowly permeable soils than in the more rapidly permeable soils. Care is needed to prevent overdraining of soils that formed in outwash or of soils that have a sandy substratum, such as Biscay, Fieldon, Harcot, and Mayer soils.

Tile drainage is very slow in Brownton, Kossuth, Okoboji, and Waldorf soils because of a fine textured subsoil and the lack of suitable outlets in many areas. Locating satisfactory outlets for a tile drainage system also is difficult in some areas of very poorly drained soils, such as Blue Earth, Houghton, Muskego, and Palms soils, and in many areas of the poorly drained Coland soils. Adequate outlets generally are more readily available in areas of the other poorly drained soils. In many of these areas, measures that improve drainage are needed.

Soil fertility is affected by the supply of available phosphorus and potassium in the subsoil, by pH, and by the content of organic matter. The supply of available phosphorus is low or very low in most of the soils in the county. Most of the soils in the county are slightly acid to moderately alkaline in the subsoil. Northeast of the Winnebago River, however, many of the soils range to medium acid in the subsoil. These are mainly the soils that formed in areas where the native vegetation was mixed trees and prairie grasses. On these soils and on many other soils in the county, applications of ground limestone are needed to raise the pH level sufficiently for crops, particularly alfalfa, to grow well.

Many soils in Hancock County have excess carbonates in the surface layer and subsoil. Examples of these are Blue Earth, Canisteo, Corwith, Crippin, Fieldon, Harcot, Harps, Harpster, Mayer, Salida, Spicer, Storden, and Sunburg soils. The high pH level of these soils, particularly the Harcot, Harps, and Harpster soils, reduces the supply of available phosphorus and some micronutrients.

The amount of nitrogen available to plants is related to the content of organic matter. In Hancock County, most of the well drained and somewhat poorly drained upland soils that formed under a native vegetation of prairie grasses, such as Clarion and Nicollet soils, have a moderate or high content of organic matter. The content generally is very low, however, in Storden and Sunburg soils. It is very high in the very poorly drained Blue Earth, Houghton, Muskego, and Palms soils and in some areas of the very poorly drained Okoboji soils and is high in the poorly drained soils.

The well drained Kilkenny and Lester soils and other soils that formed under a native vegetation of trees or mixed trees and grasses have a low or moderate content of organic matter. They generally have a lower content than the soils that formed under a native vegetation of prairie grasses. In eroded areas, the content of organic matter generally is very low. It generally is low or very low in moderately coarse textured soils, such as Dickman, Ridgeport, and Salida soils.

Biscay, Bolan, Dickman, Estherville, Fieldon, Linder, Mayer, Ridgeport, Salida, and Wadena soils have a limited available water capacity. The other soils in the county, however, have a high or very high available water capacity and generally are very productive if the proper kinds and amounts of fertilizer are applied.

Applications of herbicide are affected by the content of organic matter, the pH level, carbonates, and texture. Applications of lime and fertilizer should be based on the results of soil tests, on the needs of the crops, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer, herbicide, and lime to be applied.

Tilth is an important factor affecting the germination of seeds, the infiltration of water into the soil, and the ease of preparing a good seedbed. Soils in which tilth is good have granular structure, generally are high in the content of organic matter, and are porous.

Many of the well drained and somewhat poorly drained soils that are intensively row cropped have a loam surface layer. Examples are Clarion and Nicollet soils. The lighter colored Lester soils also have a loam surface layer, but this layer is lower in content of organic matter than that of the Clarion and Nicollet soils, has a weaker structure, and is more likely to form a crust during periods of intense rainfall. The crust is hard when dry. It reduces the rate of water infiltration and increases the rate of runoff. In other soils, such as Storden, the content of organic matter also is low or very low and tilth is poor. Rainfall readily runs off the surface of these soils, causing erosion. Regular additions of crop residue, manure, and other organic material improve soil structure and help to prevent excessive crusting. Including legumes and grasses in the cropping sequence improves tilth and reduces the susceptibility to erosion.

Tilth is somewhat poorer in the finer textured, well drained soils, such as Kilkenny and Vinje soils, than in medium textured, well drained soils. The finer textured soils generally are sticky when wet and are hard and cloddy when dry. Careful management and timely fieldwork are needed to obtain a good seedbed. Regular additions of organic material, such as crop residue and manure, and a cropping sequence that includes grasses and legumes improve tilth and help to control erosion.

Preparing a good seedbed is somewhat difficult on Collinwood and Ottosen soils and on the poorly drained Kossuth and Waldorf soils. All of these soils have a high content of clay in the surface layer. Fall tillage is common on these soils. Freezing and thawing improves tilth on soils that have been tilled in the fall. A good seedbed is more easily prepared in fall-tilled soils than in soils that are tilled in the spring. If large areas are tilled in the fall, however, soil blowing can be a problem as the soil dries in the spring. It can be controlled by leaving alternating protective strips or by leaving crop residue on the surface or mixing it into the surface layer. Chisel plowing is very effective in controlling soil blowing. These soils are well suited to ridge planting.

Permanent pasture in the county generally is planted to bluegrass, but many pastured areas also support trees and brush. Some have been renovated and are planted to legume-grass mixtures, such as alfalfa and bromegrass. Most of the pastures are not used as cropland because the soils are too steep or too wet for cultivation, are frequently flooded, or support trees.

Forage production can be increased by renovating the pasture, which helps to establish the more productive grasses and legumes, and by planting warm-season grasses, including switchgrass, big bluestem, and indiangrass. Improved drainage is needed in many areas. Brush and trees should be removed or thinned in some areas.

The management needed on established stands includes applications of fertilizer, control of weeds and brush, rotation and deferred grazing in a full-season grazing system, proper stocking rates, and adequate livestock watering facilities. If the protective plant cover is destroyed when pasture or hayland is renovated, erosion is a serious hazard in the steeper areas. If cultivated crops are grown prior to reseeding, contour farming, grassed waterways, and no-till planting or other systems of conservation tillage that leave crop residue on the surface are needed to control erosion. Interseeding grasses and legumes into the existing sod eliminates the need for destroying the plant cover during seedbed preparation.

Yields Per Acre

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

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

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

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

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

Land Capability Classification

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

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

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

Class I soils have few limitations or hazards that restrict their use.

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

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

Class IV soils have very severe limitations or hazards 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 or hazards, impractical to remove, that limit their use.

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

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

Class VIII soils and miscellaneous areas have limitations or hazards 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, woodland, wildlife habitat, or recreation.

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

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife (fig. 12). Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

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

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

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

Recreation

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

Figure 12.—This windbreak on Lester loam, 5 to 9 percent slopes, moderately eroded, protects buildings and yards from wind and snow. It also provides excellent habitat for wildlife.

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 gentle 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 camp sites.

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

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

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

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

Wildlife Habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Hancock County has a large and varied population of wildlife. White-tailed deer, ring-necked pheasant, Hungarian partridge, squirrels, and various waterfowl are the main game in the county, along with many other species of mammals and birds. Fishing generally is limited to ponded sand and gravel pits, the Iowa River, and a few smaller rivers and streams. Largemouth bass, northern pike, bullheads, and sunfish are the main species.

In the past, waterfowl habitat in the county was excellent. Intensive farming and the draining of many small sloughs and potholes have reduced this habitat. However, many migratory ducks and geese continue to rest and feed every fall in the remaining wetlands, particularly Eagle Lake, Twin Lakes, and Ventura Marsh (fig. 13).

Most of the white-tailed deer and squirrels are in the wooded areas, but many squirrels are around farmsteads and some deer are attracted to brushy areas near drainage ditches, along small streams, and in marshes.

White-tailed jackrabbit, cottontail rabbit, red fox, mink, raccoon, and muskrat find food and cover in various parts of the county. Among the common songbirds are robins, English sparrows, meadowlarks, blackbirds, mourning doves, purple martins, wrens, bluebirds, chickadees, brown thrashes, swallows, orioles, woodpeckers, and starlings.

Introduced ring-necked pheasant and Hungarian partridge have adapted well to the county. The numbers of these species vary from year to year, depending on the amount of nesting cover and on weather conditions. A lack of cover in winter and at nesting time and severe weather at nesting time greatly reduce the number of pheasants. The best pheasant range is probably the west-central and northwestern parts of the county. More desirable cover is available on the steeper sloping soils in the area. Some areas include or are adjacent to wet marshes that provide needed winter cover.

Pheasants are somewhat less abundant in other parts of the county. Many of the soils in these areas are nearly level or gently sloping, and much of the acreage is farmed intensively. Consequently, little food or cover is available for the pheasants in winter and the number of nesting sites is limited.

Nesting cover is the most critical factor affecting the number of pheasants. The best nesting sites in intensively farmed areas are in road ditches and along fence lines. Only a few of these sites are available in the intensively farmed areas in the county. As a result, the pheasant population is limited in these areas. It can be significantly increased if the plant cover in ditches and along fence lines is left unclipped until early summer.

Winter cover can be provided through farmstead windbreaks and wildlife plantings. Winter cover should be near a source of food. Leaving a few rows of grain in a field adjacent to a windbreak or other wildlife planting helps to provide food.

Small, odd-shaped areas unsuitable for farming provide excellent wildlife habitat. The strongly sloping to very steep Storden soils as well as marshes and depressional soils are most likely to have these areas. Good wildlife habitat may also be found in such areas as small, steep, eroded, or gravelly areas of cropland; gravel pits; railroad right-of-ways; or tracts of land cut off from the rest of a field by a stream or drainage ditch.

The type of existing cover and the location of the odd-shaped areas determine whether or not any additional vegetation should be established. In many of

Figure 13.—Marsh provides good natural habitat for waterfowl and muskrats.

these small areas, the only measures needed to develop wildlife habitat are those that protect the habitat from fire or grazing. In other areas, planting and measures that maintain the habitat may be necessary. A satisfactory wildlife habitat consists of low-growing plant cover, such as locally adapted grasses and legumes, which provide nesting sites and some food; a taller cover of grasses and shrubs, which provide refuge and resting areas; and clumps of evergreens and shrubs, which provide the best winter cover.

Measures that maintain the wildlife habitat are needed in many areas. Deferment of mowing before midsummer helps to protect ground-nesting birds and rabbits. Control of invading woody plants by chemical or mechanical means helps to maintain an adequate cover of grasses and legumes. Reseeding is occasionally needed. Further information about planning wildlife areas can be obtained from the Soil Conservation Service or the wildlife management biologist of the Iowa Conservation Commission.

Engineering

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

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

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

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

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

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

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

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

Building Site Development

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

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

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, 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, the available water capacity in the upper 40 inches, and the content of calcium carbonate affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

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

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

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

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

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

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

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

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

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

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

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

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

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

Construction Materials

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

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

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

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

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

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

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

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

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

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

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

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

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

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

Water Management

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

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

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

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

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

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

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

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water 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.

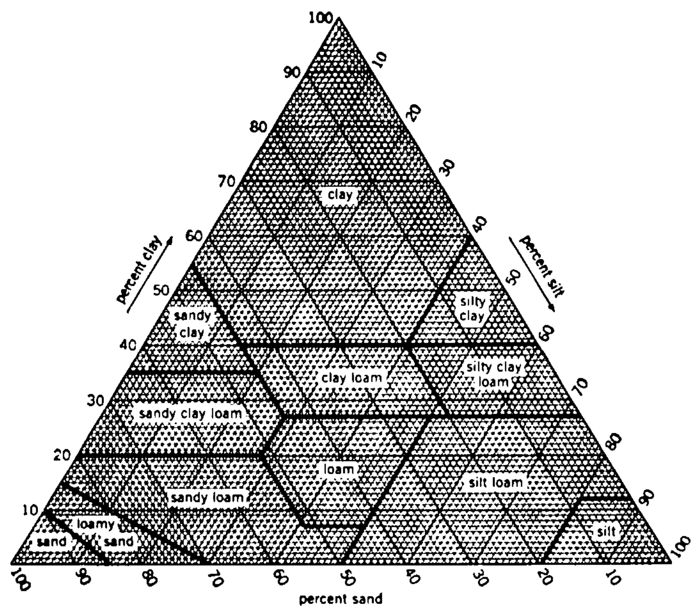

Figure 14.—Percentage of clay, silt, and sand in the basic USDA textural classes.

Engineering Index Properties

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 14). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

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

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

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

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

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

Physical and Chemical Properties

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

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

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

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

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

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone.

The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

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

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

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

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

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

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

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

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

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

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

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

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

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

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

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

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

Soil and Water Features

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

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

The four hydrologic soil groups are:

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

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

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

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

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

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

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

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

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(31)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

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

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

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

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (30)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (31)*. 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."

Adrian Series

The Adrian series consists of very poorly drained soils in depressions and old lakebeds within outwash plains. These soils formed in organic materials and the underlying sandy glacial outwash materials. Native vegetation was sedges, reeds, and other water-tolerant grasses. Permeability is moderately slow to moderately rapid in the organic material and rapid in the substratum. Slopes range from 0 to 1 percent.

Typical pedon of Adrian muck, 0 to 1 percent slopes, in a cultivated field; 2,480 feet north and 1,980 feet west of the southeast corner of sec. 1, T. 96 N., R. 25 W.

Oap—0 to 7 inches; black (N 2/0) sapric materials, about 5 percent fibers, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine granular structure; slightly sticky; common fine roots; slightly acid; abrupt smooth boundary.

Oa1—7 to 17 inches; black (10YR 2/1) sapric material, about 5 percent fibers, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly sticky; common fine roots; slightly acid; gradual smooth boundary.

Oa2—17 to 34 inches; black (10YR 2/1) sapric material, about 5 percent fibers, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; slightly sticky; common fine roots; few yellowish red (5YR 4/6) iron stains; slightly acid; abrupt smooth boundary.

2Cg—34 to 60 inches; olive gray (5Y 4/2) loamy sand (about 9 percent clay); common fine distinct olive brown (2.5Y 4/4) mottles; single grained; loose; few fine roots; neutral.

The thickness of the organic layer and the depth to the sandy materials range from 16 to 50 inches.

The surface tier is neutral in hue or has hue of 10YR. It has chroma of 0 or 1. The subsurface and bottom tiers have value of 2 or 3 and chroma of 0 to 3. The 2C horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. Its texture is loamy sand or sand.

Biscay Series

The Biscay series consists of poorly drained soils on glacial outwash plains and stream terraces. These soils formed in loamy material and in the underlying calcareous sand and gravel. Native vegetation was water-tolerant grasses. Permeability is moderate in the solum and rapid in the substratum. Slopes range from 0 to 2 percent.

Typical pedon of Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 1,440 feet south and 140 feet east of the northwest corner of sec. 26, T. 96 N., R. 26 W.

Ap—0 to 9 inches; black (N 2/0) clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; few small pebbles; neutral; abrupt smooth boundary.

A—9 to 14 inches; black (N 2/0) clay loam (29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine roots; few small pebbles; neutral; clear smooth boundary.

AB—14 to 18 inches; very dark gray (10YR 3/1) clay loam (29 percent clay), dark gray (10YR 4/1) dry; some mixing of black (N 2/0) subsurface material; very dark gray (10YR 3/1) kneaded; few fine distinct dark olive gray (5Y 3/2) mottles; weak fine subangular blocky structure; friable; few fine roots; few small pebbles; mildly alkaline; clear smooth boundary.

Bg1—18 to 24 inches; olive gray (5Y 4/2) clay loam (28 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; few fine faint olive (5Y 5/3) mottles; weak fine subangular blocky structure; friable; few fine roots; few small pebbles; mildly alkaline; clear smooth boundary.

Bg2—24 to 31 inches; olive gray (5Y 5/2) clay loam (29 percent clay); few olive gray (5Y 4/2) coatings on faces of peds; common fine faint olive (5Y 5/3) mottles; weak fine and medium subangular blocky structure; friable; few fine roots; few black (10YR 2/1) krotovina channels; mildly alkaline; clear smooth boundary.

BCg—31 to 36 inches; olive gray (5Y 5/2) sandy loam (13 percent clay); few olive gray (5Y 4/2) coatings on faces of peds; common fine faint olive (5Y 5/3) and few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; few fine roots; few black (10YR 2/1) krotovina channels; few soft accumulations (calcium carbonate); 4 to 5 percent coarse gravel, 8 to 10 percent fine gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

2Cg—36 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly loamy sand (6 percent clay); common medium prominent dark brown (7.5YR 4/4) mottles; single grained; loose; 20 percent fine and medium gravel; strong effervescence; mildly alkaline.

The thickness of the solum and the fine-loamy mantle is 32 to 40 inches. The mollic epipedon ranges from

16 to 24 inches in thickness.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 0 or 1. It dominantly is clay loam but includes loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 to 3. It is clay loam or loam. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 6.

Blue Earth Series

The Blue Earth series consists of very poorly drained, moderately permeable soils in depressions and old shallow lakebeds. These soils formed in coprogenous earth. Native vegetation was sedges, reeds, and other water-tolerant grasses. Slopes range from 0 to 1 percent.

Typical pedon of Blue Earth mucky silt loam, 0 to 1 percent slopes, in a cultivated field; 1,160 feet west and 21 feet south of the northeast corner of sec. 11, T. 97 N., R. 25 W.

Ap—0 to 7 inches; black (10YR 2/1) mucky silt loam (19 percent clay), coprogenous earth, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; few fine roots; few snail shell fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 28 inches; very dark gray (5Y 3/1) mucky silt loam (20 percent clay), coprogenous earth, gray (10YR 6/1) dry; common fine prominent strong brown (7.5YR 4/6) mottles; weak thick platy structure parting to weak fine subangular blocky; very friable; many snail shell fragments; strong brown (7.5YR 4/6) stains in root channels; strong effervescence; mildly alkaline; diffuse wavy boundary.

C2—28 to 60 inches; very dark gray (5Y 3/1) mucky silt loam (19 percent clay), coprogenous earth, gray (10YR 6/1) dry; common medium prominent dark brown (7.5YR 4/4) mottles; weak fine prismatic structure with some weak fine subangular blocky; very friable; common snail shell fragments; strong brown (7.5YR 4/6) stains in root channels; strong effervescence; mildly alkaline.

The coprogenous earth ranges from 30 to more than 80 inches in thickness. It has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 or 2.

Bode Series

The Bode series consists of well drained, moderately permeable soils on convex knolls and side slopes on uplands. These soils formed in glacial or lacustrine sediments and in the underlying glacial till. Native vegetation was tall prairie grasses. Slopes range from 2 to 18 percent.

Typical pedon of Bode clay loam, 2 to 5 percent slopes, in a cultivated field; 1,540 feet north and 180 feet east of the southwest corner of sec. 26, T. 94 N., R. 24 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam (about 32 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; few fine roots; slightly acid; abrupt smooth boundary.

A—9 to 13 inches; very dark gray (10YR 3/1) clay loam (about 32 percent clay), dark grayish brown (10YR 4/2) dry; black (10YR 2/1) coatings on faces of peds; weak fine granular structure; friable; few fine roots; slightly acid; clear smooth boundary.

AB—13 to 18 inches; very dark grayish brown (10YR 3/2) clay loam (about 33 percent clay), dark grayish brown (10YR 4/2) dry; some mixing of brown (10YR 4/3) subsoil material; few very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

Bw—18 to 28 inches; brown (10YR 4/3) clay loam (about 33 percent clay); few very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; slightly acid; abrupt smooth boundary.

BC—28 to 40 inches; dark yellowish brown (10YR 4/4) clay loam (about 30 percent clay); weak fine prismatic structure parting to weak medium subangular blocky; friable; few fine roots; few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline; gradual smooth boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) clay loam (about 28 percent clay); few fine distinct grayish brown (2.5Y 5/2) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few soft accumulations (calcium carbonate); few fine shale fragments; strong effervescence; mildly alkaline.

Typically, the thickness of the solum and the depth to free carbonates range from 18 to 50 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has chroma of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 3 or 4. It typically is clay loam, but the range includes loam in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8. It is clay loam or, less commonly, loam.

Map units 52C2, 52D2, and 52E2 are taxadjuncts to the Bode series because they do not have a mollic epipedon, which is definitive for the Bode series.

Bolan Series

The Bolan series consists of well drained soils on nearly level to slightly convex slopes on uplands and stream terraces. These soils formed in loamy eolian materials and alluvial sediments. Native vegetation was tall prairie grasses. Permeability is moderate in the upper part and rapid in the lower part. Slopes range from 0 to 5 percent.

Typical pedon of Bolan loam, 2 to 5 percent slopes, in a cultivated field; 2,400 feet west and 540 feet north of the southeast corner of sec. 6, T. 96 N., R. 24 W.

Ap—0 to 7 inches; black (10YR 2/1) loam (20 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few fine roots; medium acid; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) loam (23 percent clay), dark grayish brown (10YR 4/2) dry; weak fine and medium granular structure; friable; few fine roots; medium acid; gradual smooth boundary.

AB—14 to 21 inches; very dark grayish brown (10YR 3/2) loam (23 percent clay), grayish brown (10YR 5/2) dry; weak medium granular and weak fine subangular blocky structure; friable; some mixings of brown (10YR 4/3) subsoil material; few fine roots; medium acid; clear smooth boundary.

Bw1—21 to 28 inches; brown (10YR 4/3) loam (18 percent clay); some very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; medium acid; gradual smooth boundary.

Bw2—28 to 36 inches; brown (10YR 4/3) fine sandy loam (14 percent clay); a few dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.

BC—36 to 41 inches; dark yellowish brown (10YR 4/4) loamy fine sand (8 percent clay); few brown (10YR 4/3) coatings on faces of peds; weak medium and coarse subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—41 to 60 inches; dark yellowish brown (10YR 4/4) fine sand (5 percent clay); single grained; loose; slightly acid.

The solum ranges from 30 to 48 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value and chroma of 3 to 6. The C horizon has value of 4 to 6 and chroma of 3 to 6. It is loamy fine sand or fine sand.

Brownton Series

The Brownton series consists of poorly drained, slowly permeable, calcareous soils on uplands. These soils are on flats and in irregularly shaped swales. They formed in clayey and silty lacustrine sediments. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Brownton silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,600 feet west and 400 feet north of the southeast corner of sec. 2, T. 95 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (35 percent clay), very dark gray (10YR 3/1) dry; weak very fine and fine granular structure; firm; few fine roots; few fine snail fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A—8 to 13 inches; very dark gray (10YR 3/1) silty clay loam (37 percent clay), dark gray (10YR 4/1) dry; some mixings of olive gray (5Y 5/2) subsoil material; weak fine subangular blocky structure; firm; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

AB—13 to 17 inches; very dark gray (5Y 3/1) silty clay loam (37 percent clay), gray (10YR 4/1) dry; some mixings of olive gray (5Y 5/2) subsoil material; weak fine subangular blocky structure; firm; few fine tubular pores; strong effervescence; moderately alkaline; clear smooth boundary.

Bg1—17 to 23 inches; olive gray (5Y 5/2) and dark gray (5Y 4/1) silty clay loam (35 percent clay); few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few dark concretions (iron and manganese oxides); few fine tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2—23 to 30 inches; olive gray (5Y 5/2) silty clay loam (35 percent clay); few fine faint olive (5Y 5/3) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few very dark gray (10YR 3/1) krotovina channels;

few dark concretions (iron and manganese oxides); few fine tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.

BC—30 to 39 inches; olive gray (5Y 5/2) silty clay (55 percent clay); common fine prominent yellowish brown (10YR 5/8 and 5/6) mottles; moderate fine and medium subangular blocky structure; firm; few very dark gray (10YR 3/1) krotovina channels; few soft accumulations (calcium carbonate); few fine tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—39 to 47 inches; olive gray (5Y 5/2) clay (75 percent clay); common fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; few soft accumulations (calcium carbonate); common fine tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—47 to 60 inches; olive gray (5Y 5/2) clay (69 percent clay); common fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; few soft accumulations (calcium carbonate); common fine tubular pores; strong effervescence; mildly alkaline.

The solum ranges from 24 to 44 inches in thickness. The mollic epipedon is 12 to 24 inches thick. The lacustrine sediments range from 30 to 60 inches or more in thickness.

The A horizon is neutral in hue or has hue of 10YR to 5Y and chroma of 0 or 1. 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 loam or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2. It is silty clay or clay. Some pedons have a 2C horizon that is clay loam or loam.

Calco Series

The Calco series consists of poorly drained, moderately permeable, calcareous soils on bottom land. These soils formed in silty alluvium. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent slopes.

Typical pedon of Calco silty clay loam, frequently flooded, 0 to 2 percent slopes, in pasture; 950 feet north and 60 feet west of the southeast corner of sec. 6, T. 94 N., R. 23 W.

A1—0 to 16 inches; black (N 2/0) silty clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; weak very fine and fine granular structure with some fine medium granular; friable; common fine and medium roots; common fine snail shells; strong effervescence; moderately alkaline; gradual smooth boundary.

A2—16 to 26 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine and fine granular; friable; common fine roots; common fine snail shells; strong effervescence; moderately alkaline; gradual smooth boundary.

