United States Department of Agriculture

Soil Conservation Service

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

Soil Survey of Wright County, Iowa

How To Use This Soil Survey

General Soil Map

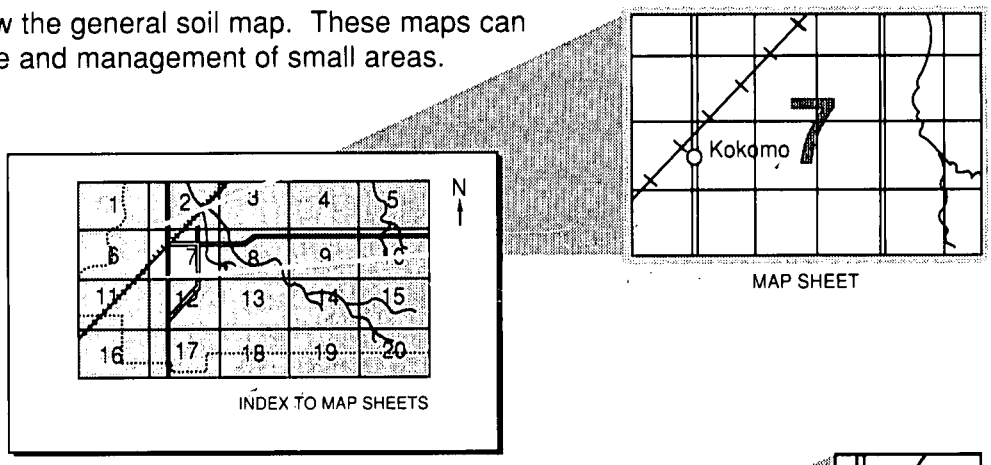
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

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.

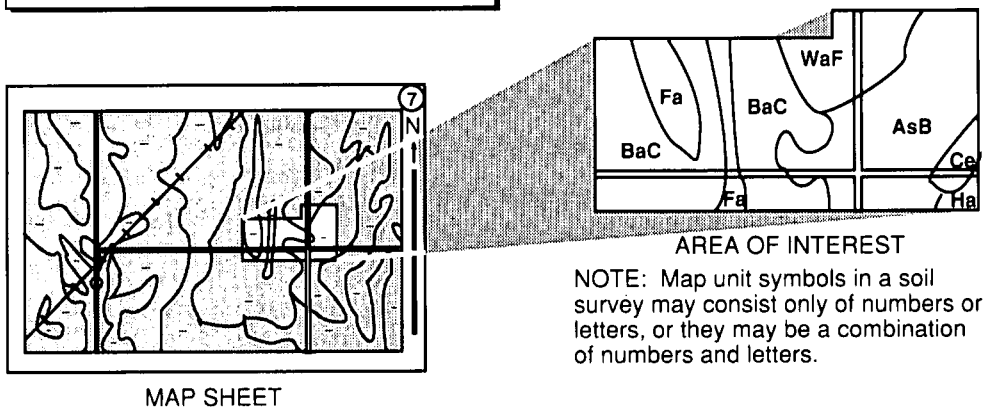
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



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.



MAP SHEET

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 1983 to 1988. Soil names and descriptions were approved in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1988. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship. The survey is part of the technical assistance furnished to the Wright County Soil and Water Conservation District. Funds appropriated by Wright County were used to defray part of the cost of the survey.

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 in an area of Nicollet loam, 1 to 3 percent slopes. Most areas of this soil are intensively row cropped.

Contents

Issued March 1992

Index to Map Units

Summary of Tables

Preface

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

By Robert O. Dideriksen, Soil Conservation Service

Fieldwork by Robert O. Dideriksen, Elmer H. Harvey, Richard A. Lensch, Dan G. Selky, Kermit D. Voy, Pat Abel, and Byron F. Chalstrom, Soil Conservation Service

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

WRIGHT COUNTY is in the north-central part of Iowa (fig. 1). It has a total area of 369,024 acres, or 576 square miles. Clarion is the county seat. It is about 25 miles northeast of Fort Dodge and 96 miles north of Des Moines.

Farming is the main enterprise in Wright County. The principal crops are corn, soybeans, oats, hay, and pasture. These crops, along with beef cattle and hogs, are the principal sources of income.

This survey updates the soil survey of Wright County published in 1923 *(10)*. It provides additional information and larger maps, which show the soils in greater detail.

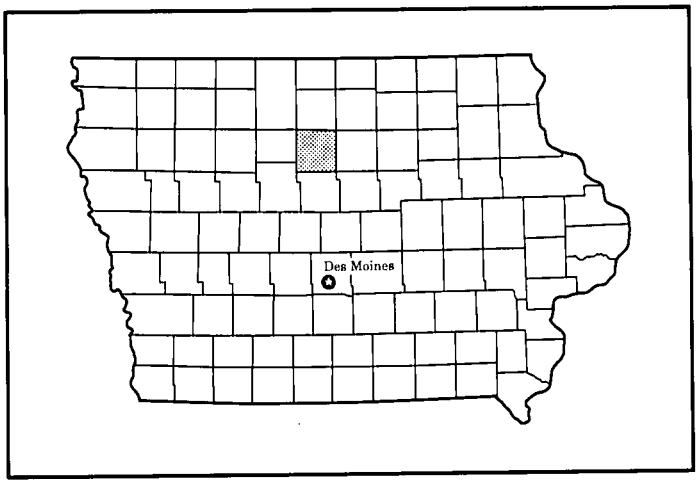


Figure 1.—Location of Wright County in Iowa.

General Nature of the County

This section describes the climate, relief and drainage, history and development, and farming in the county.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Clarion, Iowa, in the period 1951 to 1987. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 18 degrees F and the average daily minimum temperature is 9 degrees. The lowest temperature on record, which occurred at Clarion on January 21, 1970, is -32 degrees. In summer, the average temperature is 71 degrees and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred on July 31, 1955, is 103 degrees.

Growing degree days are shown in table 1. They are

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

The total annual precipitation is about 31 inches. Of this, about 23 inches, or about 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.74 inches at Clarion on September 20, 1983. Thunderstorms occur on about 42 days each year.

The average seasonal snowfall is 36 inches. The greatest snow depth at any one time during the period of record was 41 inches. On the average, 43 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 south. 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 little damage. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

Relief and Drainage

Most of the soils in Wright County are nearly level to gently rolling and are on glacial drift plains. The Boone River and its few tributaries have caused very little surface erosion and flow through narrow channels. The prevailing slope of the county is to the south, and the drainage system generally flows in that direction. Large areas between drainage systems are nearly level and have only slight variations in the land surface.

The difference in elevation between the lowlands and the adjoining uplands is generally 50 to 100 feet. Elevation varies from 1,008 to 1,240 feet above sea level.

Wright County is in the upper Mississippi drainage basin. Most of the rivers, streams, and drainage ditches generally flow toward the south. All of the county is drained by tributaries of the Mississippi River.

A chain of shallow lakes extends north and south across the county, somewhat east of the center. Cornelia Lake, Elm Lake, Morse Lake, and Wall Lake are the largest lakes in the county. Several large marshy areas have been drained and are now farmed. The use of tile and drainage ditches has been extensive.

History and Development

Before it was designated a county in Iowa, the land that is now Wright County was part of an area declared by the U.S. Government as neutral ground between warring Indian tribes. The southern part of the county was ceded by the Sac and Fox tribes and the northern part by several bands of Santee Sioux *(1)*. Prior to 1850, the survey area was part of two very large counties known as Fayette and Buchanan Counties.

The first settlements in Wright County were established along the Boone River in Troy and Liberty townships in 1854. The early settlers favored the wooded areas along the Boone River. Game was plentiful in this area, and the timber provided fuel, construction materials, and protection from severe winter storms. Wright County was organized in 1855. In that year the first courthouse was established at Eagleville, which was later named Eagle Grove. In 1858, the courthouse was moved to the town of Liberty, which was later incorporated into the town of Goldfield. In 1866, the county seat was moved to its present site at Clarion.

The population and the number of farms gradually increased in the 1850's. The settlers farmed the better drained areas first. Much of the territory was poorly drained. Most farms were small or medium in size. The principal crops were corn, oats, and wheat; hay was also grown for home use and for consumption by livestock. Horses, cattle, hogs, and chickens were the primary kinds of livestock.

As settlers arrived in the survey area, some sawmills were built along the Boone River. Although initially operated by water power, the mills were later switched to steam power because of the river's erratic rate of flow. After the establishment of the railroads, which provided access to marketing facilities and increased the demand for and value of agricultural land, drainage systems were installed in the county.