A3—26 to 34 inches; black (10YR 2/1) silty clay loam (about 35 percent clay), dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to moderate very fine and fine granular; firm; few olive gray (5Y 4/2 and 5/2) krotovina channels; few fine roots; common fine snail shells; strong effervescence, moderately alkaline; gradual smooth boundary.

A4—34 to 40 inches; black (10YR 2/1) silty clay loam (about 35 percent clay), dark gray (10YR 4/1) dry; moderate medium subangular blocky structure with some weak fine subangular blocky; firm; few fine roots; common fine snail shells; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—40 to 48 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay loam (about 35 percent clay), dark gray (10YR 4/1) dry; common fine prominent olive gray (5Y 4/2) mottles; weak fine prismatic structure; firm; common fine snail shells; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cg—48 to 60 inches; olive gray (5Y 5/2) silty clay loam (about 27 percent clay); few medium prominent strong brown (7.5YR 4/6), common fine distinct light olive brown (2.5Y 5/6), and common fine faint light olive gray (5Y 6/2) mottles; massive; friable; some black (10YR 2/1) root fills; few fine snail shells; strong effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon commonly is 40 to 50 inches thick and has a minimum thickness of 30 inches.

The A horizon is neutral in hue or has hue of 10YR to 5Y and chroma of 0 or 1. The Cg horizon has hue of 10YR to 5Y, value of 3 to 6, and chroma of 0 to 2.

Canisteo Series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils on nearly level or slightly concave slopes on uplands. These soils formed in calcareous, glacial till-derived sediments or glacial till. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo clay loam, 0 to 2 percent slopes, in a cultivated field; 100 feet north and 200 feet east of the southwest corner of sec. 35, T. 97 N., R. 26 W.

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

A1—8 to 15 inches; black (N 2/0) clay loam (about 32 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

A2—15 to 21 inches; very dark gray (10YR 3/1) clay loam (about 32 percent clay), gray (10YR 5/1) dry; some mixing of dark gray (5Y 4/1) and olive gray (5Y 5/2) subsoil material; few fine distinct very dark gray (5Y 3/1) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; strong effervescence; mildly alkaline; clear wavy boundary.

BA—21 to 29 inches; dark gray (5Y 4/1) clay loam (about 30 percent clay); some mixing of olive gray (5Y 5/2) subsoil material; very dark gray (5Y 3/1) coatings on faces of peds; common fine faint olive gray (5Y 5/2) and light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

Bg—29 to 36 inches; olive gray (5Y 5/2) clay loam (about 32 percent clay); very dark gray (5Y 3/1) coatings on faces of peds; common fine faint olive (5Y 5/3) mottles; weak fine and medium subangular blocky structure; friable; few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline; gradual smooth boundary.

BCg—36 to 43 inches; olive gray (5Y 5/2) loam (about 22 percent clay); few fine prominent yellowish red (5YR 5/8), common fine prominent strong brown (7.5YR 5/6), and common fine faint olive (5Y 5/3) mottles; weak medium subangular blocky structure; friable; few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline; abrupt smooth boundary.

Cg—43 to 60 inches; olive gray (5Y 5/2) loam (about 22 percent clay); few medium prominent yellowish red (5YR 5/8) and common medium prominent dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; massive; friable; few black concretions (iron and manganese oxides); few soft accumulations (calcium carbonates); strong effervescence; mildly alkaline.

The solum ranges from 20 to 50 inches in thickness. Carbonates are throughout the solum. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR. It is clay loam 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 clay loam, silty clay loam, or loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. Its texture is loam or clay loam.

Clarion Series

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

Typical pedon of Clarion loam, 2 to 5 percent slopes, in a cultivated field; 2,100 feet east and 540 feet north of the southwest corner of sec. 2, T. 97 N., R. 26 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 23 percent clay), very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

A—8 to 16 inches; very dark brown (10YR 2/2) loam (about 24 percent clay), dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; common fine roots; slightly acid; clear smooth boundary.

AB—16 to 21 inches; very dark grayish brown (10YR 3/2) loam (about 24 percent clay); some mixing of brown (10YR 4/3) and dark yellowish brown (10YR 4/4) subsoil material; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw1—21 to 30 inches; dark yellowish brown (10YR 4/4) and brown (10YR 4/3) loam (about 24 percent clay); dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw2—30 to 38 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loam (about 24 percent clay); weak fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

BC—38 to 45 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loam (about 24 percent clay); weak fine and medium subangular blocky structure; friable; few dark concretions (manganese and iron oxides); friable; neutral; gradual smooth boundary.

C1—45 to 52 inches; yellowish brown (10YR 5/4) loam (about 17 percent clay); massive; friable; few dark concretions (manganese and iron oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline; gradual smooth boundary.

C2—52 to 60 inches; yellowish brown (10YR 5/4) loam (about 14 percent clay); massive; friable; common dark concretions (manganese and iron oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline.

The solum ranges from 18 to 50 inches in thickness. The mollic epipedon is 10 to 22 inches thick.

The A horizon has value of 2 or 3. It dominantly is loam but includes clay loam that is as much as 28 percent clay. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y.

The Clarion soils in map units 138C2, 138D2, 641C2, 641D2, and 641E2 are taxadjuncts to the Clarion series because they do not have a mollic epipedon, which is definitive for the Clarion series.

Coland Series

The Coland series consists of poorly drained, moderately permeable soils on bottom land. These soils formed in loamy alluvium. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Coland clay loam, 0 to 2 percent slopes, in a cultivated field; 580 feet west and 300 feet north of the southeast corner of sec. 15, T. 94 N., R. 26 W.

Ap—0 to 8 inches; black (N 2/0) clay loam (about 34 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A1—8 to 21 inches; black (N 2/0) clay loam (about 32 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

A2—21 to 34 inches; black (10YR 2/1) clay loam (about 29 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AC—34 to 45 inches; black (5Y 2/1) clay loam (about 27 percent clay), very dark gray (10YR 3/1) dry; weak very fine prismatic structure parting to weak subangular blocky; friable; discontinuous sand lens 1 inch thick; neutral; clear smooth boundary.

Cg—45 to 60 inches; black (5Y 2/1) clay loam (about 30 percent clay); few very dark gray (10YR 3/1) mixings; massive; friable; neutral.

The solum ranges from 32 to 48 inches in thickness. The mollic epipedon is 36 or more inches thick.

The A horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 0 or 1. The AC horizon is neutral in hue or has hue of 10YR to 5Y, value of 2 to 4, and chroma of 0 or 1. The C horizon is neutral in hue or has hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 0 or 1.

Collinwood Series

The Collinwood series consists of somewhat poorly drained, moderately slowly or slowly permeable soils on low rises on ridgetops and concave side slopes on uplands. These soils formed in silty and clayey lacustrine sediments. Native vegetation was tall prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Collinwood silty clay loam, 0 to 2 percent slopes, in a cultivated field; 60 feet east and 500 feet south of the northwest corner of sec. 20, T. 95 N., R. 24 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; moderate fine granular structure with some moderate fine subangular blocky; firm; few fine roots; slightly acid; abrupt smooth boundary.

A1—8 to 13 inches; black (10YR 2/1) silty clay (about 40 percent clay), very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; firm; few fine roots; slightly acid; gradual smooth boundary.

A2—13 to 17 inches; black (10YR 2/1) silty clay (about 41 percent clay), very dark gray (10YR 3/1) dry; some mixings of dark grayish brown (2.5Y 4/2) subsoil material; moderate fine subangular blocky structure; firm; few fine roots; slightly acid; clear smooth boundary.

Bw1—17 to 24 inches; dark grayish brown (2.5Y 4/2) silty clay (about 46 percent clay); some black (10YR 2/1) and very dark gray (10YR 3/1) coatings on faces of peds; moderate fine prismatic structure parting to moderate very fine subangular blocky; firm; few fine roots; neutral; gradual smooth boundary.

Bw2—24 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay (about 47 percent clay); about 40 percent very dark gray (10YR 3/1) coatings on faces of peds; common fine faint light olive brown (2.5Y 5/4) and few fine faint grayish brown (2.5Y 5/2) mottles; moderate fine prismatic structure parting to moderate fine subangular blocky; firm; few fine roots; few fine tubular pores; neutral; gradual smooth boundary.

BCg—31 to 36 inches; grayish brown (2.5Y 5/2) silty clay (about 45 percent clay); dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine faint light olive brown (2.5Y 5/4) mottles; moderate fine prismatic structure parting to moderate fine subangular blocky; firm; few fine roots; common fine tubular pores; few black (10YR 2/1) krotovina channels; neutral; clear smooth boundary.

C1—36 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam (about 35 percent clay); common fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few fine roots; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline; gradual smooth boundary.

C2—44 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam (about 35 percent clay); common fine and medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few dark accumulations (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 46 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches.

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

Corwith Series

The Corwith series consists of somewhat poorly drained, moderately permeable, calcareous soils on low rises on glacial lake plains and in outwash areas on uplands. These soils formed in loamy and silty sediments. Native vegetation was tall prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Corwith loam, 1 to 3 percent slopes, in a cultivated field; 1,480 feet south and 1,060 feet west of the northeast corner of sec. 26, T. 96 N., R. 26 W.

Ap—0 to 9 inches; black (10YR 2/1) loam (about 19 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

A—9 to 17 inches; very dark gray (10YR 3/1) loam (about 20 percent clay), dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bw1—17 to 25 inches; dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) loam (about 16 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw2—25 to 30 inches; dark grayish brown (2.5Y 4/2) and light olive brown (2.5Y 5/4) silt loam (about 12 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; few fine faint grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.

C1—30 to 35 inches; mottled light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) silt loam (about 10 percent clay); few fine faint light olive brown (2.5Y 5/6) and few fine distinct gray (5Y 5/1) mottles; massive; friable; few dark concretions (manganese oxides); few soft accumulations (calcium carbonate); few black (10YR 2/1) fills along root channels; strong effervescence; moderately alkaline; clear smooth boundary.

C2—35 to 50 inches; mottled light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/6) silt loam (about 14 percent clay); few fine faint light olive brown (2.5Y 5/4), few fine prominent dark yellowish brown (10YR 4/6) and strong brown (7.5YR 4/6) mottles; massive; friable; few dark concretions (manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C3—50 to 60 inches; mottled light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/4) silt loam (about 9 percent clay); few fine faint light olive brown (2.5Y 5/6) and few fine prominent strong brown (7.5YR 4/6) mottles; massive; friable; few dark concretions (manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 24 to 44 inches in thickness. The mollic epipedon is 10 to 20 inches thick.

The A horizon is neutral in hue or has hue of 10YR and chroma of 0 to 2. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. The C horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 2 to 8.

Crippin Series

The Crippin series consists of somewhat poorly drained, moderately permeable soils on low rises on side slopes on uplands. These soils formed in glacial till. Native vegetation was tall prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Crippin loam, 1 to 3 percent slopes, in a cultivated field; 800 feet south and 2,050 feet west of the northeast corner of sec. 23, T. 97 N., R. 24 W.

Ap—0 to 9 inches; black (10YR 2/1) loam (about 26 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; strong effervescense; moderately alkaline; abrupt smooth boundary.

A—9 to 15 inches; black (10YR 2/1) clay loam (about 28 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

AB—15 to 19 inches; very dark gray (10YR 3/1) loam (about 26 percent clay), dark gray (10YR 4/1) dry; mixed with black (10YR 2/1) subsurface material and dark grayish brown (2.5Y 4/2) subsoil material; weak very fine and fine subangular blocky structure; friable; few fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

Bw1—19 to 24 inches; dark grayish brown (2.5Y 4/2) loam (25 percent clay); dark gray (10YR 3/1) coatings on faces of peds; weak fine and very fine subangular blocky structure; friable; few fine roots; black (10YR 2/1) and light olive brown (2.5Y 5/4) krotovinas; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw2—24 to 34 inches; light olive brown (2.5Y 5/4) loam (about 24 percent clay); very dark gray (10YR 3/1) coatings on faces of peds; common fine faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; few fine dark concretions (iron and manganese oxides); few very fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.

C—34 to 60 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) loam (about 22 percent clay); common fine distinct dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; massive; friable; few fine dark concretions (iron and manganese oxides); common fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 20 to 48 inches in thickness. The mollic epipedon is 12 to 23 inches thick.

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

Dickman Series

The Dickman series consists of well drained soils on uplands and outwash plains. These soils formed in loamy and sandy glacial outwash material. Native vegetation was tall prairie grasses. Permeability is moderately rapid in the solum and rapid in the substratum. Slopes range from 0 to 14 percent.

Typical pedon of Dickman sandy loam, 2 to 5 percent slopes, in a cultivated field; 2,500 feet north and 700 feet east of the center of sec. 13, T. 96 N., R. 25 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) sandy loam (about 13 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

A1—9 to 13 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) sandy loam (about 12 percent clay), dark grayish brown (10YR 4/2) dry; some mixing of dark yellowish brown (10YR 4/4) subsoil material; weak fine granular and weak very fine subangular blocky structure; very friable; common fine roots; medium acid; clear smooth boundary.

A2—13 to 17 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) sandy loam (about 11 percent clay), dark grayish brown (10YR 4/2) dry; some mixing of dark yellowish brown (10YR 4/4) subsoil material; weak fine granular and weak fine subangular blocky structure; very friable; few fine roots; black (10YR 2/1) worm fills; medium acid; clear smooth boundary.

BA—17 to 20 inches; dark brown (10YR 3/3) loamy sand (about 9 percent clay), grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; few fine roots; black (10YR 2/1) worm fills; medium acid; clear smooth boundary.

Bw—20 to 25 inches; dark brown (10YR 3/3) and brown (10YR 4/3) loamy sand (about 9 percent clay); weak fine subangular blocky structure; very friable; few fine roots; black (10YR 2/1) worm fills; medium acid; clear smooth boundary.

BC—25 to 35 inches; dark yellowish brown (10YR 4/4) loamy sand (about 8 percent clay); single grained and weak coarse subangular blocky structure; loose; few fine roots; few tubular pores; medium acid; clear smooth boundary.

C1—35 to 45 inches; yellowish brown (10YR 5/4) sand (about 7 percent clay); single grained; loose; few fine roots; medium acid; clear smooth boundary.

C2—45 to 60 inches; yellowish brown (10YR 5/4) sand (about 7 percent clay); single grained; loose; medium acid.

The solum ranges from 30 to 50 inches in thickness. The mollic epipedon is 10 to 20 inches thick.

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

Estherville Series

The Estherville series consists of somewhat excessively drained soils on uplands and glacial outwash plains. These soils formed in loamy and sandy glacial outwash. Native vegetation was tall prairie grasses. Permeability is moderately rapid in the upper part of the solum and very rapid in the lower part. Slopes range from 0 to 14 percent.

Typical pedon of Estherville loam, 2 to 5 percent slopes, in a cultivated field; 2,400 feet east and 260 feet south of the northwest corner of sec. 1, T. 96 N., R. 24 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam (about 18 percent clay), dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on peds; weak fine and very fine granular structure; friable; few fine roots; medium acid; clear smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) loam (about 17 percent clay), dark grayish brown (10YR 4/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; weak fine and very fine subangular blocky structure; friable; few fine roots; medium acid; gradual wavy boundary.

Bw—14 to 20 inches; brown (10YR 4/3) sandy loam (about 17 percent clay); very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine and very fine subangular blocky structure; very friable; few fine roots; slightly acid; gradual smooth boundary.

2BC—20 to 26 inches; dark yellowish brown (10YR 4/4) loamy sand (about 8 percent clay); some dark brown (10YR 3/3) coatings on faces of peds; weak fine subangular blocky structure; very friable; about 1 percent medium gravel; slightly acid; clear smooth boundary.

2C1—26 to 36 inches; brown (10YR 5/3) sand (about 4 percent clay); single grained; loose; about 8 percent fine gravel; slight effervescence; mildly alkaline; gradual smooth boundary.

2C2—36 to 60 inches; brown (10YR 5/3) sand (about 4 percent clay); single grained; loose; about 2 percent fine gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 30 inches. The mollic epipedon ranges from 7 to 20 inches in thickness.

The Ap and A horizons have value of 2 or 3. The Bw horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It typically is coarse sandy loam, sandy loam, or loam, averaging less than 18 percent clay. The 2BC horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. It is loamy sand, sand, loamy coarse sand, or coarse sandy loam. The 2C horizon has value of 4 to 7 and chroma of 2 to 6.

Fieldon Series

The Fieldon series consists of poorly drained, calcareous soils on glacial outwash plains and upland flats. These soils formed in loamy sediments that overlie sand. Native vegetation was tall prairie grasses. Permeability is moderate in the solum and rapid in the substratum. Slopes range from 0 to 2 percent.

Typical pedon of Fieldon loam, 0 to 2 percent slopes, in a cultivated field; 2,600 feet east and 300 feet north of the southwest corner of sec. 25, T. 96 N., R. 26 W.

Ap—0 to 7 inches; black (10YR 2/1) loam (about 21 percent clay), very dark gray (10YR 3/1) and dark gray (10YR 4/1) dry; weak fine and medium granular structure; friable; few fine roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) sandy clay loam (about 21 percent clay), very dark gray (10YR 3/1) dry; some mixing of olive gray (5Y 4/2) subsoil material; weak fine and medium granular structure; friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

AB—14 to 21 inches; very dark gray (10YR 3/1) sandy clay loam (about 21 percent clay), dark gray (10YR 4/1) dry; some mixing of olive gray (5Y 5/2) subsoil material; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine granular and weak fine subangular blocky structure; friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg—21 to 28 inches; olive gray (5Y 5/2) fine sandy loam (about 16 percent clay); dark gray (5Y 4/1) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/4) and common fine faint light olive gray (5Y 6/2) mottles; weak fine and medium subangular blocky structure; very friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

BCg—28 to 36 inches; olive gray (5Y 5/2) and pale olive (5Y 6/4) fine sandy loam (about 12 percent clay); few fine prominent reddish brown (5YR 5/4) mottles; weak medium and coarse subangular blocky structure; very friable; common dark concretions (iron and manganese oxides); strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—36 to 60 inches; mottled olive gray (5Y 5/2) and light olive brown (2.5Y 5/4) loamy fine sand (about 8 percent clay); few medium prominent strong brown (7.5YR 5/8) mottles; single grained; very friable; few very fine dark concretions (iron and manganese oxides); slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 0 or 1. It dominantly is loam and sandy clay loam but includes fine sandy loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2 in the upper part and chroma of 1 to 4 in the lower part. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4. Its texture typically is loamy fine sand or fine sand but includes stratifications of fine sandy loam and silt loam.

Fostoria Series

The Fostoria series consists of somewhat poorly drained, moderately permeable soils on low rises on uplands. These soils formed in loamy sediments. Native vegetation was tall prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Fostoria loam, 1 to 3 percent slopes, in a cultivated field; 2,300 feet north and 680 feet east of the southwest corner of sec. 11, T. 96 N., R. 25 W.

Ap—0 to 10 inches; black (10YR 2/1) loam (about 26 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; slightly acid; clear smooth boundary.

A—10 to 15 inches; black (10YR 2/1) loam (about 26 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

AB—15 to 20 inches; black (10YR 2/1) and very dark gray (10YR 3/1) clay loam (about 28 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine roots; slightly acid; gradual wavy boundary.

Bw1—20 to 26 inches; dark grayish brown (2.5Y 4/2) loam (about 25 percent clay); very dark gray (10YR 3/1) coatings on faces of peds; some mixing of light olive brown (2.5Y 5/4) subsoil material; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw2—26 to 33 inches; olive brown (2.5Y 4/4) clay loam (about 27 percent clay); dark grayish brown (2.5Y 4/2) and a few very dark gray (10YR 3/1) coatings on faces of peds; few fine faint grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) mottles; weak fine and medium prismatic structure parting to weak fine subangular blocky; friable; few dark concretions (manganese oxides); neutral; gradual smooth boundary.

Bw3—33 to 39 inches; light olive brown (2.5Y 5/4) clay loam (about 30 percent clay); few dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine faint grayish brown (2.5Y 5/2) and few fine faint light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; few dark concretions (manganese oxides); neutral; abrupt smooth boundary.

BC—39 to 43 inches; light olive brown (2.5Y 5/4) silt loam (about 25 percent clay); common fine and medium faint grayish brown (2.5Y 5/2) and few fine faint light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; few dark concretions (manganese oxides); slight effervescence; moderately alkaline; clear smooth boundary.

C—43 to 60 inches; mottled grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) silt loam (about 17 percent clay); massive; friable; few dark concretions (manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 30 to 48 inches in thickness. Depth to free carbonates ranges from 24 to 48 inches. The A horizon is 12 to 24 inches thick.

The A horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 0 or 1. The texture of the A horizon is loam or clay loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 in the upper part grading to chroma of 3 or 4 as depth increases. Clay content of the Bw horizon ranges from 25 to 30 percent clay. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6.

Harcot Series

The Harcot series consists of poorly drained, highly calcareous soils in lower-lying areas and on rims around depressions on glacial outwash plains. These soils formed in loamy sediments that overlie sand or sand and gravel. Native vegetation was water-tolerant grasses. Permeability is moderate in the solum and very rapid in the substratum. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Harcot series because they have a sandy loam B horizon, which is not definitive for the Harcot series.

Typical pedon of Harcot clay loam, 0 to 2 percent slopes, in a cultivated field; 120 feet south and 620 feet west of the northeast corner of sec. 3, T. 96 N., R. 25 W.

Akp—0 to 9 inches; black (10YR 2/1) clay loam (about 29 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; 24 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; abrupt smooth boundary.

Ak—9 to 15 inches; black (10YR 2/1) loam (about 25 percent clay), dark gray (10YR 4/1) dry; weak fine and very fine granular structure with some weak fine subangular blocky; friable; few fine roots; 21 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; gradual smooth boundary.

ABk—15 to 20 inches; very dark gray (10YR 3/1) sandy loam (about 19 percent clay), dark gray (10YR 4/1) dry; some mixing of olive gray (5Y 5/2) subsoil material; weak fine subangular blocky structure; friable; 16 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

Bg1—20 to 25 inches; olive gray (5Y 5/2) sandy loam (about 15 percent clay), some mixing of very dark gray (10YR 3/1) subsurface material; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; 7 percent calcium carbonate equivalent; slight effervescence; moderately alkaline; gradual smooth boundary.

Bg2—25 to 32 inches; olive gray (5Y 5/2) sandy loam (about 15 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; common fine faint olive (5Y 5/3) mottles; weak medium subangular blocky structure; very friable; 3 percent calcium carbonate equivalent; slight effervescence; moderately alkaline; clear smooth boundary.

2Cg—32 to 60 inches; olive gray (5Y 5/2) and olive (5Y 5/3) fine sand (about 6 percent clay); single grained; loose; few dark concretions (iron oxides); 0 percent calcium carbonate equivalent; slight effervescence; moderately alkaline.

The solum typically is 24 to 40 inches thick and is terminated by underlying sand and gravel. The mollic epipedon ranges from 12 to 24 inches in thickness.

The Ak horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 0 or 1. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The 2C horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 to 6. It is loamy fine sand or fine sand.

Harps Series

The Harps series consists of poorly drained, moderately permeable, highly calcareous soils on rims of depressions on broad upland flats. These soils formed in glacial till or till-derived sediments. Native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Harps loam, 0 to 2 percent slopes, in a cultivated field; 200 feet south and 60 feet east of the northwest corner of sec. 36, T. 94 N., R. 23 W.

Akp—0 to 10 inches; black (10YR 2/1) loam (about 26 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; few fine snail shells; 37 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; gradual smooth boundary.

Ak—10 to 18 inches; very dark gray (10YR 3/1) loam (about 25 percent clay), dark gray (10YR 4/1) dry; few distinct faint olive gray (5Y 4/2) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine snail shells; 27 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

Bgk1—18 to 27 inches; olive gray (5Y 5/2) loam (about 18 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; few fine distinct light olive brown (2.5Y 5/4) and common fine faint olive (5Y 5/3) mottles; weak fine subangular blocky structure; friable; common soft accumulations (calcium carbonates); 21 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; gradual smooth boundary.

Bgk2—27 to 34 inches; olive gray (5Y 5/2) loam (about 19 percent clay); few medium faint olive (5Y 5/3), few fine prominent strong brown (7.5YR 4/6), and common fine distinct light olive brown (2.5Y 5/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few dark concretions (iron and manganese oxides); common soft accumulations (calcium carbonate); 21 percent calcium carbonate equivalent; strong effervescence; moderately alkaline; gradual smooth boundary.

BCg—34 to 42 inches; olive gray (5Y 5/2) loam (about 19 percent clay); few fine prominent brown (7.5YR 4/4) and many fine distinct light olive brown (2.5Y 5/4) mottles; weak fine prismatic structure; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); 21 percent calcium carbonate equivalent; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—42 to 60 inches; mottled olive gray (5Y 5/2) and light olive brown (2.5Y 5/4) loam (about 22 percent clay); few fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations (calcium carbonate); 18 percent calcium carbonate equivalent; strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. The mollic epipedon ranges from 12 to 21 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR and chroma of 0 or 1. It is loam or clay loam. The B horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is loam or clay loam. The C horizon has value of 4 to 6 and chroma of 1 to 4.

Harpster Series

The Harpster series consists of poorly drained, moderately permeable, highly calcareous soils on rims of depressions and in lower-lying areas on outwash plains on uplands. These soils formed in silty glacial sediments. Native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Harpster silty clay loam, 0 to 2 percent slopes, in a cultivated field; 900 feet east and 1,350 feet south of the northwest corner of sec. 13, T. 95 N., R. 25 W.

Akp—0 to 9 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; few fine snail shells; 20 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; abrupt smooth boundary.

Ak1—9 to 15 inches; very dark gray (10YR 3/1) silty clay loam (about 35 percent clay), dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on faces of peds; weak fine granular structure; friable; few fine roots; few fine snail shells; 25 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; gradual smooth boundary.

Ak2—15 to 21 inches; very dark gray (10YR 3/1) silty clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; weak fine subangular blocky structure; friable; few fine roots; 22 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

Bg1—21 to 26 inches; dark grayish brown (2.5Y 4/2) silty clay loam (about 30 percent clay); very dark gray (10YR 3/1) and dark gray (10YR 4/1) coatings on faces of peds; few fine faint grayish brown (2.5Y

5/2) mottles; weak fine subangular blocky structure; friable; few fine roots; few light brownish gray (2.5Y 6/2) krotovina channels; 18 percent calcium carbonate equivalent; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2—26 to 32 inches; grayish brown (2.5Y 5/2) silt loam (about 22 percent clay); dark gray (10YR 4/1) coatings on faces of peds; common fine faint light olive brown (2.5Y 5/4) and few fine faint light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; friable; few very dark gray (5Y 3/1) krotovina channels; few dark concretions (iron and manganese oxides); 21 percent calcium carbonate equivalent; strong effervescence; moderately alkaline; gradual smooth boundary.

BCg—32 to 40 inches; light brownish gray (2.5Y 6/2) silt loam (about 22 percent clay); common fine faint light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure; friable; few very dark gray (5Y 3/1) krotovina channels; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); 21 percent calcium carbonate equivalent; strong effervescence; moderately alkaline; clear smooth boundary.

Cg—40 to 60 inches; light brownish gray (2.5Y 6/2) silt loam (about 22 percent clay); common fine distinct yellowish brown (10YR 5/6) and common fine and medium prominent strong brown (7.5YR 4/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); 18 percent calcium carbonate equivalent; strong effervescence; moderately alkaline.

The solum ranges from 22 to 46 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR to 5Y and chroma of 0 or 1. Its texture is silty clay loam, less commonly silt loam. The Bg horizon has hue of 2.5Y or 5Y and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 8.

Houghton Series

The Houghton series consists of very poorly drained, moderately slowly to moderately rapidly permeable soils in depressions and in old, shallow lakebeds. These soils formed in herbaceous organic deposits. Native vegetation was sedges, reeds, and other water-tolerant grasses. Slopes range from 0 to 1 percent.

Typical pedon of Houghton muck, 0 to 1 percent slopes, in a cultivated field; 2,420 feet west and 1,640 feet south of the northeast corner of sec. 14, T. 97 N., R. 23 W.

Oap—0 to 10 inches; black (N 2/0) broken face and rubbed sapric material, about 5 percent fibers, less than 5 percent rubbed, black (10YR 2/1) dry; weak fine granular structure; slightly sticky; fibers are herbaceous; common fine roots; neutral; clear smooth boundary.

Oa1—10 to 44 inches; black (N 2/0) sapric material, less than 5 percent rubbed, black (10YR 2/1) dry; massive; slightly sticky; fibers are herbaceous; few fine roots; few small fragments of undecayed organic matter giving the horizon a strong brown cast; neutral; clear smooth boundary.

Oa2—44 to 60 inches; black (10YR 2/1) sapric material, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; massive; slightly sticky; few fine roots; neutral.

The thickness of the Oa horizon typically is more than 51 inches. The organic material is mainly herbaceous. The Oa horizon is neutral in hue or has hue of 10YR to 5YR, value of 2 or 3, and chroma of 0 to 3.

Kamrar Series

The Kamrar series consists of well drained, moderately slowly permeable soils on low convex knolls on uplands. These soils formed in loamy glacial lacustrine sediments over glacial till. Native vegetation was tall prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Kamrar clay loam, in an area of Bode-Kamrar clay loams, 2 to 5 percent slopes, in a cultivated field; 280 feet north and 1,720 feet west of the southeast corner of sec. 20, T. 95 N., R. 24 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam (35 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine and medium roots; neutral; abrupt smooth boundary.

A—9 to 14 inches; black (10YR 2/1) clay loam (38 percent clay), dark gray (10YR 4/1) dry; moderate fine granular structure; firm; few fine and medium roots; neutral; gradual smooth boundary.

AB—14 to 20 inches; very dark grayish brown (10YR 3/2) clay loam (38 percent clay), dark gray (10YR

4/1) dry; some mixings of brown (10YR 4/3) subsoil material; black (10YR 2/1) coatings on faces of peds; moderate fine subangular blocky structure; firm; few fine roots; neutral; gradual smooth boundary.

Bt1—20 to 28 inches; brown (10YR 4/3) clay loam (38 percent clay); moderate fine prismatic structure parting to moderate fine subangular blocky; firm; few faint very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) clay films on faces of peds; few fine pores; few fine and medium shale fragments; neutral; gradual smooth boundary.

Bt2—28 to 35 inches; yellowish brown (10YR 5/4) clay (41 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; moderate fine prismatic structure parting to moderate fine and medium subangular blocky; firm; common faint very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) clay films on faces of peds; few fine roots; few fine shale fragments; neutral; clear smooth boundary.

2BC—35 to 40 inches; light olive brown (2.5Y 5/4) clay loam (28 percent clay); few fine faint grayish brown (2.5Y 5/2) and few fine prominent dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; few distinct dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) clay films on faces of peds; few fine roots; few dark concretions (iron and manganese oxides); few fine shale fragments; slight effervescence in places; mildly alkaline; gradual smooth boundary.

2C1—40 to 47 inches; light olive brown (2.5Y 5/4) clay loam (about 29 percent clay); common fine faint grayish brown (2.5Y 5/2) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; very few distinct dark grayish brown (10YR 4/2) clay films along root channels; common dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonates); few fine shale fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

2C2—47 to 60 inches; light olive brown (2.5Y 5/4) loam (20 percent clay); common fine faint grayish brown (2.5Y 5/2), common fine prominent yellowish brown (10YR 5/4), and few fine prominent strong brown (7.5YR 4/6) mottles; massive; friable; common dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonates); strong effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon is 10 to 20 inches thick.

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

Kilkenny Series

The Kilkenny series consists of well drained, moderately slowly permeable soils on ridges and side slopes on uplands. These soils formed in a mantle of lacustrine sediments and the underlying loamy glacial till. Native vegetation was mixed prairie grasses and trees. Slopes range from 2 to 18 percent.

Typical pedon of Kilkenny clay loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field; 2,000 feet south and 180 feet west of the northeast corner of sec. 1, T. 97 N., R. 23 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam (about 30 percent clay), gray (10YR 5/1) dry; mixed with some streaks and pockets of brown (10YR 4/3) subsoil material; weak fine granular structure; friable; common fine and medium roots; very few fine shale fragments; slightly acid; clear smooth boundary.

Bt1—7 to 11 inches; brown (10YR 4/3) clay (about 41 percent clay); some mixing of very dark gray (10YR 3/1) surface material; moderate fine and medium subangular blocky structure; firm; few faint dark grayish brown (10YR 4/2) clay films on vertical faces of peds; few distinct light gray (10YR 7/2) silt coatings on faces of peds; common fine roots; few dark concretions (manganese oxides); few fine shale fragments; medium acid; gradual smooth boundary.

Bt2—11 to 19 inches; olive brown (2.5Y 4/4) clay (about 40 percent clay); some mixing of light olive brown (2.5Y 5/4) subsoil material; moderate fine and medium subangular blocky structure; firm; few distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; few distinct light gray (10YR 7/2) silt coatings on faces of peds; few fine roots; few dark concretions (manganese oxides); few fine shale fragments; medium acid; gradual smooth boundary.

Bt3—19 to 25 inches; light olive brown (2.5Y 5/4) clay (about 41 percent clay); few fine faint light olive brown (2.5Y 5/6) mottles; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; firm; common faint dark grayish brown (2.5Y 4/2) clay films on vertical faces of peds; few distinct light gray (10YR 7/2) silt coatings on faces of peds; few fine roots; few dark concretions (manganese oxides); few fine medium shale fragments; medium acid; gradual smooth boundary.

Bt4—25 to 33 inches; light olive brown (2.5Y 5/4) clay loam (about 37 percent clay); few fine faint light olive brown (2.5Y 5/6) and grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; common faint dark grayish brown (2.5Y 4/2) clay films on vertical faces of peds; few fine roots; common black (10YR 2/1) organic fills along root channels; common dark concretions (manganese oxides); few fine to coarse shale fragments; medium acid; gradual smooth boundary.

BC—33 to 42 inches; light olive brown (2.5Y 5/4) clay loam (about 35 percent clay); few fine distinct yellowish brown (10YR 5/6), few fine prominent strong brown (7.5YR 5/6), and common fine faint grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure; firm; few faint dark grayish brown (2.5Y 4/2) clay films on vertical faces of peds; few black (10YR 2/1) organic fills along root channels; few dark concretions (iron and manganese oxides); very few fine shale fragments; slightly acid; gradual smooth boundary.

C1—42 to 51 inches; light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) clay loam (about 29 percent clay); few fine prominent strong brown (7.5YR 5/6) and dark reddish brown (5YR 3/3) and common fine prominent brown (7.5YR 4/4) mottles; massive; friable; few black (10YR 2/1) organic fills along root channels; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline; clear smooth boundary.

C2—51 to 60 inches; grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) loam (about 25 percent clay); few fine prominent strong brown (7.5YR 5/6) and brown (7.5YR 4/4) mottles; massive; friable; few black (10YR 2/1) organic fills along root channels; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 60 inches.

The A horizon has value of 2 or 3. The B horizon has value of 4 or 5 and chroma of 3 to 5 in the lower part. The C horizon typically is clay loam but ranges to loam.

Kossuth Series

The Kossuth series consists of poorly drained, moderately slowly permeable soils on nearly level or slightly concave slopes on uplands. These soils formed in silty lacustrine or glacial sediments and the underlying loamy glacial till. Native vegetation was tall prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Kossuth silty clay loam, 0 to 2 percent slopes, in a cultivated field; 52 feet east and 1,000 feet north of the southwest corner of sec. 19, T. 94 N., R. 23 W.

Ap—0 to 7 inches; black (N 2/0) silty clay loam (about 36 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; firm; common fine roots; neutral; abrupt smooth boundary.

A—7 to 14 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; black (N 2/0) coatings on faces of peds; moderate very fine subangular blocky structure; firm; few fine roots; neutral; gradual smooth boundary.

AB—14 to 20 inches; very dark gray (5Y 3/1) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; black (5Y 2/1) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) mottles; moderate very fine subangular blocky structure; firm; few fine roots; neutral; clear smooth boundary.

Bt—20 to 30 inches; olive gray (5Y 4/2) silty clay loam (about 38 percent clay); very dark gray (10YR 3/1) coatings on faces of peds; common fine faint olive (5Y 5/3) mottles; moderate fine prismatic structure parting to moderate fine and very fine subangular blocky; firm; few fine roots; few faint dark gray (5Y 4/1) clay films; neutral; clear smooth boundary.

2BCg—30 to 39 inches; olive gray (5Y 5/2) loam (about 23 percent clay); olive gray (5Y 4/2) coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine prismatic structure parting to weak fine and medium; friable; few fine rounded accumulations (calcium carbonate); strong effervescence; mildly alkaline; gradual smooth boundary.

2Cg—39 to 60 inches; olive gray (5Y 5/2) loam (about 23 percent clay); common fine and medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few fine rounded accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 50 inches. The mollic epipedon ranges from 16 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR or 5Y and value of 2 or 3. It is silty clay loam or silty clay. The Bt horizon has hue of 2.5Y or 5Y and chroma of 1 or 2. The 2BCg horizon is clay loam or loam. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3. It is clay loam or loam.

Lester Series

The Lester series consists of well drained, moderately permeable soils on upland ridges and side slopes. These soils formed in glacial till. Native vegetation was mixed prairie grasses and trees. Slopes range from 2 to 25 percent.

Typical pedon of Lester loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field; 80 feet south and 2,520 feet east of the northwest corner of sec. 5, T. 97 N., R. 23 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam (about 26 percent clay), grayish brown (10YR 5/2) dry; mixed with some streaks and pockets of brown (10YR 4/3) subsoil material; weak fine granular structure; friable; few fine roots; slightly acid; abrupt smooth boundary.

Bt1—7 to 14 inches; brown (10YR 4/3) clay loam (about 34 percent clay); weak fine subangular blocky structure parting to weak fine granular; friable; few faint very dark grayish brown (10YR 3/2) clay films on vertical faces of peds; few faint light gray (10YR 7/2) silt coatings; few very dark gray (10YR 3/1) root fills; medium acid; clear smooth boundary.

Bt2—14 to 21 inches; dark yellowish brown (10YR 4/4) clay loam (about 35 percent clay); moderate fine subangular blocky structure; friable; common faint dark brown (10YR 3/3) clay films on vertical faces of peds; few faint light gray (10YR 7/2) silt coatings; medium acid; gradual smooth boundary.

Bt3—21 to 29 inches; dark yellowish brown (10YR 4/4) clay loam (about 28 percent clay); weak fine prismatic structure parting to weak fine and medium subangular blocky; friable; few faint dark brown (10YR 3/3) clay films on vertical faces of peds; few faint light gray (10YR 7/2) silt coatings; medium acid; gradual smooth boundary.

BC—29 to 38 inches; dark yellowish brown (10YR 4/4) loam (about 24 percent clay); weak medium prismatic structure; friable; few faint dark brown (10YR 3/3) clay films on vertical faces of peds; few faint light gray (10YR 7/2) silt coatings; few dark concretions (iron and manganese oxides); few very dark gray (10YR 3/1) and black (10YR 2/1) root fills; medium acid; gradual smooth boundary.

C1—38 to 47 inches; light olive brown (2.5Y 5/4) sandy loam (about 19 percent clay); few fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron oxides); few soft accumulations (calcium carbonate); few shale fragments; less than 5 percent gravel; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—47 to 60 inches; light olive brown (2.5Y 5/4) sandy loam (about 13 percent clay); few fine prominent yellowish brown (10YR 5/6) mottles; massive; very friable; few dark concretions (iron oxides); few soft accumulations (calcium carbonate); slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 54 inches.

The A or Ap horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have an E horizon that has value of 3 or 4 and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has value of 4 or 5. The C horizon has value of 4 to 6 and chroma of 3 to 6.

Linder Series

The Linder series consists of somewhat poorly drained soils on upland outwash plains and on stream terraces. These soils formed in loamy alluvium and the underlying sand and gravel. Native vegetation was tall prairie grasses. Permeability is moderately rapid in the solum and very rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

Typical pedon of Linder sandy loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 900 feet north and 2,680 feet west of the southeast corner of sec. 26, T. 96 N., R. 26 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam (about 18 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; few fine roots; slightly acid; gradual smooth boundary.

A—10 to 15 inches; very dark gray (10YR 3/1) sandy loam (about 18 percent clay), dark gray (10YR 4/1) dry; few black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; very friable; few fine roots; neutral; clear smooth boundary.

AB—15 to 21 inches; very dark grayish brown (10YR

3/2) sandy loam (about 17 percent clay), dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) dry; some mixing of dark grayish brown (2.5Y 4/2) subsoil material; common very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; very friable; few fine roots; neutral; clear smooth boundary.

Bw1—21 to 28 inches; dark grayish brown (2.5Y 4/2) sandy loam (about 17 percent clay); weak fine subangular blocky structure; very friable; mildly alkaline; gradual smooth boundary.

Bw2—28 to 34 inches; dark grayish brown (2.5Y 4/2) sandy loam (about 18 percent clay); common fine faint light olive brown (2.5Y 5/4) and few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; few dark concretions (iron and manganese oxides); mildly alkaline; clear smooth boundary.

BC—34 to 39 inches; grayish brown (2.5Y 5/2) sandy loam (about 16 percent clay); few fine distinct olive gray (5Y 5/2) and few fine faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; very friable; common fine shale fragments; few small pebbles; mildly alkaline; abrupt smooth boundary.

2C1—39 to 51 inches; dark grayish brown (2.5Y 4/2) loamy coarse sand (about 5 percent clay); single grained; loose; 5 percent fine and medium gravel; strong effervescence; moderately alkaline; abrupt smooth boundary.

2C2—51 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) coarse sand (about 5 percent clay); single grained; loose; 5 percent fine gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 24 to 40 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has chroma of 1 or 2. It is sandy loam or, less commonly, loam. The Bw horizon has value of 4 or 5 and chroma of 2 or 3. If chroma is 3, the horizon has low chroma mottles. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 6.

Mayer Series

The Mayer series consists of poorly drained soils on stream terraces and in upland outwash areas. These soils formed in loamy sediments and the underlying sand and gravel. Native vegetation was water-tolerant grasses. Permeability is moderate in the solum and rapid in the substratum. Slopes range from 0 to 2 percent.

Typical pedon of Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 2,300 feet south and 240 feet west of the northeast corner of sec. 25, T. 95 N., R. 26 W.

Ap—0 to 10 inches; black (10YR 2/1) loam (26 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; common fine roots; few fine shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

A—10 to 17 inches; black (10YR 2/1) loam (26 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine roots; few fine shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

AB—17 to 21 inches; very dark gray (10YR 3/1) loam (26 percent clay), dark gray (10YR 4/1) dry; some mixings of grayish brown (2.5Y 5/2) subsoil material; few very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; few fine shell fragments; slight effervescence; moderately alkaline; clear smooth boundary.

Bg1—21 to 28 inches; grayish brown (2.5Y 5/2) sandy clay loam (24 percent clay); few very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct olive gray (5Y 5/2) and few fine faint dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; few fine roots; few fine shell fragments; slight effervescence; moderately alkaline; clear smooth boundary.

Bg2—28 to 33 inches; grayish brown (2.5Y 5/2) sandy clay loam (21 percent clay); few very dark gray (10YR 3/1) coatings on faces of peds; few fine faint light olive brown (2.5Y 5/4) and olive gray (5Y 5/2) mottles; weak fine subangular blocky structure; friable; about 9 percent fine gravel; slight effervescence; moderately alkaline; clear smooth boundary.

2BC—33 to 37 inches; olive gray (5Y 5/2) sandy loam (18 percent clay); few very dark gray (10YR 3/1) coatings on faces of peds; few fine prominent strong brown (7.5YR 4/6) and few fine faint olive (5Y 5/3) mottles; weak medium subangular blocky structure; friable; about 10 percent fine and medium gravel; slight effervescence; mildly alkaline; abrupt smooth boundary.

2C—37 to 60 inches; olive gray (5Y 4/2) gravelly coarse sand (5 percent clay); single grained; loose; 30

percent fine and medium gravel; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to the 2C horizon range from 24 to 40 inches. The A horizon ranges from 14 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR to 5Y, value of 2 or 3, and chroma of 0 or 1. The B horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2. It typically is loam or sandy clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 3. It is gravelly coarse sand or coarse sand.

Muskego Series

The Muskego series consists of very poorly drained soils in large depressions that were shallow, glacial lakes. These soils formed in organic deposits of decomposed herbaceous materials underlain by limnic sediments of coprogenous earth. Native vegetation was sedges, reeds, and other water-tolerant grasses. Permeability is moderate or moderately rapid in the sapric material and slow in the underlying coprogenous earth. Slopes range from 0 to 1 percent.

Typical pedon of Muskego muck, 0 to 1 percent slopes, in a cultivated field; 400 feet west and 300 feet south of the center of sec. 24, T. 95 N., R. 26 W.

Oap—0 to 10 inches; black (10YR 2/1) broken faced and rubbed sapric material, about 5 percent fiber, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; nonsticky; common fine roots; neutral; clear smooth boundary.

Oa1—10 to 19 inches; black (10YR 2/1) broken faced and rubbed sapric material, about 5 percent fiber, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine platy structure parting to weak fine subangular blocky; nonsticky; common fine roots; neutral; gradual smooth boundary.

Oa2—19 to 28 inches; black (10YR 2/1) broken faced sapric material, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine platy structure parting to weak fine subangular blocky; slightly sticky; neutral; abrupt smooth boundary.

C—28 to 60 inches; black (10YR and 5Y 2/1) coprogenous earth; massive; slightly sticky; few yellowish red (5YR 4/6) and brown (7.5YR 4/4) organic stains along old root channels; many fine snail shells; strong effervescence; mildly alkaline.

The thickness of the Oa horizon and depth to coprogenous earth range from 16 to 51 inches.

The surface tier has chroma of 1 or 2. The subsurface and bottom tiers have hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 to 3. The C horizon has value of 2 to 5 and chroma of 1 to 3.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on low rises and in slightly concave side slopes on uplands. These soils formed in glacial till. Native vegetation was tall prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet loam, 1 to 3 percent slopes, in a cultivated field; 220 feet east and 100 feet north of the southwest corner of sec. 17, T. 96 N., R. 26 W.

Ap—0 to 9 inches; black (10YR 2/1) loam (about 26 percent clay), very dark gray (10YR 3/1) dry; black (N 2/0) coatings on faces of peds; weak fine and very fine granular structure; friable; few fine roots; slightly acid; abrupt smooth boundary.

A—9 to 16 inches; black (10YR 2/1) clay loam (about 28 percent clay), very dark gray (10YR 3/1) dry; black (N 2/0) coatings on faces of peds; weak fine and very fine granular structure; friable; few fine roots; slightly acid; gradual smooth boundary.

AB—16 to 20 inches; very dark grayish brown (10YR 3/2) clay loam (about 28 percent clay), dark grayish brown (10YR 4/2) dry; some mixings of olive brown (2.5Y 4/4) subsoil material; black (10YR 2/1) and very dark gray (10YR 3/1) coatings on faces of peds; weak fine and very fine subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

Bw1—20 to 26 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) clay loam (about 29 percent clay); very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few dark concretions (iron and manganese oxides); slightly acid; gradual smooth boundary.

Bw2—26 to 33 inches; dark grayish brown (2.5Y 4/2) loam (about 26 percent clay); common fine faint olive brown (2.5Y 4/4) mottles; weak fine and medium subangular blocky structure; friable; few dark concretions (iron and manganese oxides); neutral; abrupt smooth boundary.

BC—33 to 41 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) loam (about 24 percent clay); common fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline; gradual smooth boundary.

C—41 to 60 inches; mottled light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) loam (about 22 percent clay); massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline; gradual smooth boundary.

The thickness of the solum and the depth to free carbonates range from 20 to 48 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

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

Okoboji Series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils on upland depressions. These soils formed in sediments derived from glacial till. Native vegetation was water-tolerant grasses. Slopes are 0 to 1 percent.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes, in a cultivated field; 726 feet south and 1,300 feet east of the northwest corner of sec. 23, T. 97 N., R. 24 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; firm; few fine roots; mildly alkaline; gradual smooth boundary.

A1—9 to 17 inches; black (N 2/0) silty clay loam (about 39 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; few fine roots; neutral; gradual smooth boundary.

A2—17 to 30 inches; black (10YR 2/1) silty clay (about 41 percent clay), dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; firm; few fine roots; mildly alkaline; gradual smooth boundary.

A3—30 to 36 inches; black (10YR 2/1) silty clay (about 42 percent clay), dark gray (10YR 4/1) dry; mixed with some streaks and pockets of very dark gray (10YR 3/1) subsoil material; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; weak very fine prismatic structure parting to weak fine and medium subangular blocky; firm; mildly alkaline; clear smooth boundary.

Bg1—36 to 40 inches; very dark gray (10YR 3/1) silty clay (about 41 percent clay); few black (10YR 2/1) coatings on faces of peds; few fine distinct very dark grayish brown (2.5Y 3/2), dark grayish brown (2.5Y 4/2), and light olive brown (2.5Y 5/4) mottles; weak very fine prismatic structure; firm; mildly alkaline; clear smooth boundary.

Bg2—40 to 46 inches; olive gray (5Y 5/2) silty clay loam (about 38 percent clay); few fine faint olive (5Y 5/3 and 5/4) mottles; weak fine prismatic structure; firm; few soft accumulations (calcium carbonate); few very dark gray (10YR 3/1) fills along root channels; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) silty clay loam (about 30 percent clay); few to common fine faint olive (5Y 5/3 and 5/4) mottles; massive; friable; few soft accumulations (calcium carbonate); few very dark gray (10YR 3/1) fills along root channels; strong effervescence; moderately alkaline.

The solum ranges from 40 to 64 inches in thickness. Depth to carbonates ranges from 20 to 50 inches. The mollic epipedon is 24 to 48 inches thick.