The population of the county was 427 in 1856. All of the residents were classified as rural. The population was 19,500 in 1915; 19,477 in 1960; 17,294 in 1970; and 16,319 in 1980. Clarion has a population of about 3,060 *(5)*. Other towns and villages in the county include Belmond, Cornelia, Downs, Eagle Grove, Galt, Goldfield, Olaf, Rowan, and Woolstock.

Farming

In 1986, Wright County had 355,800 acres of farmland *(4)*. Of this acreage, 315,000 acres was used for row crops, small grain, or hay. The rest was used for permanent pasture, woodland, lots, buildings, or roads or was left idle. Corn was planted on 140,000 acres, soybeans on 168,000 acres, and oats on 2,000 acres. Yields of corn averaged 150.4 bushels per acre, yields of soybeans averaged 41.8 bushels per acre, and yields of oats averaged 60.5 bushels per acre. About 4,900 acres was used for all types of hay.

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. In 1986, about 8,500 grain-fed cattle and 161,000 hogs were sold. In the same year, 17,800 sows were farrowed. The total number of beef cattle was 3,200, and the county had a few milk cows, sheep, and lambs and 11,000 laying hens *(4)*.

In recent years the number of people living on farms and the number of farms have declined. Farm size has increased. In 1986, the county had 950 farms, which averaged 375 acres in size. In 1980, about 6,430 people lived on farms *(5)*.

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 biological 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 a considerable degree of 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, 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 interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are 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 are 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

predict with a fairly high degree of accuracy 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. Canisteo-Nicollet-Webster Association

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

This association consists of nearly level soils on flats and in swales and gently undulating soils on low rises. The flats have intermittent depressions that were marshes and ponds before a drainage system was installed. Slopes range from 0 to 3 percent.

This association makes up about 41 percent of the county. It is about 30 percent Canisteo and similar soils, 25 percent Nicollet and similar soils, 25 percent Webster and similar soils, and 20 percent soils of minor extent.

Canisteo and Webster soils are poorly drained and nearly level and are on flats and in swales. Nicollet soils are somewhat poorly drained and very gently sloping and are on rises.

Typically, the surface layer of the Canisteo soils is black, calcareous silty clay loam about 9 inches thick. The subsurface layer also is black, calcareous silty clay loam about 9 inches thick. The subsoil is friable, calcareous, mottled clay loam about 16 inches thick. The upper part is dark gray, and the lower part is olive gray. 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 loam about 9 inches thick. The subsurface layer is very dark brown loam about 9 inches thick. The subsoil is about 18 inches thick. The upper part is dark grayish brown, friable loam, and the lower part is dark grayish brown and grayish brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is olive, mottled, calcareous loam.

Typically, the surface layer of the Webster soils is black silty clay loam about 8 inches thick. The subsurface layer is about 12 inches thick. The upper part is black silty clay loam, and the lower part is black clay loam. The subsoil is mottled, friable clay loam about 13 inches thick. The upper part is dark gray, and the lower part is dark gray and olive gray. The substratum to a depth of about 60 inches is light olive gray, mottled, calcareous loam.

Minor in this association are the very poorly drained Calcousta, Okoboji, and Wacousta soils in depressions; the poorly drained, highly calcareous Harps soils around the depressions; and the well drained Clarion soils on knolls and ridges.

The soils in this association generally are intensively cultivated. They are well suited to the cultivated crops commonly grown in the county. Corn and soybeans are the principal crops. Cash grain farming is the dominant farm enterprise. Some areas are used for small hog enterprises.

The main management concerns are maintaining the existing drainage system and the level of fertility and controlling soil blowing. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. The soils in depressions have a high content of organic matter and a high water table, both of which make weed and disease control difficult. Maintaining fertility is a problem on the Canisteo and Harps soils, which have a high