The A horizon is neutral in hue or has hue of 10YR and chroma of 0 or 1. It is silty clay loam, silty clay, or mucky silt loam. The Bg1 horizon is neutral in hue or has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 0 or 1. The Bg2 horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam or silty clay. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam, and in some pedons contains thin strata of loam or silt loam.

Ottosen Series

The Ottosen series consists of somewhat poorly drained, moderately slowly permeable soils on gently convex or slightly concave slopes on uplands. These soils formed in loamy glacial or lacustrine sediments and the underlying loamy glacial till. Native vegetation was tall prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Ottosen clay loam, 1 to 3 percent slopes; 890 feet east and 400 feet north of the southwest corner of sec. 19, T. 94 N., R. 23 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam (about

32 percent clay), very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—8 to 15 inches; black (10YR 2/1) clay loam (about 32 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; neutral; clear smooth boundary.

AB—15 to 19 inches; very dark grayish brown (2.5Y 3/2) silty clay loam (about 34 percent clay), dark gray (10YR 4/1) dry; some mixings of olive brown (2.5Y 4/4) subsoil material; black (10YR 2/1) and very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; clear wavy boundary.

Bw1—19 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay loam (about 34 percent clay); some mixings of grayish brown (2.5Y 5/2) lower subsoil material; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt wavy boundary.

Bw2—27 to 35 inches; grayish brown (2.5Y 5/2) clay loam (about 30 percent clay); few fine faint light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; few fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

2C—35 to 60 inches; mottled olive gray (5Y 5/2) and olive brown (2.5Y 4/4) loam (about 24 percent clay); massive; friable; few fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 24 to 50 inches in thickness. The mollic epipedon ranges from 12 to 24 inches in thickness.

The Ap or A horizon is neutral in hue or has hue of 10YR and chroma of 0 or 1. The AB horizon has value of 2 or 3 and chroma of 1 or 2. The A horizon is clay loam or silty clay loam. In the upper part the Bw horizon has hue of 10YR or 2.5Y. In the lower part it has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 to 4. It is silty clay loam or clay loam. The 2C horizon has value of 4 to 6.

Palms Series

The Palms series consists of very poorly drained soils in depressions and old lakebeds on uplands. These soils formed in organic material and the underlying silty sediments. Native vegetation was sedges, reeds, and other water-tolerant grasses. Permeability is moderately slow to moderately rapid in the upper part and moderate in the lower part. Slopes range from 0 to 1 percent.

Typical pedon of Palms muck, 0 to 1 percent slopes, in a cultivated field; 300 feet north and 2,370 feet west of the southeast corner of sec. 26, T. 97 N., R. 25 W.

Op—0 to 10 inches; black (N 2/0) sapric material, about 5 percent fibers, less than 5 percent rubbed, black (10YR 2/1) dry; weak fine granular structure; slightly sticky; fibers are herbaceous; few fine roots; slightly acid; abrupt smooth boundary.

Oa1—10 to 18 inches; black (N 2/0) sapric material, about 5 percent fibers, less than 5 percent rubbed, 3 percent brown (7.5YR 4/4) undecomposed fibers, black (10YR 2/1) dry; weak fine granular and weak fine subangular blocky structure; slightly sticky; fibers are herbaceous; slightly acid; gradual smooth boundary.

Oa2—18 to 26 inches; black (10YR 2/1) sapric material, less than 5 percent rubbed, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; slightly sticky; few strong brown (7.5YR 4/6) organic stains along root channels; slightly acid; gradual smooth boundary.

Oa3—26 to 32 inches; black (10YR 2/1) sapric material, less than 5 percent rubbed, dark gray (10YR 4/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; slightly sticky; few strong brown (7.5YR 4/6), yellowish red (5YR 4/6), and black (N 2/0) organic stains along root channels; slightly acid; clear smooth boundary.

2Cg1—32 to 37 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay loam (about 29 percent clay), dark gray (10YR 4/1) dry; few fine prominent olive gray (5Y 5/2) mottles; massive; friable; few strong brown (7.5YR 4/6) and red (2.5YR 5/8) organic stains along root channels; neutral; clear smooth boundary.

2Cg2—37 to 50 inches; olive gray (5Y 4/2) silty clay loam (about 35 percent clay); very dark gray (10YR 3/1) mixings; few fine faint olive (5Y 5/3) and few fine prominent dark yellowish brown (10YR 4/4) mottles; massive; friable; few strong brown (7.5YR 4/6) and red (2.5YR 4/8) stains along root channels; neutral; clear smooth boundary.

2Cg3—50 to 60 inches; olive gray (5Y 4/2 and 5/2) silty clay loam (about 35 percent clay); few medium faint gray (5Y 5/1) and few medium prominent dark yellowish brown (10YR 4/4) mottles; massive; friable; few strong brown (7.5YR 4/6) and red (2.5YR 5/8) stains along root channels; neutral.

The Oa horizon ranges from 16 to 50 inches in thickness. It is neutral in hue or has hue of 7.5YR or 10YR and chroma of 0 to 2. The 2Cg horizon has hue of 10YR to 5Y and value of 2 to 7. It typically is silty clay loam, but in some pedons it is silt loam, loam, or clay loam.

Ridgeport Series

The Ridgeport series consists of somewhat excessively drained soils on stream terraces and glacial outwash plains. These soils formed in loamy sediments and the underlying sand and gravel. Native vegetation was tall prairie grasses. Permeability is moderately rapid in the solum and very rapid in the substratum. Slopes range from 0 to 5 percent.

Typical pedon of Ridgeport sandy loam, 2 to 5 percent slopes, in a cultivated field; 549 feet north and 150 feet east of the southwest corner of sec. 26, T. 96 N., R. 26 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam (about 18 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; 1 percent coarse fragments; few fine roots; neutral; abrupt smooth boundary.

A—10 to 19 inches; very dark gray (10YR 3/1) sandy loam (about 18 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; very friable; 1 percent coarse fragments; few fine roots; neutral; clear smooth boundary.

Bw1—19 to 25 inches; brown (10YR 4/3) sandy loam (about 18 percent clay); some mixing of very dark gray (10YR 3/1) subsurface material; weak fine subangular blocky structure; very friable; 1 percent coarse fragments; neutral; gradual smooth boundary.

Bw2—25 to 29 inches; dark yellowish brown (10YR 4/4) sandy loam (about 16 percent clay); weak fine and medium subangular blocky structure; very friable; 2 percent coarse fragments; neutral; clear smooth boundary.

2C—29 to 60 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand (about 8 percent clay); single grained; very friable; few dark concretions (iron and manganese oxides); 2 percent shale fragments, 25 percent fine and medium gravel; slight effervescence; mildly alkaline.

The solum thickness and the depth to free carbonates range from 24 to 50 inches. The mollic epipedon ranges from 10 to 24 inches.

The A horizon has chroma of 1 or 2. The Bw horizon has hue of 10YR or 7.5YR and value of 3 to 5. Some pedons have a 2BC horizon that has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is gravelly sandy loam or gravelly loamy sand. The 2C horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is gravelly loamy sand or gravelly sand.

Rolfe Series

The Rolfe series consists of very poorly drained, slowly permeable soils in depressions on uplands and stream terraces. These soils formed in glacial drift and local, loamy alluvial sediments. Native vegetation was sedges, reeds, and other water-tolerant grasses. Slopes range from 0 to 1 percent.

Typical pedon of Rolfe silty clay loam, 0 to 1 percent slopes, in a cultivated field; 2,540 feet west and 740 feet north of the southeast corner of sec. 4, T. 94 N., R. 23 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 30 percent clay), dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; few fine roots; medium acid; abrupt smooth boundary.

A—9 to 13 inches; very dark gray (10YR 3/1) silt loam (about 22 percent clay), gray (10YR 5/1) and dark gray (10YR 4/1) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak thin platy structure; friable; few fine roots; common fine tubular pores; slightly acid; clear smooth boundary.

E—13 to 21 inches; dark gray (10YR 4/1) silt loam (about 15 percent clay), light gray (10YR 6/1) dry; few fine distinct olive brown (2.5Y 4/4) mottles; weak medium platy structure; friable; few fine roots; common fine tubular pores; slightly acid; clear smooth boundary.

Btg1—21 to 29 inches; olive gray (5Y 4/2) silty clay loam (about 38 percent clay); few fine distinct olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; common prominent very dark gray (10YR 3/1) clay films on vertical faces of peds; few fine roots; few fine tubular pores; few dark concretions (iron oxides); medium acid; gradual smooth boundary.

Btg2—29 to 41 inches; olive gray (5Y 5/2) silty clay loam (about 38 percent clay); few fine prominent yellowish brown (10YR 5/4 and 5/6) and common fine faint olive (5Y 5/3) mottles; moderate medium prismatic structure parting to moderate fine and medium angular blocky; firm; common prominent very dark gray (10YR 3/1) clay films on vertical faces of peds; few fine roots; black (10YR 2/1) fills along root channels; few fine tubular pores; few dark concretions (iron oxides); slightly acid; clear smooth boundary.

Btg3—41 to 52 inches; olive gray (5Y 5/2) sandy clay loam (about 23 percent clay); few fine prominent yellowish brown (10YR 5/4 and 5/6) and many fine faint olive (5Y 5/3) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; few prominent very dark gray (10YR 3/1) clay films on vertical faces of peds; few fine roots; few black (10YR 2/1) fills along root channels; few fine tubular pores; few dark concretions (iron oxides); neutral; clear smooth boundary.

BCg—52 to 60 inches; olive gray (5Y 5/2) sandy clay loam (about 20 percent clay); common fine prominent yellowish brown (10YR 5/6 and 5/8) and common fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse prismatic structure; friable; few black (10YR 2/1) fills along root channels; few dark concretions (iron oxides); neutral.

The thickness of the solum and the depth to free carbonates range to more than 60 inches. The mollic epipedon is 10 to 18 inches thick.

The Ap horizon has value of 2 or 3. It is silty clay loam or silt loam. The E horizon has value of 3 to 6. The Btg horizon has value of 4 to 6 and chroma of 1 or 2.

Salida Series

The Salida series consists of excessively drained, very rapidly permeable soils on upland knolls and outwash plains. These soils formed in loamy and sandy glacial outwash. Native vegetation was tall prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Salida gravelly sandy loam, 2 to 9 percent slopes, moderately eroded, in a cultivated field; 1,480 feet south and 100 feet east of the northwest corner of sec. 1, T. 96 N., R. 24 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) gravelly sandy loam (about 12 percent clay), grayish brown (10YR 5/2) dry; mixed with streaks and pockets of brown (10YR 4/3) subsoil material; weak medium and fine granular structure; very friable; 19 percent medium and fine gravel; slight effervescence; moderately alkaline; clear smooth boundary.

Bw—7 to 15 inches; brown (10YR 4/3) gravelly loamy coarse sand (about 8 percent clay); single grained; loose; 15 percent medium and fine gravel; many shale fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

C1—15 to 36 inches; variegated brown (10YR 4/3) and yellowish brown (10YR 5/4 and 5/6) very gravelly coarse sand (about 5 percent clay); single grained; loose; 40 percent medium and fine gravel; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—36 to 51 inches; variegated dark grayish brown (10YR 4/2), brown (10YR 4/3), and dark yellowish brown (10YR 4/4) very gravelly coarse sand (about 5 percent clay); single grained; loose; 36 percent medium and fine gravel; few shale fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

C3—51 to 60 inches; variegated brown (10YR 4/3), dark yellowish brown (10YR 4/4), and yellowish brown (10YR 5/4) very gravelly coarse sand (about 5 percent clay); single grained; loose; 36 percent fine gravel; slight effervescence; moderately alkaline.

The solum ranges from 7 to 20 inches in thickness. The depth to free carbonates is 0 to 20 inches, and most pedons are calcareous throughout. The thickness of the mollic epipedon is 7 to 14 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value and chroma of 3 or 4. The C horizon has value of 3 to 6 and chroma of 2 to 6.

Spicer Series

The Spicer series consists of poorly drained, moderately permeable soils on upland outwash and lake plains. These soils formed in glacial lacustrine sediments. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,380 feet north and 460 feet west of the southeast corner of sec. 20, T. 97 N., R. 24 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam (about

34 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

A—10 to 19 inches; black (N 2/0) silty clay loam (about 35 percent clay), very dark gray (10YR 3/1) dry; few fine distinct olive (5Y 5/3) mottles in lower part; weak very fine and fine granular structure; friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

BA—19 to 24 inches; olive gray (5Y 4/2) silty clay loam (about 30 percent clay); some mixing of black (10YR 2/1) subsurface material; very dark gray (5Y 3/1) coatings on faces of peds; few fine faint olive (5Y 5/3) mottles; weak very fine and fine subangular blocky structure; friable; few fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

Bg—24 to 32 inches; olive gray (5Y 5/2) silt loam (about 21 percent clay); some mixing of very dark gray (5Y 3/1) and olive gray (5Y 4/2) upper subsoil material; few fine prominent dark yellowish brown (10YR 4/6) mottles; weak very fine and fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

BCg—32 to 40 inches; olive gray (5Y 5/2) silt loam (about 23 percent clay); few fine faint olive (5Y 5/3) and few fine prominent strong brown (7.5YR 5/6) mottles; weak fine prismatic structure parting to weak medium subangular blocky; friable; common tubular pores; few dark concretions (iron and manganese oxides); strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—40 to 60 inches; mottled olive gray (5Y 5/2) and strong brown (7.5YR 5/6 and 5/8) silt loam (about 18 percent clay); massive; friable; common tubular pores; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The solum ranges from 18 to 48 inches in thickness. The mollic epipedon ranges from 12 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR, value of 2 or 3, and chroma of 0 or 1. It typically is silty clay loam but in some pedons is silt loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2.

Spillville Series

The Spillville series consists of moderately well drained, moderately permeable soils in upland foot slope positions. These soils formed in loamy alluvium. Native vegetation was tall prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Spillville loam, 2 to 5 percent slopes, in a cultivated field; 620 feet west and 320 feet south of the northeast corner of sec. 23, T. 94 N., R. 25 W.

Ap—0 to 7 inches; black (10YR 2/1) loam (about 24 percent clay), very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

A1—7 to 21 inches; black (10YR 2/1) loam (about 26 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak medium granular; friable; few fine roots; medium acid; gradual smooth boundary.

A2—21 to 36 inches; black (10YR 2/1) loam (about 23 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine roots; medium acid; gradual smooth boundary.

A3—36 to 48 inches; black (10YR 2/1) loam (about 23 percent clay), dark gray (10YR 4/1) dry; weak very fine prismatic structure parting to weak fine and medium subangular blocky; friable; slightly acid; clear smooth boundary.

AC—48 to 60 inches; very dark grayish brown (10YR 3/2) loam (about 23 percent clay), grayish brown (10YR 5/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; common fine faint dark brown (10YR 3/3) mottles; weak fine prismatic structure; friable; neutral.

The solum generally ranges from 30 to 60 inches in thickness. The depth of the mollic epipedon extends to 60 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2.

Storden Series

The Storden series consists of well drained, moderately permeable soils on convex knolls and side slopes on uplands. These soils formed in calcareous glacial till. Native vegetation was tall prairie grasses. Slopes range from 5 to 25 percent.

Typical pedon of Storden clay loam, 14 to 18 percent slopes, moderately eroded, in a cultivated field; 2,150 feet east and 180 feet south of the northwest corner of sec. 13, T. 97 N., R. 25 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) clay loam (about 29 percent clay), light brownish gray (10YR 6/2) dry; mixed with some streaks and pockets of yellowish brown (10YR 5/4) substratum material; weak fine subangular blocky structure; friable; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C1—7 to 14 inches; yellowish brown (10YR 5/4) clay loam (about 27 percent clay); massive; friable; few fine roots; few dark concretions (iron oxides); few soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C2—14 to 26 inches; yellowish brown (10YR 5/4) clay loam (about 28 percent clay); massive; friable; few fine roots; few dark concretions (iron and manganese oxides); common soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C3—26 to 42 inches; light olive brown (2.5Y 5/4) clay loam (about 27 percent clay); common fine and medium prominent strong brown (7.5YR 5/6), common fine faint grayish brown (2.5Y 5/2), and few fine faint olive brown (2.5Y 4/4) mottles; massive; friable; few fine roots; common dark concretions (iron and manganese oxides); many soft accumulations (calcium carbonate); few fine and medium shale fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C4—42 to 60 inches; light olive brown (2.5Y 5/4) clay loam (about 30 percent clay); common fine faint grayish brown (2.5Y 5/2), few fine faint olive brown (2.5Y 4/4), and common fine prominent strong brown (7.5YR 4/6) mottles; massive; friable; common dark concretions (iron and manganese oxides); common soft accumulations (calcium carbonate); few fine shale fragments; strong effervescence; moderately alkaline.

The thickness of the solum generally is the same as the thickness of the A horizon and ranges from 7 to 10 inches.

The A horizon has value of 4 or 5 and chroma of 2 or 3. The C horizon has value of 5 or 6 and chroma of 2 to 6.

Sunburg Series

The Sunburg series consists of well drained, moderately rapidly permeable soils on convex knolls and side slopes on uplands. These soils formed in calcareous glacial till. Native vegetation was tall prairie grasses. Slopes range from 2 to 25 percent.

Typical pedon of Sunburg sandy loam, 14 to 18 percent slopes, moderately eroded, in a cultivated field; 2,150 feet east and 200 feet north of the center of sec. 1, T. 94 N., R. 23 W.

Ap—0 to 7 inches; brown (10YR 4/3) and dark brown (10YR 3/3) sandy loam (17 percent clay), pale brown (10YR 6/3) dry; mixed with some streaks and pockets of brown (10YR 5/3) substratum material; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—7 to 18 inches; brown (10YR 5/3) sandy loam (16 percent clay); massive; very friable; few fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C2—18 to 36 inches; light olive brown (2.5Y 5/4) sandy loam (13 percent clay); many medium prominent yellowish red (5YR 4/6) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; very friable; common fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C3—36 to 60 inches; light olive brown (2.5Y 5/4) sandy loam (11 percent clay); few fine prominent strong brown (7.5YR 4/6) mottles; massive; very friable; few fine soft accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The thickness of the solum generally is the same as the thickness of the A horizon and ranges from 6 to 10 inches.

The A horizon has chroma of 1 to 3. It is sandy loam or loam. The C horizon has value of 4 to 6 and chroma of 3 or 4.

Truman Series

The Truman series, stratified substratum, consists of well drained, moderately permeable soils on convex slopes on uplands and on stream terraces. These soils formed in glacial till sediments overlying glacial outwash. Native vegetation was tall prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Truman silty clay loam, stratified substratum, 0 to 2 percent slopes, in a cultivated field; 1,540 feet south and 1,960 feet east of the northwest corner of sec. 27, T. 97 N., R. 23 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 28 percent clay), dark gray (10YR 4/1) dry;

weak fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A1—9 to 15 inches; black (10YR 2/1) silty clay loam (about 30 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; neutral; clear smooth boundary.

A2—15 to 22 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silty clay loam (about 30 percent clay), dark gray (10YR 4/1) dry; some mixings in the lower part of brown (10YR 4/3) subsoil material; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; slightly acid; clear smooth boundary.

BA—22 to 27 inches; brown (10YR 4/3) silty clay loam (about 29 percent clay); some mixings of very dark gray (10YR 3/1) subsurface material; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

Bw1—27 to 34 inches; dark yellowish brown (10YR 4/4) silty clay loam (about 32 percent clay); brown (10YR 4/3) coatings on faces of peds; common fine faint yellowish brown (10YR 5/6) mottles; weak fine and medium blocky structure; friable; few fine light gray (10YR 7/2) silt coatings on faces of peds; few fine roots; slightly acid; gradual smooth boundary.

Bw2—34 to 40 inches; dark yellowish brown (10YR 4/4) silty clay loam (about 28 percent clay); brown (10YR 4/3) coatings on faces of peds; few fine distinct gray (2.5Y 5/2) and common fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; common fine light gray (10YR 7/2) silt coatings on faces of peds; very few fine roots; slightly acid; common smooth boundary.

2BC—40 to 50 inches; dark yellowish brown (10YR 4/4) loam (about 18 percent clay); few fine prominent yellowish red (5YR 4/6) and dark brown (7.5YR 3/4), common fine distinct brown (7.5YR 4/4), and many fine distinct grayish brown (2.5Y 5/2) mottles; weak fine prismatic structure; friable; neutral; abrupt smooth boundary.

2C—50 to 60 inches; brown (10YR 5/3) and dark yellowish brown (10YR 4/4) fine sandy loam (about 12 percent clay); common medium distinct yellowish brown (10YR 5/6) and many medium distinct gray (2.5Y 5/2) mottles; massive; very friable; slightly acid.

The solum ranges from 36 to 56 inches in thickness. The depth to stratified substratum material ranges from 40 to 60 inches. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has chroma of 1 or 2. The Bw horizon has value of 4 or 5 and chroma of 3 to 6. Texture of the 2BC horizon typically is loam but ranges to silt loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. Its texture generally is fine sandy loam and strata of fine sand, loamy fine sand, sandy clay loam, clay loam, loam, and silt loam.

Vinje Series

The Vinje series consists of well drained, moderately slowly permeable soils on convex knolls and side slopes on uplands. These soils formed in silty glacial lacustrine sediments over glacial till. Native vegetation was tall prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Vinje silty clay loam, 2 to 5 percent slopes, in a cultivated field; 2,500 feet north and 580 feet east of the southwest corner of sec. 16, T. 95 N., R. 24 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 35 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; abrupt smooth boundary.

A—9 to 15 inches; very dark brown (10YR 2/2) silty clay (about 43 percent clay), very dark grayish brown (10YR 3/2) dry; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate very fine subangular blocky structure parting to moderate fine granular; friable; few fine roots; neutral; gradual smooth boundary.

AB—15 to 20 inches; very dark grayish brown (10YR 3/2) silty clay (about 41 percent clay), dark grayish brown (10YR 4/2) dry; some mixing of brown (10YR 4/3) subsoil material; black (10YR 2/1) and very dark gray (10YR 3/1) coatings on faces of peds; moderate fine and very fine subangular blocky structure parting to some moderate fine granular; firm; slightly acid; gradual smooth boundary.

Bt1—20 to 26 inches; brown (10YR 4/3) silty clay (about 42 percent clay); very dark grayish brown (10YR 3/2) organic coatings on faces of peds; weak fine prismatic structure; parting to moderate fine and very fine subangular blocky; firm; few faint dark brown (10YR 3/3) clay films on vertical faces of peds; slightly acid; gradual smooth boundary.

Bt2—26 to 33 inches; brown (10YR 5/3) silty clay loam (about 39 percent clay); brown (10YR 4/3) coatings on faces of peds; common fine distinct strong brown (7.5YR 4/6) and very dark grayish brown (2.5Y 4/2) mottles; weak fine prismatic structure parting to weak fine and very fine subangular blocky; firm; few fine tubular pores; few faint dark brown (10YR 3/3) clay films on vertical faces of peds; few black (10YR 2/1) fills in root channels; slightly acid; gradual smooth boundary.

Bt3—33 to 43 inches; light olive brown (2.5Y 5/4) silty clay loam (about 37 percent clay); brown (10YR 4/3) coatings on faces of peds; few fine prominent strong brown (7.5YR 5/6), common fine prominent yellowish brown (10YR 5/6), and common fine faint grayish brown (2.5Y 5/2) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; common fine tubular pores; few faint olive brown (2.5Y 4/4) clay films on vertical faces of peds; few dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

2BC—43 to 46 inches; light olive brown (2.5Y 5/4) clay loam (about 29 percent clay); dark grayish brown (2.5Y 4/2) coatings on faces of peds; common fine faint olive brown (2.5Y 4/4) and common medium distinct dark yellowish brown (10YR 4/6) mottles; weak medium prismatic structure; friable; few faint dark grayish brown (2.5Y 4/2) clay films on peds; few black (10YR 2/1) root fills; few dark concretions (iron and manganese oxides); neutral; gradual smooth boundary.

2C—46 to 60 inches; mottled light olive brown (2.5Y 5/4) and grayish brown (2.5Y 5/2) loam (about 23 percent clay); common medium prominent brown (7.5YR 4/4) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); slight effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches in thickness. The mollic epipedon ranges from 10 to 24 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bt horizon has value of 4 or 5 and chroma of 3 or 4 in the upper part and has hue of 10YR or 2.5Y in the lower part. The 2BC and 2C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The 2C horizon is loam, but its texture ranges to clay loam.

The Vinje soils in map unit 787C2 are taxadjuncts to the Vinje series because it does not have a mollic epipedon, which is definitive for the Vinje series.

Wacousta Series

The Wacousta series consists of very poorly drained, moderately permeable soils in upland depressions. These soils formed in silty lacustrine sediments. Native vegetation was water-tolerant grasses. Slopes range from 0 to 1 percent.

Typical pedon of Wacousta silty clay loam, 0 to 1 percent slopes, in a cultivated field; 140 feet north and 800 feet east of the southwest corner of sec. 17, T. 95 N., R. 23 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 35 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; mildly alkaline; abrupt smooth boundary.

A—9 to 15 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; some mixing of olive gray (5Y 5/2) subsoil material; common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine granular structure; friable; mildly alkaline; abrupt smooth boundary.

Bg—15 to 24 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); common fine prominent dark yellowish brown (10YR 4/6) and common medium distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; few very dark gray (10YR 3/1) root fills; slight effervescence; mildly alkaline; clear smooth boundary.

Cg—24 to 60 inches; olive gray (5Y 5/2) silt loam (about 25 percent clay); many medium prominent dark yellowish brown (10YR 4/6) and common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The solum ranges from 10 to 24 inches in thickness. The mollic epipedon ranges from 8 to 18 inches in thickness. The depth to free carbonates ranges from about 12 to 20 inches.

The A horizon is neutral in hue or has hue of 10YR and chroma of 0 or 1. It is silt loam or silty clay loam. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or, less commonly, silt loam. The Cg horizon has value of 5 or 6 and chroma of 1 or 2.

Wadena Series

The Wadena series consists of well drained soils in upland outwash areas and stream terraces. These soils formed in loamy glacial outwash overlying sand and gravel. Native vegetation was tall prairie grasses. Permeability is moderate in the solum and very rapid in the underlying sand and gravel. Slopes range from 0 to 5 percent.

Typical pedon of Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 2,340 feet west and 140 feet south of the northeast corner of sec. 19, T. 97 N., R. 24 W.

Ap—0 to 10 inches; black (10YR 2/1) loam (about 24 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few fine roots; slightly acid; clear smooth boundary.

AB—10 to 18 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam (about 25 percent clay), dark grayish brown (10YR 4/2) dry; some mixing of brown (10YR 4/3) subsoil material; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

Bw1—18 to 23 inches; brown (10YR 4/3) loam (about 25 percent clay); few dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

Bw2—23 to 33 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loam (26 percent clay); weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

2C—33 to 60 inches; yellowish brown (10YR 5/4) and brown (10YR 4/3) gravelly coarse sand (about 5 percent clay); single grained; loose; about 25 percent fine and medium gravel; slight effervescence; mildly alkaline.

The solum ranges from 24 to 40 inches in thickness. The depth to carbonates ranges from 30 to 50 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It dominantly is loam but includes clay loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It typically is loam, although in some pedons it is sandy loam or sandy clay loam in the lower part. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is coarse sand or sand or their gravelly or very gravelly analogs.

Waldorf Series

The Waldorf series consists of poorly drained, moderately slowly permeable soils on nearly level or slightly concave slopes on uplands. These soils formed in lacustrine sediments. Native vegetation was water-tolerant prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Waldorf silty clay, 0 to 2 percent slopes, in a cultivated field; 2,000 feet north and 24 feet east of the southwest corner of sec. 15, T. 96 N., R. 24 W.

Ap—0 to 8 inches; black (N 2/0) silty clay (about 41 percent clay), very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; firm; common fine roots; neutral; abrupt smooth boundary.

A—8 to 15 inches; black (N 2/0) silty clay (about 43 percent clay), very dark gray (10YR 3/1) dry; moderate very fine and fine subangular blocky structure; firm; few fine roots; neutral; gradual smooth boundary.

AB—15 to 21 inches; very dark gray (5Y 3/1) silty clay (about 44 percent clay); black (10YR 2/1) coatings on faces of peds; dark gray (10YR 4/1) dry; few fine faint dark olive gray (5Y 3/2) mottles; moderate very fine and fine subangular blocky structure; firm; few fine roots; neutral; clear smooth boundary.

Bg1—21 to 28 inches; olive gray (5Y 4/2) silty clay (about 42 percent clay); very dark gray (5Y 3/1) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) and few fine prominent strong brown (7.5YR 5/8) mottles; moderate fine prismatic structure parting to moderate very fine and fine subangular blocky; firm; few fine roots; neutral; gradual smooth boundary.

Bg2—28 to 37 inches; olive gray (5Y 5/2) silty clay (about 41 percent clay); few olive gray (5Y 4/2) coatings on faces of peds; common fine prominent yellowish brown (10YR 5/6) and few fine prominent strong brown (7.5YR 5/8) mottles; moderate medium prismatic structure parting to very fine and fine subangular blocky; firm; few fine roots; neutral; abrupt smooth boundary.

C—37 to 60 inches; olive gray (5Y 5/2) silty clay loam (about 34 percent clay); common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; few fine tubular pores; few fine rounded accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The solum ranges from 26 to 48 inches in thickness. The depth to free carbonates ranges from 26 to 55 inches. The mollic epipedon ranges from 16 to 24 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR to 5Y, value of 2 or 3, and chroma of 0 or 1. The Bg horizon has hue of 2.5Y or 5Y 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.

Webster Series

The Webster series consists of poorly drained, moderately permeable soils on nearly level or slightly concave slopes on uplands. These soils formed in glacial till-derived sediments or glacial till. Native vegetation was water-tolerant grasses. Slopes range from 0 to 2 percent.

Typical pedon of Webster clay loam, 0 to 2 percent slopes, in a cultivated field; 70 feet east and 450 feet south of the northwest corner of sec. 26, T. 97 N., R. 26 W.

Ap—0 to 9 inches; black (N 2/0) clay loam (about 30 percent clay), very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

A—9 to 16 inches; black (N 2/0) clay loam (about 31 percent clay), very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

AB—16 to 21 inches; black (10YR 2/1) clay loam (about 33 percent clay); with olive gray (5Y 5/2) mixings; few fine distinct olive gray (5Y 4/2) mottles; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

Bg1—21 to 28 inches; olive gray (5Y 5/2) and dark gray (5Y 4/1) clay loam (about 34 percent clay); common medium faint olive (5Y 5/3) mottles; weak medium prismatic structure parting to weak fine and very fine subangular blocky; friable; few black (N 2/0) fills in root channels; few dark concretions (iron oxides); neutral; gradual smooth boundary.

Bg2—28 to 32 inches; olive gray (5Y 5/2) clay loam (about 28 percent clay); few fine prominent strong brown (7.5YR 5/8) and common medium faint olive (5Y 5/3) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few dark concretions (iron and manganese oxides); neutral; clear smooth boundary.

BCg—32 to 42 inches; olive gray (5Y 5/2) loam (about 25 percent clay); common fine prominent yellowish brown (10YR 5/8) and light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine tubular pores; few dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—42 to 60 inches; olive gray (5Y 5/2) loam (about 22 percent clay); many fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; few fine tubular pores; common dark concretions (iron and manganese oxides); few soft accumulations (calcium carbonate); strong effervescence; mildly alkaline.

The thickness of the solum typically ranges from 30 to 42 inches but in some pedons is as much as 50 inches. The depth to free carbonates is the same as the thickness of the solum. The mollic epipedon ranges from 14 to 20 inches in thickness.

The A horizon is neutral in hue or has hue of 10YR and chroma of 0 or 1. It is clay loam but includes silty clay loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Texture in the Bg horizon is clay loam or silty clay loam. The BC horizon is loam but includes clay loam. The C horizon has colors similar to those of the B horizon, although in some pedons the value is as high as 6 and the chroma is 3.

Formation of the Soils

In this section, the factors that have affected the formation of soils in Hancock County are described and the processes of horizon differentiation are explained.

Factors of Soil Formation

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life, including human activities, on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material *(11)*.

The active factors of soil formation are climate and plant and animal life. These factors act on the parent material and slowly change it into a natural body that has genetically related horizons. Relief conditions the effects of plant and animal life. The parent material affects the kind of soil profile that forms and in extreme cases determines it almost entirely. Finally, time is needed for a soil to form in the parent material. Some time is always needed for the differentiation of soil horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effects of any one factor unless conditions are specified for the others.

Parent Material

The accumulation of parent material is the first step in the formation of a soil. The soils of Hancock County formed in material that was transported from the site of the parent rock and redeposited at a new location through the actions of glacial ice, water, wind, and gravity.

The parent materials in the county are glacial till, glacial outwash, alluvium, organic deposits, wind- or water-deposited sandy material, and glaciolacustrine sediment. The bedrock beneath these materials has been buried so deeply that it has had no influence on the soils. The glacial drift is as thick as 225 feet in the northwestern part of the county and is as thin as 30 feet southwest of Garner *(17)*. The bedrock topography ranges from about 1,050 feet above mean sea level in the western part of the county to about 1,150 feet in the eastern part *(7)*.

Glacial till is unsorted sediment in which particles range in size from clay to boulders. It is the most important parent material in the county. The earliest glaciations in Iowa began sometime before 2.2 million years ago *(4, 5, 6, 7)*. The county was probably glaciated several times during the earliest pre-Illinoian stages *(7)*. But later glacial erosion either has removed younger deposits or has deeply buried these earlier glacial materials.

Glacial deposits of the youngest glacial stage, the Wisconsinan, make up most of the surface and near-surface parent material in the uplands. These deposits are from the Des Moines Lobe of the continental ice sheet approximately 12,000 to 14,000 years ago *(13, 20)*. The upland topography and parent materials vary throughout the county as a result of this glaciation. A broad belt of hummocky topography in the Altamont Moraine complex extends through the central part of the county generally paralleling U.S. Highway 69 to the west. Similar hummocky topography of the Algona Moraine complex passes through the northwestern part of the county. A small part of the Altamont Moraine juts off to the west, near Forest City, merging with the Algona Moraine southeast of Crystal Lake.

The hummocky topography of these end moraines formed primarily through supraglacial deposition *(12)*. As a result, the parent material in the uplands varies locally. Most areas are dominated by glacial till, but some contain fine textured, glaciolacustrine sediments, and a few areas contain sandier sediments. The till is a heterogeneous mixture, indicating its glacial origin, and shows little evidence of sorting or stratification. The glaciolacustrine sediments are more homogeneous in nature, generally lack coarse fragments, are low in sand, and are noticeably stratified. Clarion, Lester, Nicollet, and Storden soils formed in glacial till. Estherville and Salida soils formed in sandy deposits. Collinwood, Vinje, and Waldorf soils formed in glaciolacustrine sediments.

To the west of the Algona and Altamont Moraines, as well as in the east-central part of the county, the uplands generally have a low-relief topography of swells and swales. Clarion and Nicollet soils are the major soils that formed in glacial till on these uplands.

Outwash deposited by glacial meltwater streams is an important geologic deposit in the county. Sand and gravel are deposited along the margin of the Algona and Altamont Moraines *(20)*. The most extensive deposits are southwest of Forest City and south of Crystal Lake. Other deposits are associated with the Algona Moraine near Hutchins. Similar deposits of lesser extent and depth are in scattered areas in other parts of the county, in some instances adjacent to smaller streams. Biscay, Estherville, Harcot, Linder, Mayer, Ridgeport, and Wadena soils formed in outwash material.

Alluvium is sediment that has been deposited along major and minor streams and drainageways and at the base of steep slopes. It varies in texture because of the differences in the source material and in the manner in which it was deposited. In Hancock County, the main source of alluvium is glacial till.

Some of the alluvial material has been transported only short distances. This material is called local alluvium or colluvium. It retains many of the characteristics of the soils from which it was washed. The sloping Spillville soils, for example, are at the base of slopes below soils that formed in glacial till.

Coland soils are of greatest extent along most rivers and streams in Hancock County. Coarser textured alluvium sometimes occurs as narrow bands in scattered areas adjacent to a river or stream. These areas are too small to be separated in mapping. In some places along the Iowa River, Calco soils intermingle with Coland soils on the flood plain.

Organic material accumulated in old lakebeds or swamps that supported a heavy growth of aquatic plants and other vegetation that grew under excessively wet conditions. The vegetation partly decomposed and accumulated in fairly thick beds under water. In places the deposits may be as deep as 20 feet. Glacial till or finer textured local alluvium generally underlies the organic material. In places layers of mineral soil material separate layers of organic material. Adrian, Blue Earth, Houghton, Muskego, and Palms soils formed in organic material. In Blue Earth and Muskego soils, the organic material has been modified by aquatic animal life.

Wind- or water-deposited sandy material in Hancock County probably was deposited mainly by water. In most areas, however, wind has partially reworked these deposits. Bolan and Dickman soils formed in these deposits.

Glaciolacustrine sediment, which is dominantly fine textured, is the parent material of a number of soils in the county. Glaciolacustrine sediments formed in lakes on the glacial surface and caps various circular-shaped knobs of the Altamont Moraine complex *(13)*. Thickness of the sediments on the circular-shaped knobs ranges from 3 to more than 9 feet. Collinwood, Kamrar, Kilkenny, and Vinje soils formed in areas where this sediment mantles knobs or hummocks.

Glaciolacustrine sediments were also deposited in swales between the knobs of the Altamont Moraine complex. These deposits formed in shallow lakes and marshes, which have now been drained. The deposits typically are 8 to 10 feet thick but may be as much as 20 feet thick. Even though they are fine textured, they are noticeably stratified. Waldorf soils formed in the lacustrine sediments.

The fine textured soils of this topography exhibit a consistent two-fold stratigraphy. The upper part is massive, fine textured material in which modern soils formed. The lower part is a thin layer of stratified sand that most generally has a pebble band. Glacial till and other glacial deposits underlie the glaciolacustrine sediments.

A large area surrounding the town of Goodell does not have the familiar knobby topography that is common to the topography of the Altamont Moraine complex. This area characteristically is low in relief and is mantled with a nearly continuous layer of lacustrine sediments. The lacustrine sediments range from 24 to 48 inches in thickness and overlie glacial till. The soils of this region exhibit similar internal soil characteristics as those glaciolacustrine soils found in other parts of the county. Bode, Kossuth, and Ottosen soils are the dominant soils in this area.

Climate

Hancock County has a midcontinental, subhumid climate. The southern part of the county has a slightly longer growing season, and receives more rainfall than the northern part *(25)*.

Climate influences the formation of soils in many ways. Rainfall affects the extent of leaching in soils, and helps to determine the kind of vegetation that grows on the soils. Temperature affects the growth of plants, the activity of micro-organisms, and the rate of chemical actions in the soils. Temperature and moisture conditions affect the rate at which parent material weathers. The amount and seasonal distribution of precipitation help to determine the depth to which calcium carbonates, other soluble minerals, and clay are moved downward through the soil and the rate of erosion. Precipitation also affects the depth to the water table in poorly drained and somewhat poorly drained soils. The depth to the water table, in turn, affects the depth of development in the subsoil. In areas where the water table is near the surface most of the year, the subsoil does not develop to so great a depth as the subsoil in areas where the water table is lower.

Soils form more rapidly in a warm climate than in a cold climate. They also form more rapidly in a wet climate than in a dry climate. Except for climatic differences resulting from topography, the soils in Hancock County formed under about the same climate. The climate has not been the same, however, during the entire period of soil formation.

The formation of the soils in Hancock County began about 13,000 years ago, after the glaciation in Iowa ended and a warming trend began *(22)*. The climate in northern Iowa since that time has varied considerably *(3, 32)*. From before 13,000 to about 11,000 years ago, the climate was cool and the vegetation was dominantly a coniferous forest of spruce. As the climate warmed, deciduous vegetation invaded and persisted until about 9,000 years ago. After this time, the climate became warmer and drier. Prairie vegetation became dominant in Iowa by about 8,000 years ago. During the past 8,000 years, the climate has fluctuated to a minor extent. During some periods it was similar to the present climate, and during other periods it was warmer and drier. During the past 3,000 years, it has been generally similar to the present climate *(14)*.

The climate in the part of Hancock County northeast of the Winnebago River has been conducive to mixed prairie grasses and deciduous forest. In this part of the county, numerous large depressions or bogs that were not drained until recent times helped to provide a more humid environment, which favored deciduous trees. Along with the Winnebago River, they also tended to impede prairie fires, which would have hindered or prevented the growth of trees.

In the rest of the county, most of the soils do not have characteristics indicating that they were ever forested. Evidently, the rapid geologic erosion that accompanied major climatic changes removed the soils that formed under forest vegetation. Therefore, the soil landscapes generally are less than 8,000 years old. Most of the soil features relating to the prairie environment have developed during the last 3,000 years of relative erosional landscape stability *(32)*. Clarion, Nicollet, Okoboji, Webster, and other soils formed under prairie vegetation.

The effect of climate on soils is modified by local conditions, such as relief. For example, the microclimate in areas of the low-lying, poorly drained Canisteo and Webster soils is cooler and wetter than that in areas of the well drained adjacent soils, such as Clarion. The microclimate in areas of Storden and other soils on the steeper slopes is drier than that in areas of the adjacent Clarion soils on gentle slopes. South- and west-facing slopes generally are slightly warmer and less humid than nearby areas. These variations account for some of the differences among soils within the same general climatic region. Partly because of these microclimatic conditions, areas in the northeastern part of the county and areas adjacent to Eagle Lake and Crystal Lake support native trees.

Plant and Animal Life

Vegetation and animal life are important factors of soil formation. Vegetation is especially important. Many changes in vegetation took place in Hancock County during the postglacial period. Forest vegetation dominated by spruce grew on the soils until about 11,000 years ago. It was followed by deciduous forest, which lasted until about 9,000 years ago. Then, prairie vegetation began to dominate *(3, 32)*. For the past 8,000 years, the soils have been influenced by both prairie grasses and deciduous trees. Big bluestem and little bluestem probably were the main prairie grasses. The main trees were oak, hickory, ash, elm, and maple.

Variations in the kinds of vegetation commonly cause marked differences among soils *(16)*. As plants grow and die, their remains are added to the soil. Burrowing animals, earthworms, bacteria, protozoa, other microbes, and fungi help to convert these plant remains into organic matter. Many kinds of micro-organisms are needed to transform organic remains into stable humus from which plants can obtain nutrients. Humus gives the surface soil its dark color.

Large burrowing animals, such as badgers, foxes, and pocket gophers, significantly affect soil formation in small areas. Small animals, such as earthworms, also influence soil formation. They move up and down in soils as the soil moisture and temperature change. In many soils in the county, earthworms have moved material from one horizon to another.

Because grasses have many roots and tops that decay on or below the surface, soils that formed under prairie vegetation have a thick, dark surface layer. In contrast, soils that formed under trees and grass have a somewhat thinner, lighter colored surface layer because the organic matter, derived partly from leaves, accumulated on the surface.

Dark soils, such as Clarion, Nicollet, and Webster soils, formed more recently under prairie vegetation. Kilkenny and Lester soils formed under mixed grasses and timber and typically are lighter colored in the surface layer than Clarion, Nicollet, and Webster soils.

Relief

Relief is an important cause of differences among soils. It indirectly influences soil formation through its effect on drainage, runoff, and erosion. More water runs off the surface of the steeper areas, and less soaks into the soil. As a result, less leaching of carbonates occurs and less clay is moved from the surface layer into the subsoil. Also, the hazard of water erosion is more severe on the steeper slopes. Much of the acreage in Hancock County is nearly level to moderately sloping, but many areas are strongly sloping to steep.

The topography in Hancock County is geologically immature, as is evidenced by a large number of small depressions or potholes, other depressions, and the lack of minor upland streams. The county has three main types of moraine topography. One type is a series of flat-topped, smooth-sided slopes that have many small depressions and an indistinct drainage pattern. This kind of topography generally has low relief. It is prevalent in most of the western part of the county as well as in the east-central part. Canisteo, Clarion, Nicollet, Okoboji, and Webster are the major soils on this topography.

Another dominant kind of topography is along the lateral front of the Algona Moraine. It is in a belt, 2 to 4 miles wide, that extends northeast to southwest through the town of Crystal Lake. It consists of high-relief hummocks or hills that have steep side slopes dissected to some extent by upland drainageways. Clarion and Sunburg soils are dominant in this area.

The third type of topography is in the central part of the county paralleling U.S. Highway 69 to the west. It generally is hummocky and has high relief. The landscape is one of relatively broad, flat-topped hummocks and ridges that have low areas or swales between knobs. The low areas and swales commonly interconnect relatively large depressional areas of organic soils. Much of the acreage probably was an area of ice-walled lakes at the time of glaciation *(12)*. In this area, the soils formed in glaciolacustrine sediments. Examples are Collinwood, Kilkenny, Vinje, and Waldorf soils.

Variations in relief are a major reason for the differing soil properties among some of the soils in the county. Topography affects the color, the thickness of the solum, and the horizon of the soils, as is evident in Clarion, Nicollet, and Sunburg soils, which formed in the same kind of parent material and under similar vegetation. These soils differ from each other because of variations in topography. The thickness and color of the surface layer and the thickness of the solum are related to the slope. The surface layer is thicker and darker in the less sloping areas. Sunburg soils typically are on the steepest slopes, Clarion soils are on the intermediate slopes, and Nicollet soils are in nearly level areas. The solum typically is thinnest in Sunburg soils and thickest in Clarion soils.

Topography affects the color of the subsoil through its effect on drainage and soil aeration. A well drained soil generally has a brown subsoil because iron compounds are oxidized and well distributed throughout the horizon. The sloping Clarion soils are an example. On the other hand, soils in nearly level or depressional areas are wet and commonly have a gray or mottled subsoil because of poor aeration and restricted drainage. Webster soils are an example.

Calco and Coland soils are on bottom land. Although they are nearly level, their microrelief affects runoff, the depth to the water table, and the rate at which they receive new sediment.

Time

Geologically, the soils in Hancock County are young. The radiocarbon technique for determining the age of carbonaceous material found in till has made it possible to determine the approximate age of soils and Pleistocene deposits in Iowa. Published studies provide information about the age of soils in Iowa *(19, 20, 22)*.

The radiocarbon technique indicates that the most recent Wisconsinan glaciation in north-central Iowa occurred 14,000 to 12,000 years ago *(7, 20, 21)*. The soils in Hancock County formed after this glaciation. Soil formation began at widely differing times, depending on the local landscape evolution.

In much of Iowa, including Hancock County, erosion has beveled the side slopes of uplands, and in places soil material has been removed and deposited on lower lying slopes *(20, 22)*. This sediment accumulated as local alluvium on foot slopes. The sloping Spillville soils formed in this alluvium. The uplands have an older surface on the summits than on the side slopes. The side slopes are less than 13,000 years old and in places less than 3,000 years old *(32)*.

Clarion, Storden, Sunburg, and other soils on side slopes are subject to geologic erosion, which continually exposes fresh material. As a result, the age of these soils ranges from that of the parent material to that of the most recent sediment.

The soils that formed in glacial outwash on terraces, such as Linder and Ridgeport soils, are less than 13,000 years old *(20)*. The age of the soils that formed in alluvium ranges from that of the recently deposited material in areas of Spillville loam and Coland clay loam, channeled, to that of the slightly older sediment in areas of Coland clay loam. The older sediment is less than about 13,000 years old and probably is much younger.

Human Activities

Important changes have taken place in the soils since Hancock County was settled. Breaking the prairie sod and draining some of the many depressions and small lakes affected the protective cover.

The most drastic changes are those caused by water erosion. Cultivation increases the runoff rate and thus the susceptibility to erosion, which removes topsoil, organic matter, and plant nutrients. Sheet or rill erosion, the most prevalent kind of erosion in the county, removes only a fraction of an inch at a time. Plowing and cultivation generally destroy the evidence of this loss. Over a period of years, however, much eroded soil is deposited on the lower slopes and foot slopes. The gently sloping Spillville soils formed in this eroded material. In other areas, shallow and deep gullies have formed. As the land was brought under cultivation, the runoff rate increased and the rate at which water moved into the soil decreased. As a result, accelerated erosion has removed part or all of the original surface layer from sloping soils in some areas (fig. 15).

Erosion has changed not only the thickness of the surface layer but also its structure. In severely eroded areas the plow layer consists of the upper part of the subsoil mixed with the remaining surface layer or, in the Storden soils, the upper part of the substratum mixed with small amounts of the remaining surface layer.

Erosion and cultivation also reduce the organic matter content, available water capacity, and fertility level of the soil. Even in areas that are not subject to erosion, compaction by heavy machinery reduces the thickness of the surface layer and alters the soil structure. The granular structure so apparent in virgin grassland breaks down somewhat under intensive cropping. As a result, the surface becomes hard when dry.

Erosion is one of the main reasons for the reduction of the organic matter content in soils. As much as a third of the organic matter, however, is lost through causes other than erosion *(28)*. Cultivation and cropping reduce the content and in places redistribute the organic matter. Maintaining as high a content as was originally present under native grasses generally is not feasible. The content should be high enough, however, to maintain crop production.

On the other hand, human activities have increased the productivity of soils, decreased soil loss, and reclaimed areas that otherwise are not suitable for crops and pasture. Terraces and similar measures, for example, have slowed runoff and thus have helped to control erosion. Flooding has been controlled in areas where streams have been straightened and deepened and obstacles to floodwater have been removed. As a result of these measures, some areas along streams are better suited to cultivated crops. Drainage ditches have provided outlets for tile drains and drained depressions and small lakes. They have improved the suitability for most agricultural uses, but they have also destroyed the native habitat for some wildlife species. Applications of commercial fertilizer and lime have corrected deficiencies in plant nutrients, so that some soils are more productive than they were in their natural state.

Processes of Horizon Differentiation

Soil horizons are faintly or moderately expressed in most of the soils in Hancock County. Canisteo, Sunburg, and Webster soils have faint horizons; Clarion and Nicollet soils have intermediate horizons; and Kilkenny and Lester soils have somewhat more prominent horizons. Some soils have a marked difference in texture between the solum and an underlying 2C horizon. Examples are soils that formed in outwash, such as Mayer and Linder soils, and soils that formed in two kinds of parent material, such as Vinje soils.

Horizon differentiation results from soil-forming processes. These processes are the accumulation of organic matter, leaching of calcium carbonates and other bases, the accumulation of calcium carbonates, the formation and translocation of silicate clay minerals, and the reduction and transfer of iron *(27)*. Each of these processes helps to determine the kind of soil

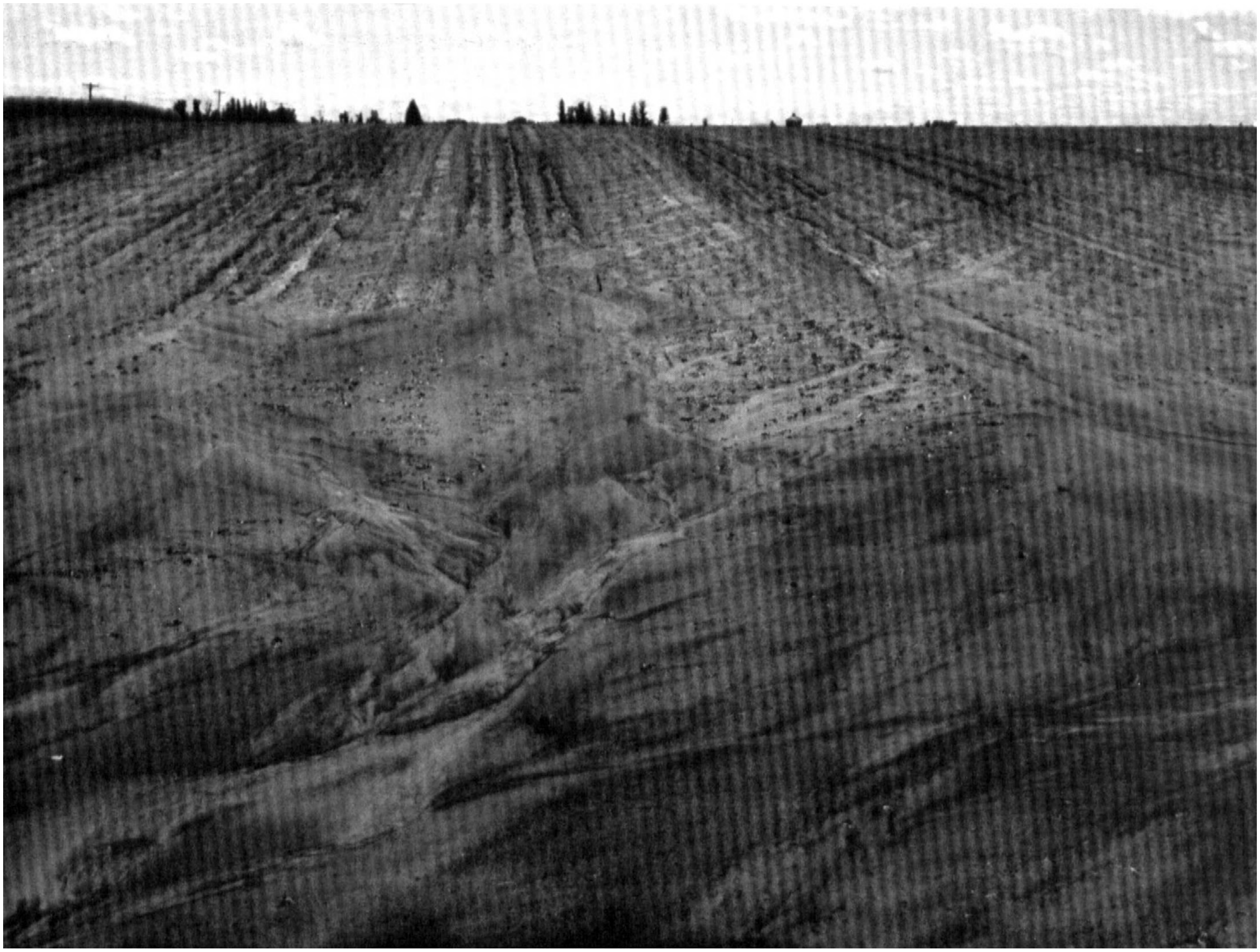

Figure 15.—Erosion on Clarion loam, 5 to 9 percent slopes, moderately eroded.

horizons that form and the rate of soil formation. As most soils form, organic matter is added, soluble salts or bases and carbonates are removed, clay is transferred from the surface downward, and primary minerals are transformed into secondary minerals that can be used by plants. In general, these processes tend to promote horizon differentiation, but some changes tend to offset or retard it. The processes and resulting changes proceed simultaneously in soils, and thus the ultimate nature of the profile is governed by the balance of these processes within the soil.

In most of the soils in Hancock County, some organic matter has accumulated in the A horizon. The accumulation of organic matter is one of the first evidences of horizon differentiation. In soils that formed in organic deposits, the A horizon has a very high organic matter content. Examples are Houghton and Palms soils. Some mineral soils have a high organic matter content and a thick A horizon. Examples are Canisteo, Coland, Okoboji, and Webster soils. Clarion soils have a moderate organic matter content. Storden soils are an example of soils that have a low organic matter content and a faint, thin A horizon.

Leaching of calcium carbonates and other bases has occurred in many soils in Hancock County. Leaching generally occurs before and during the translocation of silicate clay minerals. Percolating water removes soluble salts and calcium carbonates from the upper horizons. The depth to which calcium carbonates precipitate generally is an indication of the usual depth to which water percolates or the depth to the water table in part of the year. As carbonates are moved downward, the B horizon forms. This leaching has occurred to a moderate depth in Clarion and Nicollet soils. Kilkenny, Lester, and Rolfe soils generally are more strongly leached and to a somewhat greater depth. The removal of calcium carbonates by leaching has progressed much more slowly, or not at all, in Storden soils because erosion removes most of the surface layer and organic matter as the soils form. Thus, only minimal horizonation has occurred.

Horizons are faintly expressed in Canisteo and Harps soils. Carbonates have accumulated in the upper horizons, partly because of the upward movement of water in the profile, which retards leaching and transformations, resulting in weakly developed upper horizons. The calcium carbonate equivalent in Harps soils ranges from about 15 to 40 percent.

The formation and translocation of silicate clay minerals have contributed to the development of more prominent horizons in Kilkenny, Lester, and Rolfe soils. The B horizon of these soils has more clay than the A horizon, and in many areas dark clay coatings are on faces of peds and in and along root channels. In places an eluviated E horizon has a platy structure, has less clay than the A or B horizon, and is lighter in color, especially when the soil is dry. The leaching of bases and the translocation of clay have been more dominant processes of horizonation in these soils than the accumulation of organic matter. The depth to which clay is moved is related to the depth of water percolation during the growing season *(23)*.

Transfers of compounds from lower horizons to upper horizons also occur. For example, phosphorus is removed from the subsoil by plant roots, is transferred to the parts of the plant above ground, and subsequently is returned to the surface in plant residue.

Transformations occur in all horizons, but the rate of transformation is most rapid in the surface layer. During the growing season, organic matter is broken down and transformed into simpler chemical compounds and elements. Also, primary minerals are transformed into secondary mineral elements. As a result of most transformations, the elements are more available to plants. For example, if the pH level is near 7, the primary mineral apatite is weathered to secondary phosphorus compounds that plants can use *(8, 24)*. At a higher pH level, however, this transformation is slowed and other phosphorus compounds that are not available to plants are formed. As a result, soils with a pH of more than 7, such as Canisteo and Harps soils, have a lower supply of available phosphorus than soils that have a pH level near 7, such as Nicollet and Webster soils.

Gleying, or the reduction and transfer of iron, is a process evident in poorly drained and very poorly drained soils *(26)*. Canisteo, Harps, Okoboji, and Webster soils, for example, have a gleyed B horizon. In gleying, the iron in this horizon is transformed from an oxidized form to a reduced form that is soluble and can be moved with water. This process results in gray or olive colors. In places these soils have reddish brown concretions of iron.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

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 follows:

Very low	0 to 3 inches
Low	3 to 6 inches
Moderate	6 to 9 inches
High	9 to 12 inches
Very high	more than 12 inches

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.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

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

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

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.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

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.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

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

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

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

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 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.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

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.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

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

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

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

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

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

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry 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.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

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.

Ice walled lakes. Glacial lakes that formed on the surface of stagnating glacial ice. They commonly contain glaciolacustrine sediments capping circular-shaped knobs of glacial till.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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 capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

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.

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

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

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 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.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

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

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

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 pH values are defined as follows:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

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.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

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.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

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.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

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.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates, in millimeters, recognized in the United States are as follows:

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.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

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

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Britt, Iowa)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	23.7	4.6	14.2	46	-24	0	1.04	0.29	1.64	3	8.5
February----	30.4	10.9	20.7	53	-21	0	1.09	.33	1.70	3	8.9
March-------	39.7	21.2	30.5	71	-9	18	2.13	.83	3.22	5	10.7
April-------	58.4	36.0	47.2	87	14	84	2.81	1.51	3.94	7	1.3
May---------	72.3	47.9	60.1	92	26	328	4.11	2.16	5.82	8	.0
June--------	81.5	58.1	69.8	97	41	594	4.87	2.19	7.15	7	.0
July--------	84.4	61.7	73.1	97	46	716	4.16	2.11	5.94	7	.0
August------	82.5	59.5	71.0	95	43	651	3.58	1.43	5.38	6	.0
September---	74.2	50.0	62.1	92	30	363	3.02	1.09	4.61	5	.0
October-----	63.2	39.8	51.5	87	19	149	1.97	.65	3.06	4	.1
November----	44.4	25.7	35.1	70	-3	7	1.53	.51	2.38	4	3.3
December----	29.6	12.4	21.0	55	-21	0	1.34	.52	2.02	4	9.1
Yearly:											
Average---	57.0	35.7	46.4	---	---	---	---	---	---	---	---
Extreme---	---	---	---	99	-26	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,910	31.65	25.08	37.15	63	41.9

* 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 1951-84 at Britt, Iowa)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 22	May 9	May 17
2 years in 10 later than--	Apr. 17	May 3	May 12
5 years in 10 later than--	Apr. 8	Apr. 20	May 5
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 10	Sept. 29	Sept. 24
2 years in 10 earlier than--	Oct. 15	Oct. 4	Sept. 28
5 years in 10 earlier than--	Oct. 25	Oct. 15	Oct. 5

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Britt, Iowa)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	181	151	136
8 years in 10	187	160	142
5 years in 10	200	176	153
2 years in 10	212	193	164
1 year in 10	219	201	169

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
6	Okoboji silty clay loam, 0 to 1 percent slopes	14,638	4.0
28	Dickman sandy loam, 0 to 2 percent slopes	643	0.2
28B	Dickman sandy loam, 2 to 5 percent slopes	1,428	0.4
28D2	Dickman sandy loam, 5 to 14 percent slopes, moderately eroded	782	0.2
52B	Bode clay loam, 2 to 5 percent slopes	1,187	0.3
52C2	Bode clay loam, 5 to 9 percent slopes, moderately eroded	4,066	1.1
52D2	Bode clay loam, 9 to 14 percent slopes, moderately eroded	2,472	0.7
52E2	Bode clay loam, 14 to 18 percent slopes, moderately eroded	511	0.1
55	Nicollet loam, 1 to 3 percent slopes	47,699	13.0
72	Estherville loam, 0 to 2 percent slopes	256	0.1
72B	Estherville loam, 2 to 5 percent slopes	1,725	0.5
72C2	Estherville loam, 5 to 9 percent slopes, moderately eroded	1,481	0.4
72D2	Estherville loam, 9 to 14 percent slopes, moderately eroded	360	0.1
73C2	Salida gravelly sandy loam, 2 to 9 percent slopes, moderately eroded	272	0.1
90	Okoboji mucky silt loam, 0 to 1 percent slopes	3,300	0.9
95	Harps loam, 0 to 2 percent slopes	10,808	3.0
107	Webster clay loam, 0 to 2 percent slopes	41,798	11.4
135	Coland clay loam, 0 to 2 percent slopes	3,916	1.1
138B	Clarion loam, 2 to 5 percent slopes	25,230	6.9
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	7,897	2.2
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	1,131	0.3
174	Bolan loam, 0 to 2 percent slopes	1,423	0.4
174B	Bolan loam, 2 to 5 percent slopes	1,161	0.3
221	Palms muck, 0 to 1 percent slopes	4,915	1.3
224	Linder sandy loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	808	0.2
236B	Lester loam, 2 to 5 percent slopes	1,770	0.5
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	1,521	0.4
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded	1,195	0.3
236F	Lester loam, 14 to 25 percent slopes	1,461	0.4
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,570	1.0
274	Rolfe silty clay loam, 0 to 1 percent slopes	948	0.3
288	Ottosen clay loam, 1 to 3 percent slopes	2,746	0.8
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	2,689	0.7
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	918	0.3
335	Harcot clay loam, 0 to 2 percent slopes	7,265	2.0
348	Fieldon loam, 0 to 2 percent slopes	4,919	1.3
384	Collinwood silty clay loam, 0 to 2 percent slopes	2,821	0.8
384B	Collinwood silty clay loam, 2 to 5 percent slopes	4,456	1.2
388	Kossuth silty clay loam, 0 to 2 percent slopes	2,583	0.7
390	Waldorf silty clay, 0 to 2 percent slopes	5,948	1.6
485B	Spillville loam, 2 to 5 percent slopes	5,509	1.5
506	Wacousta silty clay loam, 0 to 1 percent slopes	1,370	0.4
507	Canisteo clay loam, 0 to 2 percent slopes	68,844	18.7
511	Blue Earth mucky silt loam, 0 to 1 percent slopes	1,174	0.3
524	Linder sandy loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,700	0.5
562D2	Storden clay loam, 5 to 14 percent slopes, moderately eroded	691	0.2
562E2	Storden clay loam, 14 to 18 percent slopes, moderately eroded	498	0.1
562F2	Storden clay loam, 18 to 25 percent slopes, moderately eroded	201	0.1
621	Houghton muck, 0 to 1 percent slopes	1,853	0.5
640C2	Sunburg sandy loam, 5 to 9 percent slopes, moderately eroded	533	0.1
640D2	Sunburg sandy loam, 9 to 14 percent slopes, moderately eroded	826	0.2
640E2	Sunburg sandy loam, 14 to 18 percent slopes, moderately eroded	273	0.1
640F2	Sunburg sandy loam, 18 to 25 percent slopes, moderately eroded	262	0.1
641B	Clarion-Sunburg complex, 2 to 5 percent slopes	361	0.1
641C2	Clarion-Sunburg complex, 5 to 9 percent slopes, moderately eroded	1,101	0.3
641D2	Clarion-Sunburg complex, 9 to 14 percent slopes, moderately eroded	1,796	0.5
641E2	Clarion-Sunburg complex, 14 to 18 percent slopes, moderately eroded	624	0.2
642D2	Sunburg-Salida complex, 9 to 14 percent slopes, moderately eroded	278	0.1
654	Corwith loam, 1 to 3 percent slopes	703	0.2
655	Crippin loam, 1 to 3 percent slopes	2,818	0.8
658	Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,337	0.4
659	Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	4,610	1.3
787B	Vinje silty clay loam, 2 to 5 percent slopes	2,387	0.7
787C2	Vinje silty clay loam, 5 to 9 percent slopes, moderately eroded	1,214	0.3

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
811	Muskego muck, 0 to 1 percent slopes	2,120	0.6
823	Ridgeport sandy loam, 0 to 2 percent slopes	3,174	0.8
823B	Ridgeport sandy loam, 2 to 5 percent slopes	1,974	0.5
836B	Kilkenny clay loam, 2 to 5 percent slopes	219	0.1
836C2	Kilkenny clay loam, 5 to 9 percent slopes, moderately eroded	460	0.1
836E2	Kilkenny clay loam, 9 to 18 percent slopes, moderately eroded	1,166	0.3
879	Fostoria loam, 1 to 3 percent slopes	1,790	0.5
956	Harps-Okoboji complex, 0 to 2 percent slopes	1,515	0.4
1032	Spicer silty clay loam, 0 to 2 percent slopes	3,727	1.0
1052B	Bode-Kamrar clay loams, 2 to 5 percent slopes	1,970	0.5
1135	Coland clay loam, channeled, 0 to 2 percent slopes	1,276	0.3
1221	Palms muck, ponded, 0 to 1 percent slopes	1,129	0.3
1259	Biscay clay loam, ponded, 32 to 40 inches to sand and gravel, 0 to 1 percent slopes	1,422	0.4
1339	Truman silty clay loam, stratified substratum, 0 to 2 percent slopes	4,118	1.1
1339B	Truman silty clay loam, stratified substratum, 2 to 5 percent slopes	2,902	0.8
1506	Wacousta silty clay loam, stratified substratum, 0 to 1 percent slopes	654	0.2
1507	Brownton silty clay loam, 0 to 2 percent slopes	761	0.2
1595	Harpster silty clay loam, 0 to 2 percent slopes	3,245	0.9
1733	Calco silty clay loam, frequently flooded, 0 to 2 percent slopes	788	0.2
2222	Adrian muck, 0 to 1 percent slopes	2,494	0.7
4000	Urban land	360	0.1
5010	Pits, sand and gravel	732	0.2
5040	Orthents, loamy	478	0.1
	Water	1,926	0.5
	Total	366,080	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
52B	Bode clay loam, 2 to 5 percent slopes
55	Nicollet loam, 1 to 3 percent slopes
95	Harps loam, 0 to 2 percent slopes (where drained)
107	Webster clay loam, 0 to 2 percent slopes (where drained)
135	Coland clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion loam, 2 to 5 percent slopes
174	Bolan loam, 0 to 2 percent slopes
174B	Bolan loam, 2 to 5 percent slopes
224	Linder sandy loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
288	Ottosen clay loam, 1 to 3 percent slopes
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes
335	Harcot clay loam, 0 to 2 percent slopes (where drained)
348	Fieldon loam, 0 to 2 percent slopes (where drained)
384	Collinwood silty clay loam, 0 to 2 percent slopes
384B	Collinwood silty clay loam, 2 to 5 percent slopes
388	Kossuth silty clay loam, 0 to 2 percent slopes (where drained)
390	Waldorf silty clay, 0 to 2 percent slopes (where drained)
485B	Spillville loam, 2 to 5 percent slopes
507	Canisteo clay loam, 0 to 2 percent slopes (where drained)
524	Linder sandy loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
641B	Clarion-Sunburg complex, 2 to 5 percent slopes
654	Corwith loam, 1 to 3 percent slopes
655	Crippin loam, 1 to 3 percent slopes
658	Mayer loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes (where drained)
659	Mayer loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
787B	Vinje silty clay loam, 2 to 5 percent slopes
836B	Kilkenny clay loam, 2 to 5 percent slopes
879	Fostoria loam, 1 to 3 percent slopes
1032	Spicer silty clay loam, 0 to 2 percent slopes (where drained)
1052B	Bode-Kamrar clay loams, 2 to 5 percent slopes
1339	Truman silty clay loam, stratified substratum, 0 to 2 percent slopes
1339B	Truman silty clay loam, stratified substratum, 2 to 5 percent slopes
1507	Brownton silty clay loam, 0 to 2 percent slopes (where drained)
1595	Harpster silty clay loam, 0 to 2 percent slopes (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	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
6--------------- Okoboji	IIIw	113	34	79	3.4	3.3	---	7.3
28-------------- Dickman	IIIs	76	22	53	3.3	2.0	---	4.1
28B------------- Dickman	IIIe	73	23	51	3.2	2.0	---	3.9
28D2------------ Dickman	IVe	56	18	40	2.2	1.6	---	2.8
52B------------- Bode	IIe	139	46	102	6.0	3.8	6.1	6.1
52C2------------ Bode	IIIe	133	39	85	5.6	3.5	5.6	5.7
52D2------------ Bode	IIIe	127	41	87	5.2	3.3	5.0	5.0
52E2------------ Bode	IVe	107	35	74	4.4	2.8	4.2	4.2
55-------------- Nicollet	I	150	49	106	6.2	4.1	---	8.3
72-------------- Estherville	IIIs	84	27	59	3.2	2.0	---	3.0
72B------------- Estherville	IIIs	81	26	57	3.0	2.0	---	2.5
72C2------------ Estherville	IVs	73	23	51	2.7	1.5	---	2.0
72D2------------ Esterville	IVs	64	20	45	2.4	1.3	---	1.3
73C2------------ Salida	IVs	35	12	27	1.6	1.0	---	1.8
90-------------- Okoboji	IIIw	117	34	82	3.1	3.3	4.3	7.3
95-------------- Harps	IIw	125	40	87	3.8	3.3	5.0	6.6
107------------- Webster	IIw	145	46	102	4.4	4.2	6.6	7.3
135------------- Coland	IIw	136	44	95	4.1	4.1	6.0	7.6
138B------------ Clarion	IIe	145	46	101	6.1	4.2	6.7	7.6

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
138C2----------- Clarion	IIIe	136	41	95	5.7	3.8	6.2	7.1
138D2----------- Clarion	IIIe	127	37	89	5.3	3.7	5.5	6.5
174------------- Bolan	IIs	125	38	84	5.2	3.6	5.3	6.3
174B------------ Bolan	IIe	122	37	87	5.1	3.6	5.2	6.1
221------------- Palms	IIIw	113	36	79	3.5	3.3	---	5.3
224------------- Linder	IIs	100	32	70	4.0	2.3	3.7	4.1
236B------------ Lester	IIe	133	40	93	5.7	3.5	---	7.3
236C2----------- Lester	IIIe	124	40	87	5.3	3.3	---	6.3
236D2----------- Lester	IIIe	115	37	81	5.0	3.3	---	5.8
236F------------ Lester	VIe	---	---	---	---	1.6	---	4.5
259------------- Biscay	IIw	128	41	90	3.9	3.5	---	5.2
274------------- Rolfe	IIIw	115	37	81	3.5	3.3	4.5	5.0
288------------- Ottosen	I	146	47	102	6.0	4.0	6.6	7.8
308------------- Wadena	IIs	112	35	78	4.8	3.7	---	6.2
308B------------ Wadena	IIe	109	34	72	4.7	3.7	---	6.0
335------------- Harcot	IIw	102	33	71	3.1	3.1	4.8	6.0
348------------- Fieldon	IIw	120	38	84	3.5	3.0	---	5.0
384------------- Collinwood	IIw	126	40	88	5.2	3.5	---	6.0
384B------------ Collinwood	IIe	123	39	86	5.0	3.5	---	6.0
388------------- Kossuth	IIw	134	43	94	4.0	4.0	5.9	5.9

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
390------------- Waldorf	IIw	108	40	76	3.3	3.3	---	6.0
485B------------ Spillville	IIe	153	47	105	6.1	4.1	7.1	8.5
506------------- Wacousta	IIIw	125	40	88	3.8	2.0	7.0	6.6
507------------- Canisteo	IIw	136	44	95	4.2	3.8	---	7.0
511------------- Blue Earth	IIIw	80	26	56	3.8	3.5	---	6.3
524------------- Linder	IIs	116	37	82	4.7	3.1	5.0	5.6
562D2----------- Storden	IIIe	105	34	74	3.5	3.3	---	5.8
562E2----------- Storden	IVe	88	29	62	2.8	2.2	---	4.2
562F2----------- Storden	VIe	---	---	---	2.5	1.5	---	3.7
621------------- Houghton	IIIw	101	34	71	3.0	3.3	---	4.6
640C2----------- Sunburg	IIIe	82	26	57	3.6	2.8	---	4.8
640D2----------- Sunburg	IIIe	73	23	51	3.2	3.0	---	4.6
640E2----------- Sunburg	IVe	55	15	39	2.6	2.2	---	4.4
640F2----------- Sunburg	VIe	---	---	---	2.0	1.8	---	3.0
641B------------ Clarion-Sunburg	IIe	122	38	85	4.3	3.7	---	6.6
641C2----------- Clarion-Sunburg	IIIe	113	33	79	4.6	3.4	---	6.2
641D2----------- Clarion-Sunburg	IIIe	99	29	73	3.7	3.3	---	5.8
641E2----------- Clarion-Sunburg	IVe	86	26	61	3.6	2.8	---	4.9
642D2----------- Sunburg-Salida	VIs	---	---	---	2.6	2.0	---	4.0
654------------- Corwith	I	133	43	93	5.3	4.3	---	7.2

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
655------------- Crippin	I	142	48	99	6.0	4.2	6.5	7.1
658------------- Mayer	IIw	109	35	76	3.0	3.2	---	5.0
659------------- Mayer	IIw	120	38	84	3.7	3.4	---	5.7
787B------------ Vinje	IIe	118	39	83	5.1	3.8	6.1	6.3
787C2----------- Vinje	IIIe	109	37	73	4.1	3.6	5.8	5.9
811------------- Muskego	IVw	106	35	70	3.0	2.9	---	4.6
823------------- Ridgeport	IIIs	78	25	55	3.3	1.7	3.2	3.6
823B------------ Ridgeport	IIIe	75	24	53	3.2	1.5	3.1	3.5
836B------------ Kilkenny	IIe	116	34	80	4.5	4.7	---	6.7
836C2----------- Kilkenny	IIIe	105	34	75	4.5	3.0	---	5.0
836E2----------- Kilkenny	IVe	98	31	50	3.2	1.7	---	3.9
879------------- Fostoria	I	128	41	90	5.1	3.7	5.8	6.6
956------------- Harps-Okoboji	IIIw	118	37	81	3.5	3.3	4.8	6.8
1032------------ Spicer	IIw	132	42	92	4.0	3.7	---	6.0
1052B----------- Bode-Kamrar	IIe	134	45	98	5.8	3.8	5.9	5.9
1135------------ Coland	Vw	---	---	---	---	4.1	---	---
1221------------ Palms	Vw	---	---	---	---	---	---	---
1259------------ Biscay	IIIw	111	36	78	3.0	3.8	---	6.6
1339------------ Truman	I	148	47	104	4.6	4.0	---	6.9
1339B----------- Truman	IIe	145	46	102	4.6	4.0	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
1506------------ Wacousta	IIIw	120	38	82	3.5	2.0	6.8	6.6
1507------------ Brownton	IIw	127	38	88	3.8	3.0	---	5.6
1595------------ Harpster	IIw	128	44	90	3.7	3.0	---	6.6
1733------------ Calco	Vw	---	---	---	---	2.2	---	---
2222------------ Adrian	IVw	85	23	60	2.3	---	---	---
4000**. Urban land								
5010**. Pits								
5040**. Orthents								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
6. Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
28, 28B, 28D2. Dickman	Siberian peashrub	Eastern redcedar, lilac.	Green ash, red pine, jack pine, Austrian pine, Russian-olive.	Eastern white pine, Siberian elm.	---
52B, 52C2, 52D2, 52E2. Bode	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Eastern redcedar, Amur maple, hackberry, northern white-cedar, blue spruce, Russian-olive.	Eastern white pine, green ash.	---
55. Nicollet	---	Redosier dogwood, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
72, 72B, 72C2, 72D2. Estherville	Siberian peashrub	Eastern redcedar, lilac.	Jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
73C2. Salida					
90. Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
95. Harps	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash.	Eastern cottonwood.
107. Webster	---	Redosier dogwood, American plum.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
135. Coland	---	Redosier dogwood, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.

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
138B, 138C2, 138D2------------ Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
174, 174B--------- Bolan	Lilac, Russian-olive, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, hackberry.	Green ash, eastern white pine, bur oak.	---	---
221--------------- Palms	Vanhoutte spirea	Silky dogwood, common ninebark, nannyberry viburnum, American cranberrybush.	Northern white-cedar, Manchurian crabapple, white spruce.	Eastern white pine, Norway spruce, green ash.	Imperial Carolina poplar.
224--------------- Linder	---	Redosier dogwood, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.
236B, 236C2, 236D2, 236F------ Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
259--------------- Biscay	---	Redosier dogwood, American plum.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
274--------------- Rolfe	---	Redosier dogwood, American plum.	Amur maple, northern white-cedar, hackberry, white spruce, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
288--------------- Ottosen	---	Redosier dogwood, lilac.	Northern white-cedar, blue spruce, white spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
308, 308B--------- Wadena	Siberian peashrub, lilac.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, 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
335 Harcot	---	Lilac, Siberian peashrub, northern white-cedar.	White spruce, eastern redcedar, bur oak, hackberry.	Green ash, golden willow.	Eastern cottonwood.
348 Fieldon	---	Northern white-cedar, lilac, Siberian peashrub.	White spruce, eastern redcedar, bur oak, hackberry.	Green ash, golden willow.	Eastern cottonwood.
384, 384B Collinwood	---	Northern white-cedar, Siberian peashrub, lilac, eastern redcedar.	White spruce, Austrian pine, hackberry, Russian-olive, bur oak.	Eastern white pine, green ash.	---
388 Kossuth	---	Redosier dogwood, American plum.	Tall purple willow, Amur maple, hackberry, white spruce, northern white-cedar.	Golden willow, green ash.	Eastern cottonwood, silver maple.
390 Waldorf	---	Redosier dogwood, American plum.	Northern white-cedar, white spruce, Amur maple, tall purple willow, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
485B Spillville	---	Redosier dogwood, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
506 Wacousta	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Golden willow, green ash.	Eastern cottonwood.
507 Canisteo	---	Siberian peashrub, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
511 Blue Earth	---	Redosier dogwood	Black ash, tall purple willow.	Black ash, golden willow, white willow.	---
524 Linder	---	Redosier dogwood, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.
562D2, 562E2, 562F2 Storden	American plum	Eastern redcedar, hackberry, Siberian peashrub.	Green ash, Russian-olive.	Siberian elm	---

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
621 Houghton	---	Silky dogwood, late lilac, Amur privet, common ninebark, nannyberry viburnum.	Japanese tree lilac, northern white-cedar.	Black willow, green ash, Siberian crabapple, eastern white pine.	Imperial Carolina poplar.
640C2, 640D2, 640E2, 640F2 Sunburg	American plum	Eastern redcedar, Siberian peashrub, hackberry.	Green ash, Russian-olive.	Siberian elm	---
641B*, 641C2*, 641D2*, 641E2*: 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.	---
Sunburg	American plum	Eastern redcedar, Siberian peashrub, hackberry.	Green ash, Russian-olive.	Siberian elm	---
642D2*: Sunburg	American plum	Eastern redcedar, Siberian peashrub, hackberry.	Green ash, Russian-olive.	Siberian elm	---
Salida.					
654 Corwith	---	Lilac, northern white-cedar, Siberian peashrub.	White spruce, hackberry, eastern redcedar, bur oak.	Green ash, golden willow.	Eastern cottonwood.
655 Crippin	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash.	Eastern cottonwood.
658, 659 Mayer	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
787B, 787C2 Vinje	Gray dogwood, silky dogwood.	Redosier dogwood, American plum.	Amur maple, eastern redcedar, Russian-olive.	Red pine, Norway spruce, hackberry.	Silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
811--------------- Muskego	---	Nannyberry viburnum, silky dogwood, common ninebark, northern white-cedar, American cranberrybush, redosier dogwood, late lilac.	White spruce, Japanese tree lilac, Manchurian crabapple.	Siberian crabapple	Imperial Carolina poplar.
823, 823B--------- Ridgeport	Lilac, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, jack pine, Russian-olive, bur oak, green ash.	---	---
836B, 836C2, 836E2------------ Kilkenny	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, hackberry, Amur maple, eastern redcedar.	Austrian pine, eastern white pine, green ash.	---
879--------------- Fostoria	---	Redosier dogwood, lilac.	White spruce, blue spruce, northern white-cedar, Amur maple.	Austrian pine, green ash, eastern white pine, hackberry.	Silver maple.
956*: Harps------------	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash.	Eastern cottonwood.
Okoboji----------	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
1032-------------- Spicer	---	Lilac, Siberian peashrub, northern white-cedar.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
1052B*: Bode-------------	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Eastern redcedar, Amur maple, hackberry, northern white-cedar, blue spruce, Russian-olive.	Eastern white pine, green ash.	---
Kamrar-----------	---	Redosier dogwood, Siberian peashrub, gray dogwood, lilac.	Blue spruce, Amur maple, eastern redcedar, hackberry, Russian-olive, northern white-cedar.	Eastern white pine, green ash.	---

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
1135: Coland	---	Redosier dogwood, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1221. Palms					
1259: Biscay	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
1339, 1339B: 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.	---
1506: Wacousta	---	Northern white-cedar, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak, white spruce.	Golden willow, green ash.	Eastern cottonwood.
1507: Brownton	---	Siberian peashrub, lilac, northern white-cedar.	White spruce, hackberry, bur oak, eastern	Golden willow, green ash.	Eastern cottonwood.
1595: Harpster	---	Lilac, Siberian peashrub, northern white-cedar.	Hackberry, white spruce, bur oak, eastern redcedar.	Hackberry, golden willow, green ash.	Eastern cottonwood.
1733: Calco	---	Lilac, Siberian peashrub, northern white-cedar.	Hackberry, eastern redcedar, bur oak, white spruce.	Golden willow, green ash.	Eastern cottonwood.
2222: Adrian	---	Silky dogwood, common ninebark, Amur privet, American cranberrybush, late lilac, Japanese tree lilac, nannyberry viburnum.	Northern white-cedar.	Eastern white pine, Siberian crabapple, green ash.	Imperial Carolina poplar.
4000*. Urban land					
5010*. Pits					
5040*. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
6-------- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
28-------- Dickman	Slight--------	Slight--------	Slight--------	Slight--------	Moderate: droughty.
28B-------- Dickman	Slight--------	Slight--------	Moderate: slope.	Slight--------	Moderate: droughty.
28D2-------- Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight--------	Moderate: droughty, slope.
52B-------- Bode	Slight--------	Slight--------	Moderate: slope.	Slight--------	Slight.
52C2-------- Bode	Slight--------	Slight--------	Severe: slope.	Slight--------	Slight.
52D2-------- Bode	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight--------	Moderate: slope.
52E2-------- Bode	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
55-------- Nicollet	Slight--------	Slight--------	Moderate: slope.	Slight--------	Slight.
72-------- Estherville	Slight--------	Slight--------	Moderate: small stones.	Slight--------	Moderate: droughty.
72B-------- Estherville	Slight--------	Slight--------	Moderate: slope, small stones.	Slight--------	Moderate: droughty.
72C2-------- Estherville	Slight--------	Slight--------	Severe: slope.	Slight--------	Moderate: droughty.
72D2-------- Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight--------	Moderate: droughty, slope.
73C2-------- Salida	Slight--------	Slight--------	Severe: small stones.	Slight--------	Severe: droughty.
90-------- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
95-------- Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107-------- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
135-------- Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
138B----- Clarion	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
138C2----- Clarion	Slight-----	Slight-----	Severe: slope.	Slight-----	Slight.
138D2----- Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
174----- Bolan	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
174B----- Bolan	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
221----- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
224----- Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight-----	Slight.
236B----- Lester	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
236C2----- Lester	Slight-----	Slight-----	Severe: slope.	Slight-----	Slight.
236D2----- Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight-----	Moderate: slope.
236F----- Lester	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
259----- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
274----- Rolfe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
288----- Ottosen	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight-----	Slight.
308----- Wadena	Slight-----	Slight-----	Slight-----	Slight-----	Slight.
308B----- Wadena	Slight-----	Slight-----	Moderate: slope.	Slight-----	Slight.
335----- Harcot	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
348----- Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
384----- Collinwood	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight-----	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
384B------------------ Collinwood	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight----------	Slight.
388------------------- Kossuth	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
390------------------- Waldorf	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
485B------------------ Spillville	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
506------------------- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
507------------------- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
511------------------- Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
524------------------- Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
562D2----------------- Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
562E2, 562F2---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
621------------------- Houghton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.
640C2----------------- Sunburg	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
640D2----------------- Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
640E2, 640F2---------- Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
641B*:					
Clarion---------------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Sunburg---------------	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Slight.
641C2*:					
Clarion---------------	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
Sunburg---------------	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
641D2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
641E2*:					
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
642D2*:					
Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Salida	Moderate	Moderate	Severe: slope, small stones.	Slight	Severe: droughty.
654 Corwith	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
655 Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
658, 659 Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
787B Vinje	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
787C2 Vinje	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
811 Muskego	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
823 Ridgeport	Slight	Slight	Slight	Slight	Moderate: droughty.
823B Ridgeport	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
836B Kilkenny	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
836C2 Kilkenny	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
836E2 Kilkenny	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	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
879 Fostoria	Moderate: wetness.	Moderate: wetness.	Moderate: wetness, slope.	Slight	Slight.
956*: Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1032 Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
1052B*: Bode	Slight	Slight	Moderate: slope.	Slight	Slight.
Kamrar	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
1135 Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1221 Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
1259 Biscay	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1339 Truman	Slight	Slight	Slight	Slight	Slight.
1339B Truman	Slight	Slight	Moderate: slope.	Slight	Slight.
1506 Wacousta	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1507 Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
1595 Harpster	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1733 Calco	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
2222 Adrian	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.

* 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: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
6 Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
28, 28B, 28D2 Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
52B Bode	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
52C2, 52D2 Bode	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
52E2 Bode	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
55 Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
72, 72B, 72C2, 72D2 Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
73C2 Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
90 Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
95 Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107 Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
135 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C2, 138D2 Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
174, 174B Bolan	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
221 Palms	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
224 Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236B Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236C2, 236D2 Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
236F: Lester	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
259: Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
274: Rolfe	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
288: Ottosen	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
308, 308B: Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
335: Harcot	Good	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
348: Fieldon	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
384, 384B: Collinwood	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
388: Kossuth	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
390: Waldorf	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
485B: Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
506: Wacousta	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
507: Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
511: Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
524: Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
562D2, 562E2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
562F2: Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
621: Houghton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
640C2, 640D2: Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
640E2: Sunburg	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
640F2: Sunburg	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
641B*:										
Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Sunburg	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
641C2*, 641D2*:										
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
641E2*:										
Clarion	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Sunburg	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
642D2*:										
Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
654 Corwith	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Poor.
655 Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
658, 659 Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
787B Vinje	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
787C2 Vinje	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
811 Muskego	Good	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
823, 823B Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
836B Kilkenny	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
836C2, 836E2 Kilkenny	Fair	Good	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
879 Fostoria	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
956*:										
Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
956*:										
Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
1032 Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
1052B*:										
Bode	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Kamrar	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1135 Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1221 Palms	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1259 Biscay	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
1339, 1339B Truman	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
1506 Wacousta	Fair	Good	Fair	Poor	Good	Good	Good	Good	Poor	Good.
1507 Brownton	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1595 Harpster	Fair	Fair	Good	Fair	Fair	Good	Fair	Fair	Fair	Fair.
1733 Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
2222 Adrian	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
4000*. Urban land										
5010*. Pits										
5040*. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
6----------------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
28, 28B----------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
28D2-------------- Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
52B--------------- Bode	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell.	Severe: low strength.	Slight.
52C2-------------- Bode	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
52D2-------------- Bode	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
52E2-------------- Bode	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
55---------------- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
72, 72B----------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
72C2-------------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
72D2-------------- Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
73C2-------------- Salida	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
90---------------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
95---------------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
107--------------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

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
135 Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
138B Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
138C2 Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
138D2 Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
174, 174B Bolan	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
221 Palms	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
224 Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
236B Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
236C2 Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
236D2 Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
236F Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
259 Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
274 Rolfe	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
288 Ottosen	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
308, 308B Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
335 Harcot	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Moderate: wetness.

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
348--------------- Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
384, 384B--------- Collinwood	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
388--------------- Kossuth	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
390--------------- Waldorf	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
485B-------------- Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
506--------------- Wacousta	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
507--------------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
511--------------- Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
524--------------- Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
562D2------------- Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
562E2, 562F2------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
621--------------- Houghton	Severe: ponding, excess humus.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: excess humus, ponding.
640C2------------- Sunburg	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
640D2------------- Sunburg	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
640E2, 640F2------ Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

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
641B*:						
Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Sunburg	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
641C2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Sunburg	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
641D2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Sunburg	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
641E2*:						
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
642D2*:						
Sunburg	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Salida	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
654 Corwith	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
655 Crippin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
658, 659 Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
787B Vinje	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
787C2 Vinje	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
811 Muskego	Severe: excess humus, ponding.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: ponding, subsides.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.

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
823, 823B Ridgeport	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
836B Kilkenny	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
836C2 Kilkenny	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
836E2 Kilkenny	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
879 Fostoria	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
956*:						
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
1032 Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
1052B*:						
Bode	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
Kamrar	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
1135 Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.
1221 Palms	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
1259 Biscay	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding.	Severe: ponding.
1339, 1339B Truman	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
1506 Wacousta	Severe: cutbanks cave, ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding.	Severe: flooding, ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	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
1507-------------- Brownton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
1595-------------- Harpster	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1733-------------- Calco	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Severe: flooding.
2222-------------- Adrian	Severe: cutbanks cave, excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
4000*. Urban land						
5010*. Pits						
5040*. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
28, 28B Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
28D2 Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
52B Bode	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
52C2 Bode	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
52D2 Bode	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
52E2 Bode	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
72, 72B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
72C2, 72D2 Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
73C2 Salida	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
90 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
107 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

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
135 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
138B Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
138C2 Clarion	Slight	Severe: slope.	Slight	Slight	Good.
138D2 Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
174, 174B Bolan	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
221 Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
224 Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
236B Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
236C2 Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
236D2 Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
236F Lester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
259 Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
274 Rolfe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
288 Ottosen	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
308, 308B Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
335 Harcot	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
348 Fieldon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
384 Collinwood	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
384B Collinwood	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
388 Kossuth	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
390 Waldorf	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
485B Spillville	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.
506 Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
507 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
511 Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
524 Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
562D2 Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
562E2, 562F2 Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
621 Houghton	Severe: subsides, ponding, percs slowly.	Severe: seepage, ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
640C2 Sunburg	Slight	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
640D2---------------- Sunburg	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
640E2, 640F2-------- Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
641B*:					
Clarion------------	Slight-----------	Moderate: slope, seepage.	Slight-----------	Slight-----------	Good.
Sunburg------------	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
641C2*:					
Clarion------------	Slight-----------	Severe: slope.	Slight-----------	Slight-----------	Good.
Sunburg------------	Slight-----------	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones.
641D2*:					
Clarion------------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Sunburg------------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
641E2*:					
Clarion------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Sunburg------------	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
642D2*:					
Sunburg------------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
Salida-------------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
654----------------- Corwith	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
655----------------- Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
658, 659------------ Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.

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
787B----------------- Vinje	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
787C2---------------- Vinje	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
811------------------ Muskego	Severe: ponding, subsides.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: hard to pack, ponding.
823, 823B----------- Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
836B----------------- Kilkenny	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
836C2---------------- Kilkenny	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
836E2---------------- Kilkenny	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: hard to pack.
879------------------ Fostoria	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
956*:					
Harps---------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Okoboji-------------	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1032----------------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1052B*:					
Bode----------------	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Kamrar--------------	Severe: percs slowly.	Moderate: seepage, slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
1135----------------- Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
1221----------------- Palms	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.

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
1259----------------- Biscay	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
1339, 1339B--------- Truman	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Slight-----------	Fair: too clayey, thin layer.
1506----------------- Wacousta	Severe: flooding, ponding.	Severe: seepage, flooding, ponding.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: too sandy, ponding.
1507----------------- Brownton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1595----------------- Harpster	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
1733----------------- Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
2222----------------- Adrian	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
4000*. Urban land					
5010*. Pits					
5040*. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
6 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
28, 28B, 28D2 Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
52B, 52C2 Bode	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
52D2 Bode	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
52E2 Bode	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
55 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
72, 72B, 72C2, 72D2 Estherville	Good	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
73C2 Salida	Good	Probable	Probable	Poor: small stones, area reclaim.
90 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
95 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
107 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138C2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
138D2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
174, 174B Bolan	Good	Probable	Improbable: too sandy.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
221 Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
224 Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
236B, 236C2 Lester	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
236D2 Lester	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
236F Lester	Fair: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
259 Biscay	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
274 Rolfe	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
288 Ottosen	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
308, 308B Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
335 Harcot	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
348 Fieldon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
384, 384B Collinwood	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
388 Kossuth	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
390 Waldorf	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
485B Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
506 Wacousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
507 Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
511 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
524 Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
562D2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
562E2, 562F2 Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
621 Houghton	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
640C2 Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
640D2 Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
640E2, 640F2 Sunburg	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
641B*, 641C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
641D2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
641E2*:				
Clarion	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sunburg	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
642D2*:				
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
642D2*:				
Salida	Good	Probable	Probable	Poor: small stones, area reclaim.
654 Corwith	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
655 Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
658, 659 Mayer	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
787B, 787C2 Vinje	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
811 Muskego	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
823, 823B Ridgeport	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
836B, 836C2 Kilkenny	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
836E2 Kilkenny	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
879 Fostoria	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
956*:				
Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1032 Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1052B*:				
Bode	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
Kamrar	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
1135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1221 Palms	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
1259 Biscay	Poor: wetness.	Probable	Probable	Poor: area reclaim, wetness.
1339, 1339B Truman	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1506 Wacousta	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1507 Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
1595 Harpster	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1733 Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
2222 Adrian	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
4000*. Urban land				
5010*. Pits				
5040*. Orthents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
6: Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
28, 28B: Dickman	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
28D2: Dickman	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
52B, 52C2: Bode	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
52D2, 52E2: Bode	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
55: Nicollet	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Frost action	Wetness	Favorable.
72, 72B, 72C2: Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy	Droughty.
72D2: Estherville	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
73C2: Salida	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy	Droughty.
90: Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
95: Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
107: Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
135: Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
138B, 138C2: Clarion	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
138D2: Clarion	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
174, 174B: Bolan	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Favorable.
221: Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
224----------- Linder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Droughty.
236B, 236C2------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
236D2, 236F------- Lester	Severe: slope.	Severe: thin layer.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
259----------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
274----------- Rolfe	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, percs slowly, frost action.	Ponding--------	Wetness, percs slowly.
288----------- Ottosen	Moderate: seepage.	Moderate: piping, wetness.	Severe: slow refill.	Frost action---	Wetness--------	Favorable.
308, 308B--------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
335----------- Harcot	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness, rooting depth.
348----------- Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
384----------- Collinwood	Slight---------	Moderate: hard to pack, wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness, percs slowly.	Percs slowly.
384B----------- Collinwood	Moderate: slope.	Moderate: hard to pack, wetness.	Severe: slow refill.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Percs slowly.
388----------- Kossuth	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
390----------- Waldorf	Moderate: seepage.	Severe: hard to pack, wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
485B----------- Spillville	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
506----------- Wacousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
507----------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
511---------------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding--------	Wetness.
524---------------- Linder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Droughty.
562D2, 562E2, 562F2------------ Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
621---------------- Houghton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Frost action, subsides, ponding.	Ponding, soil blowing.	Wetness.
640C2-------------- Sunburg	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing---	Favorable.
640D2, 640E2, 640F2------------ Sunburg	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
641B*, 641C2*: Clarion----------	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Sunburg----------	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing---	Favorable.
641D2*, 641E2*: Clarion----------	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Sunburg----------	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
642D2*: Sunburg----------	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
Salida-----------	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope----------	Slope, droughty.
654---------------- Corwith	Moderate: seepage.	Severe: piping.	Moderate: deep to water, slow refill.	Frost action---	Erodes easily, wetness.	Erodes easily, rooting depth.
655---------------- Crippin	Moderate: seepage.	Moderate: wetness, piping.	Moderate: slow refill, deep to water.	Frost action---	Wetness, erodes easily.	Erodes easily.
658, 659---------- Mayer	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
787B, 787C2------- Vinje	Moderate: seepage, slope.	Moderate: hard to pack.	Severe: no water.	Deep to water	Favorable------	Favorable.
811--------------- Muskego	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, percs slowly.	Ponding, soil blowing, percs slowly.	Wetness, percs slowly.
823, 823B--------- Ridgeport	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing---	Droughty.
836B, 836C2------- Kilkenny	Moderate: seepage, slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Favorable------	Favorable.
836E2------------- Kilkenny	Severe: slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Slope----------	Slope.
879--------------- Fostoria	Moderate: seepage.	Moderate: wetness, piping.	Moderate: deep to water, slow refill.	Frost action---	Wetness, erodes easily.	Erodes easily.
956*:						
Harps------------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
Okoboji----------	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
1032-------------- Spicer	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness, erodes easily.	Wetness, erodes easily.
1052B*:						
Bode-------------	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
Kamrar-----------	Moderate: seepage, slope.	Moderate: hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
1135-------------- Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
1221-------------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding--------	Wetness, rooting depth.
1259-------------- Biscay	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, frost action.	Ponding, too sandy.	Wetness.
1339, 1339B------- Truman	Severe: seepage.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
1506-------------- Wacousta	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, flooding, frost action.	Erodes easily, ponding, too sandy.	Wetness, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
1507-------------- Brownton	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness--------	Wetness, percs slowly.
1595-------------- Harpster	Moderate: seepage.	Severe: ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding--------	Wetness.
1733-------------- Calco	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
2222-------------- Adrian	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, too sandy, soil blowing.	Wetness, rooting depth.
4000*. Urban land						
5010*. Pits						
5040*. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
6----------------- Okoboji	0-9	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	9-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-46	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	46-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
28, 28B, 28D2---- Dickman	0-17	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	17-35	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	35-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
52B--------------- Bode	0-18	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
	18-28	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	28-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	90-95	75-90	50-75	25-40	5-15
52C2, 52D2, 52E2- Bode	0-6	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
	6-30	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	30-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	90-95	75-90	50-75	25-40	5-15
55---------------- Nicollet	0-20	Loam, clay loam	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	20-41	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
	41-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
72, 72B, 72C2, 72D2------------ Estherville	0-14	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	80-100	50-75	50-60	25-40	4-15
	14-20	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	Loamy sand, sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-90	10-40	2-25	---	NP
73C2-------------- Salida	0-7	Gravelly sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	7-15	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	15-60	Very gravelly coarse sand, very gravelly sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
90---------------- Okoboji	0-9	Mucky silt loam	MH	A-7	0	100	100	95-100	90-95	60-90	10-30
	9-29	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	29-39	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	39-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30

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	
95---------------- Harps	0-18	Loam-------------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	18-42	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	42-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107-------------- Webster	0-21	Clay loam--------	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	21-42	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
	42-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
135-------------- Coland	0-8	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	8-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
138B, 138C2, 138D2----------- Clarion	0-21	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	21-45	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	45-60	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
174, 174B-------- Bolan	0-21	Loam-------------	CL, ML	A-4, A-6	0	100	100	85-95	50-70	30-40	5-15
	21-36	Loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	100	80-90	40-55	25-35	5-15
	36-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2	0	100	100	70-85	10-30	---	NP
221-------------- Palms	0-32	Sapric material	PT	A-8	---	---	---	---	---	---	---
	32-60	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
224-------------- Linder	0-21	Sandy loam-------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	21-39	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	39-60	Gravelly sand, coarse sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
236B, 236C2, 236D2, 236F----- Lester	0-7	Loam-------------	ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	50-70	30-40	5-15
	7-38	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	38-60	Loam, sandy loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
259-------------- Biscay	0-18	Clay loam--------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	18-31	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
	31-36	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	36-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
274-------------- Rolfe	0-21	Silty clay loam, silt loam.	OL, CL, ML	A-6, A-4	0	100	95-100	90-100	80-95	30-40	5-15
	21-41	Silty clay loam, clay loam.	CH	A-7	0	100	95-100	90-100	75-95	50-65	25-35
	41-60	Sandy clay loam, loam.	CL	A-7, A-6	0	95-100	90-100	80-90	55-75	30-45	10-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
288-------------- Ottosen	0-19	Clay loam, silty clay loam.	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
	19-35	Clay loam, silty clay loam.	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
	35-60	Loam-------------	CL	A-4, A-6	0-5	90-100	90-100	80-95	60-75	25-40	8-20
308, 308B-------- Wadena	0-18	Loam-------------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	18-33	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
	33-60	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
335-------------- Harcot	0-9	Clay loam--------	CH, CL	A-7	0	95-100	90-95	80-90	55-75	40-55	15-25
	9-32	Loam, sandy loam, fine sandy loam.	CL	A-6	0	95-100	90-95	75-85	55-75	30-40	10-20
	32-60	Fine sand, loamy fine sand, gravelly sand.	SP, SM, SP-SM	A-1	0-5	80-95	55-95	40-50	3-25	---	NP
348-------------- Fieldon	0-21	Loam, sandy clay loam.	CL-ML, CL, ML	A-4	0	100	100	85-95	50-75	20-32	NP-10
	21-36	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	36-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
384, 384B-------- Collinwood	0-8	Silty clay loam	CL, CH, ML, MH	A-7	0	100	100	95-100	90-95	40-55	15-25
	8-36	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-95	50-65	20-35
	36-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-95	40-60	15-30
388-------------- Kossuth	0-20	Silty clay loam	CL	A-7	0	95-100	95-100	80-85	75-85	40-50	20-30
	20-30	Silty clay loam, clay loam, clay.	CL, CH	A-7	0	95-100	95-100	80-85	75-85	45-65	25-35
	30-60	Loam-------------	CL	A-4, A-6	0-5	95-100	90-100	70-85	50-70	25-40	8-20
390-------------- Waldorf	0-21	Silty clay-------	ML, MH	A-7	0	100	100	95-100	90-100	45-65	14-30
	21-37	Silty clay, silty clay loam.	MH	A-7	0	100	100	95-100	95-100	50-70	20-35
	37-60	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
485B------------- Spillville	0-60	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
506-------------- Wacousta	0-15	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-65	20-40
	15-24	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	40-60	20-35
	24-60	Silt loam, silty clay loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15
507-------------- Canisteo	0-21	Clay loam--------	OL, CL	A-7	0	95-100	95-100	85-100	60-100	40-50	15-20
	21-43	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
	43-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
511------------- Blue Earth	0-7	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	7-60	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
524------------- Linder	0-21	Sandy loam-------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	21-39	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	39-60	Gravelly sand, loamy sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
562D2, 562E2, 562F2----------- Storden	0-7	Clay loam--------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
621------------- Houghton	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
640C2, 640D2, 640E2, 640F2---- Sunburg	0-7	Sandy loam-------	SC, SM, SM-SC	A-4, A-2	0-5	85-95	75-95	50-80	30-50	15-30	2-10
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
641B*, 641C2*, 641D2*, 641E2*: Clarion--------	0-21	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	21-45	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	45-60	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
Sunburg--------	0-7	Sandy loam-------	SC, SM, SM-SC	A-4, A-2	0-5	85-95	75-95	50-80	30-50	15-30	2-10
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
642D2*: Sunburg---------	0-7	Sandy loam-------	SC, SM, SM-SC	A-4, A-2	0-5	85-95	75-95	50-80	30-50	15-30	2-10
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
Salida----------	0-7	Gravelly sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	7-15	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	15-60	Very gravelly coarse sand, very gravelly sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
654---------- Corwith	0-17	Loam----------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	17-30	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	30-60	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
655---------- Crippin	0-19	Loam, clay loam	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	19-34	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	34-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
658---------- Mayer	0-17	Loam----------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	17-28	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
659---------- Mayer	0-21	Loam----------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	21-37	Loam, sandy clay loam, sandy loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	37-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
787B, 787C2------ Vinje	0-9	Silty clay loam	CL, CH, ML, MH	A-7	0	100	100	95-100	95-100	40-55	15-25
	9-43	Silty clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	95-100	40-60	15-30
	43-60	Clay loam, loam, silty clay loam.	CL, SC	A-6	0-5	90-100	85-95	75-90	45-70	25-40	10-20
811---------- Muskego	0-28	Sapric material	PT	A-8	0	---	---	---	---	---	---
	28-60	Coprogenous earth	OL	A-5	0	95-100	95-100	85-100	75-96	40-50	2-8
823, 823B-------- Ridgeport	0-19	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	19-29	Sandy loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	29-60	Gravelly loamy sand, gravelly sand, sand.	SW, SP, SW-SM, SP-SM	A-1	0-5	80-95	75-95	35-50	2-10	<25	NP-6
836B, 836C2, 836E2---------- Kilkenny	0-7	Clay loam--------	ML, MH	A-7	0	95-100	95-100	80-95	70-85	40-60	10-25
	7-42	Clay loam, clay, silty clay loam.	MH, CH	A-7	0	95-100	90-98	80-95	65-80	50-70	25-35
	42-60	Clay loam, loam	CL, ML	A-7, A-6	0-5	95-100	90-98	75-90	60-75	35-50	10-25
879---------- Fostoria	0-39	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-95	25-40	5-15
	39-60	Silt loam, loam, sandy loam.	CL	A-6	0-5	100	100	75-100	55-95	30-40	10-20
956*: Harps----------	0-18	Loam----------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	18-42	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	42-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
956*:											
Okoboji---------	0-9	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	9-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-46	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	46-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
1032------------- Spicer	0-19	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	19-40	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	40-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
1052B*:											
Bode------------	0-18	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
	18-40	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	40-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	90-95	75-90	50-75	25-40	5-15
Kamrar----------	0-20	Clay loam--------	CL	A-7	0	95-100	95-100	70-90	60-85	40-50	15-25
	20-35	Clay loam, clay, silty clay.	CL, CH	A-7	0	90-100	90-100	70-90	60-85	40-55	15-30
	35-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	85-95	60-80	50-75	35-50	15-30
1135------------- Coland	0-15	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	15-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
1221------------- Palms	0-40	Muck-------------	PT	A-8	0	---	---	---	---	---	---
	40-60	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
1259------------- Biscay	0-22	Clay loam--------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	22-30	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
	30-35	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	35-60	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
1339, 1339B------ Truman	0-22	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-100	30-45	10-20
	22-40	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	80-100	30-45	10-20
	40-50	Loam, silt loam	CL, CL-ML	A-4, A-6	0	100	100	85-95	50-80	25-40	5-15
	50-60	Stratified sand to clay loam.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	50-90	20-80	15-40	NP-20
1506------------- Wacousta	0-17	Silty clay loam	CL	A-7, A-6	0	100	100	95-100	95-100	35-50	20-35
	17-34	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	90-100	90-100	30-50	15-35
	34-60	Stratified loam to fine sand.	CL, SM, ML, SC	A-4, A-2	0-5	100	95-100	60-90	15-60	<25	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1507------------- Brownton	0-30	Silty clay loam	MH, CH	A-7	0	100	95-100	90-100	85-95	50-65	20-35
	30-60	Silty clay, clay	MH, CH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
1595------------- Harpster	0-21	Silty clay loam	CL, CH	A-7	0	100	95-100	95-100	90-100	45-60	20-35
	21-26	Silty clay loam, silt loam, loam.	CL, CH	A-6, A-7	0	100	95-100	95-100	70-100	35-55	20-35
	26-60	Stratified sandy loam to clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6, A-7	0	100	95-100	95-100	45-95	20-50	5-25
1733------------- Calco	0-16	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	16-48	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	48-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
2222------------- Adrian	0-34	Sapric material	PT	A-8	---	---	---	---	---	---	---
	34-60	Sand, fine sand, loamy sand.	SP, SM	A-2, A-3, A-1	0	80-100	80-100	30-80	0-35	---	NP
4000*. Urban land											
5010*. Pits											
5040*. Orthents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
6---------------- Okoboji	0-9	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High---------	0.37	5	4
	9-36	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37		
	36-46	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37		
	46-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
28, 28B, 28D2---- Dickman	0-17	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low----------	0.20	3	3
	17-35	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low----------	0.20		
	35-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low----------	0.15		
52B, 52C2, 52D2-- Bode	0-18	32-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.28	5	6
	18-28	28-35	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate-----	0.28		
	28-60	24-30	1.65-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
52E2------------- Bode	0-6	32-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.28	5	6
	6-30	28-35	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate-----	0.28		
	30-60	24-30	1.65-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
55--------------- Nicollet	0-20	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	0.24	5	6
	20-41	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-----	0.32		
	41-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32		
72, 72B, 72C2, 72D2------------ Estherville	0-14	10-18	1.35-1.45	2.0-6.0	0.19-0.22	5.6-7.3	Low----------	0.20	3	5
	14-20	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	>20	0.02-0.04	6.1-8.4	Low----------	0.10		
73C2------------- Salida	0-7	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low----------	0.10	3	8
	7-15	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
	15-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
90--------------- Okoboji	0-9	20-30	1.20-1.25	0.6-2.0	0.22-0.26	6.1-7.8	Moderate-----	0.37	5	6
	9-29	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37		
	29-39	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37		
	39-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
95--------------- Harps	0-18	25-27	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L
	18-42	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32		
	42-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
107-------------- Webster	0-21	26-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate-----	0.24	5	6
	21-42	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32		
	42-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
135-------------- Coland	0-8	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	8-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		
138B, 138C2, 138D2----------- Clarion	0-21	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6
	21-45	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	45-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
174, 174B-------- Bolan	0-21	20-26	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	4	6
	21-36	12-20	1.45-1.50	0.6-2.0	0.17-0.19	5.6-6.5	Low----------	0.28		
	36-60	2-8	1.60-1.70	6.0-20	0.08-0.10	6.1-7.3	Low----------	0.17		
221-------------- Palms	0-32	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	-------------	----	5	2
	32-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----		

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 K	Erosion factors T	Wind erodi-bility group
	In	Pct	g/cc	In/hr	In/in	pH				
224------------- Linder	0-21	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	Low----------	0.24	4	5
	21-39	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	Low----------	0.24		
	39-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	Low----------	0.10		
236B, 236C2, 236D2, 236F----- Lester	0-7	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6
	7-38	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28		
	38-60	13-27	1.55-1.75	0.6-2.0	0.14-0.19	6.6-8.4	Low----------	0.37		
259------------- Biscay	0-18	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
	18-31	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	31-36	10-27	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low----------	0.28		
	36-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
274------------- Rolfe	0-21	15-30	1.35-1.40	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.28	5	6
	21-41	38-45	1.40-1.50	0.06-0.2	0.11-0.13	5.6-7.3	High---------	0.28		
	41-60	20-35	1.50-1.60	0.2-2.0	0.14-0.16	6.1-8.4	Moderate-----	0.28		
288------------- Ottosen	0-19	32-35	1.35-1.45	0.2-0.6	0.19-0.22	5.6-7.3	Moderate-----	0.28	5	6
	19-35	30-35	1.45-1.55	0.2-0.6	0.17-0.19	6.1-8.4	Moderate-----	0.28		
	35-60	22-27	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
308, 308B-------- Wadena	0-18	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
	18-33	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	33-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
335------------- Harcot	0-9	27-29	1.35-1.40	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.28	4	4L
	9-32	15-30	1.40-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.28		
	32-60	2-8	1.60-1.75	>20	0.05-0.07	6.6-8.4	Low----------	0.15		
348------------- Fieldon	0-21	15-22	1.25-1.40	0.6-2.0	0.18-0.20	7.4-8.4	Low----------	0.28	5	4L
	21-36	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	Low----------	0.20		
	36-60	5-15	1.40-1.60	6.0-20	0.05-0.07	7.4-8.4	Low----------	0.20		
384, 384B-------- Collinwood	0-8	35-40	1.20-1.30	0.2-0.6	0.14-0.17	5.6-7.3	Moderate-----	0.32	5	4
	8-36	35-60	1.25-1.35	0.06-0.6	0.13-0.16	5.6-7.3	High---------	0.32		
	36-60	35-45	1.25-1.40	0.06-0.6	0.11-0.15	7.4-8.4	High---------	0.32		
388------------- Kossuth	0-20	32-40	1.35-1.45	0.2-0.6	0.21-0.23	6.1-7.3	High---------	0.28	5	4
	20-30	35-42	1.45-1.55	0.2-0.6	0.18-0.20	6.1-7.8	High---------	0.28		
	30-60	23-27	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.28		
390------------- Waldorf	0-21	40-45	1.20-1.30	0.2-2.0	0.18-0.25	6.1-7.3	Moderate-----	0.28	5	4
	21-37	40-55	1.25-1.35	0.2-0.6	0.13-0.16	6.6-7.8	High---------	0.28		
	37-60	24-45	1.25-1.35	0.2-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.28		
485B------------ Spillville	0-60	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
506------------- Wacousta	0-15	27-35	1.20-1.25	0.6-2.0	0.21-0.23	6.1-7.8	High---------	0.28	5	7
	15-24	24-35	1.25-1.30	0.6-2.0	0.18-0.20	6.6-7.8	High---------	0.43		
	24-60	18-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.43		
507------------- Canisteo	0-21	27-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	4L
	21-43	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low----------	0.32		
	43-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32		
511------------- Blue Earth	0-7	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L
	7-60	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low----------	0.28		
524------------- Linder	0-21	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	Low----------	0.24	4	5
	21-39	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	Low----------	0.24		
	39-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	Low----------	0.10		

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 K	Erosion factors T	Wind erodi-bility group
	In	Pct	g/cc	In/hr	In/in	pH				
562D2, 562E2, 562F2----------- Storden	0-7	27-30	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
621-------------- Houghton	0-60	---	0.15-0.45	0.2-6.0	0.35-0.45	4.5-7.8	-------------	----	2	2
640C2, 640D2, 640E2, 640F2---- Sunburg	0-7	12-20	1.35-1.55	2.0-6.0	0.16-0.18	6.6-8.4	Low-----------	0.24	5	3
	7-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low-----------	0.24		
641B*, 641C2*, 641D2*, 641E2*:										
Clarion--------	0-21	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6
	21-45	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37		
	45-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
Sunburg--------	0-7	12-20	1.35-1.55	2.0-6.0	0.16-0.18	6.6-8.4	Low-----------	0.24	5	3
	7-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low-----------	0.24		
642D2*:										
Sunburg---------	0-7	12-20	1.35-1.55	2.0-6.0	0.16-0.18	6.6-8.4	Low-----------	0.24	5	3
	7-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low-----------	0.24		
Salida----------	0-7	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low-----------	0.10	3	8
	7-15	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
	15-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low-----------	0.10		
654-------------- Corwith	0-17	18-24	1.35-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	6
	17-30	12-20	1.40-1.55	0.6-2.0	0.20-0.22	7.9-8.4	Low-----------	0.28		
	30-60	5-15	1.40-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low-----------	0.43		
655-------------- Crippin	0-19	22-28	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low-----------	0.28	5	4L
	19-34	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
	34-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low-----------	0.37		
658-------------- Mayer	0-17	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	4	4L
	17-28	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low-----------	0.28		
	28-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.15		
659-------------- Mayer	0-21	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	4	4L
	21-37	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low-----------	0.28		
	37-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.15		
787B, 787C2------ Vinje	0-9	35-40	1.25-1.30	0.2-0.6	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
	9-43	35-45	1.30-1.45	0.2-0.6	0.20-0.22	5.6-7.3	Moderate-----	0.32		
	43-60	20-30	1.45-1.70	0.6-2.0	0.17-0.19	6.6-8.4	Low-----------	0.32		
811-------------- Muskego	0-28	0	0.10-0.21	0.6-6.0	0.35-0.45	5.6-7.3	-------------	----	2	2
	28-60	18-35	0.30-1.10	0.06-0.2	0.18-0.24	6.6-8.4	Moderate-----	0.28		
823, 823B-------- Ridgeport	0-19	10-18	1.50-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low-----------	0.24	4	3
	19-29	10-18	1.55-1.60	2.0-6.0	0.07-0.09	5.6-7.3	Low-----------	0.24		
	29-60	2-8	1.60-1.75	>20	0.01-0.03	7.4-8.4	Low-----------	0.10		
836B, 836C2, 836E2----------- Kilkenny	0-7	27-30	1.15-1.25	0.2-0.6	0.17-0.19	5.6-6.5	Moderate-----	0.28	5	6
	7-42	35-45	1.25-1.35	0.2-0.6	0.15-0.19	4.5-6.5	Moderate-----	0.28		
	42-60	25-35	1.35-1.45	0.2-2.0	0.14-0.16	5.6-7.8	Moderate-----	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 K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
879-------------- Fostoria	0-39	25-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
	39-60	16-26	1.40-1.75	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43		
956*:										
Harps-----------	0-18	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L
	18-42	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32		
	42-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
Okoboji---------	0-9	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High---------	0.37	5	4
	9-36	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37		
	36-46	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37		
	46-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
1032------------- Spicer	0-19	27-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L
	19-40	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37		
	40-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low----------	0.37		
1052B*:										
Bode------------	0-18	32-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.28	5	6
	18-40	28-35	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate-----	0.28		
	40-60	24-30	1.65-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
Kamrar----------	0-20	35-40	1.20-1.30	0.6-2.0	0.17-0.19	5.6-7.3	Moderate-----	0.28	5	4
	20-35	35-50	1.25-1.35	0.2-0.6	0.15-0.19	5.6-7.3	Moderate-----	0.28		
	35-60	20-30	1.35-1.55	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.37		
1135------------- Coland	0-15	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	15-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		
1221------------- Palms	0-40	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	-------------	----	5	8
	40-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----		
1259------------- Biscay	0-22	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
	22-30	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	30-35	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low----------	0.28		
	35-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10		
1339, 1339B------ Truman	0-22	27-32	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	Moderate-----	0.32	5	7
	22-40	18-32	1.30-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.43		
	40-50	18-26	1.35-1.45	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.37		
	50-60	5-30	1.45-1.75	0.6-6.0	0.08-0.16	6.1-7.3	Low----------	0.20		
1506------------- Wacousta	0-17	27-35	1.20-1.25	0.6-2.0	0.21-0.23	6.1-7.8	High---------	0.28	5	7
	17-34	24-35	1.25-1.30	0.6-2.0	0.18-0.20	6.6-7.8	High---------	0.43		
	34-60	8-20	1.40-1.65	0.6-6.0	0.08-0.10	7.4-8.4	Low----------	0.28		
1507------------- Brownton	0-30	35-40	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	High---------	0.28	5	4
	30-60	35-70	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	High---------	0.28		
1595------------- Harpster	0-21	27-35	1.05-1.25	0.6-2.0	0.21-0.24	7.4-8.4	Moderate-----	0.28	5	4L
	21-26	22-35	1.25-1.55	0.6-2.0	0.17-0.22	7.4-8.4	Moderate-----	0.28		
	26-60	15-30	1.40-1.60	0.6-2.0	0.11-0.22	7.4-8.4	Low----------	0.28		
1733------------- Calco	0-16	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	4L
	16-48	30-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28		
	48-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
2222------------- Adrian	0-34	---	0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.3	-------------	----	4	2
	34-60	2-10	1.40-1.75	6.0-20	0.03-0.08	5.6-8.4	Low----------	----		

* 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	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
6----------------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
28, 28B, 28D2----- Dickman	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
52B, 52C2, 52D2, 52E2------------ Bode	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
55---------------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Nov-Jul	High-----	High-----	Low.
72, 72B, 72C2, 72D2------------ Estherville	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
73C2-------------- Salida	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
90---------------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
95---------------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
107--------------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
135--------------- Coland	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
138B, 138C2, 138D2------------ Clarion	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
174, 174B--------- Bolan	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
221--------------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
224--------------- Linder	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	Moderate	Low.
236B, 236C2, 236D2, 236F------ Lester	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
259--------------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	Moderate	Low.
274--------------- Rolfe	C	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
288--------------- Ottosen	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
308, 308B--------- Wadena	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
335--------------- Harcot	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
348--------------- Fieldon	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
384, 384B--------- Collinwood	C	None--------	---	---	2.0-5.0	Apparent	Nov-Jul	High-----	High-----	Low.
388--------------- Kossuth	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
390--------------- Waldorf	C/D	None--------	---	---	0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
485B-------------- Spillville	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
506--------------- Wacousta	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
507--------------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
511--------------- Blue Earth	B/D	None--------	---	---	+2-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
524--------------- Linder	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	Moderate	Low.
562D2, 562E2, 562F2------------ Storden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
621--------------- Houghton	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
640C2, 640D2, 640E2, 640F2----- Sunburg	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
641B*, 641C2*, 641D2*, 641E2*: Clarion---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Sunburg---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
642D2*: Sunburg----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Salida-----------	A	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
654--------------- Corwith	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
655--------------- Crippin	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
658, 659---------- Mayer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
787B, 787C2------- Vinje	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
811--------------- Muskego	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	Moderate	Moderate.
823, 823B--------- Ridgeport	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
836B, 836C2, 836E2------------ Kilkenny	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
879--------------- Fostoria	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
956*:										
Harps------------	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Okoboji----------	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
1032-------------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
1052B*:										
Bode-------------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
Kamrar-----------	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
1135-------------- Coland	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
1221-------------- Palms	D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	High-----	Moderate.
1259-------------- Biscay	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	Moderate	Low.
1339, 1339B------- Truman	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
1506-------------- Wacousta	B/D	Occasional	Brief-----	Mar-Sep	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
1507-------------- Brownton	C/D	None--------	---	---	1.0-2.5	Apparent	Nov-Jul	High-----	High-----	Low.
1595-------------- Harpster	B/D	None--------	---	---	+.5-2.0	Apparent	Nov-Jul	High-----	High-----	Low.
1733-------------- Calco	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
2222-------------- Adrian	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Bode	Fine-loamy, mixed, mesic Typic Hapludolls
Bolan	Coarse-loamy, mixed, mesic Typic Hapludolls
Brownton	Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Collinwood	Fine, montmorillonitic, mesic Aquic Hapludolls
Corwith	Coarse-silty, mixed, mesic Aquic Hapludolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fieldon	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Fostoria	Fine-loamy, mixed, mesic Aquic Hapludolls
*Harcot	Fine-loamy over sandy or sandy-skeletal, mesic Typic Calciaquolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Harpster	Fine-silty, mesic Typic Calciaquolls
Houghton	Euic, mesic Typic Medisaprists
Kamrar	Fine, montmorillonitic, mesic Typic Hapludolls
Kilkenny	Fine, montmorillonitic, mesic Mollic Hapludalfs
Kossuth	Fine-loamy, mixed, mesic Typic Haplaquolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Muskego	Coprogenous, euic, mesic Limnic Medisaprists
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, nonacid, mesic Typic Udorthents
Ottosen	Fine-loamy, mixed, mesic Aquic Hapludolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
Rolfe	Fine, montmorillonitic, mesic Typic Argialbolls
Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Sunburg	Coarse-loamy, mixed (calcareous), mesic Typic Udorthents
Truman	Fine-silty, mixed, mesic Typic Hapludolls
Vinje	Fine, montmorillonitic, mesic Typic Hapludolls
Wacousta	Fine-silty, mixed, mesic Typic Haplaquolls
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

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