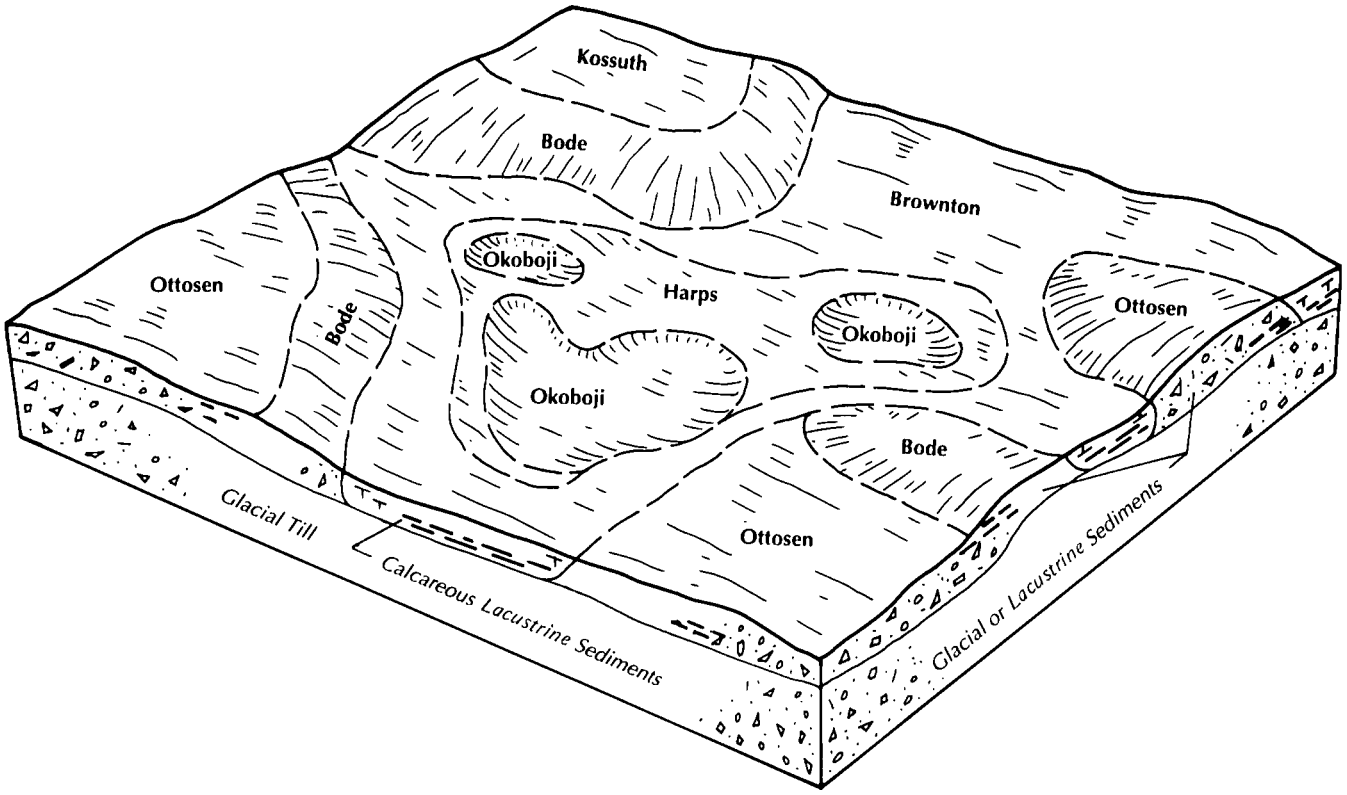


Figure 2.—Typical pattern of soils and parent material in the Brownton-Ottosen-Bode association.

content of lime. Soil blowing is a hazard in large bare areas that have been plowed in the fall.

2. Brownton-Ottosen-Bode Association

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

This association consists of soils on broad upland flats and short, convex or plane side slopes. There are many scattered potholes, and the natural drainage system is poorly defined. Most areas are drained by tile and surface outlets. Large drainage ditches have been dug to provide outlets for tile drains. Slopes range from 0 to 14 percent.

This association makes up about 27 percent of the county. It is about 25 percent Brownton and similar soils, 25 percent Ottosen soils, 20 percent Bode soils, and 30 percent soils of minor extent (fig. 2).

Brownton soils are poorly drained and nearly level and are on flats and in swales. Ottosen soils are somewhat poorly drained and very gently sloping and are on rises and side slopes. Bode soils are well drained and gently sloping or moderately sloping and are on convex side slopes.

Typically, the surface layer of the Brownton soils is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray, calcareous silty clay loam about 13 inches thick. The subsoil is gray, mottled, firm silty clay loam about 11 inches thick. 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 clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown clay loam about 11 inches thick. The subsoil is friable clay loam about 15 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown and mottled. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous loam.

Typically, the surface layer of the Bode soils is black clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown clay loam about 10 inches thick. The subsoil is friable clay loam about 15 inches thick. The upper part is brown, and the

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

Minor in this association are the Harps, Kossuth, and Okoboji soils. The poorly drained, highly calcareous Harps soils are on the rims of depressions. The poorly drained Kossuth soils are on upland flats and in narrow drainageways. They do not have carbonates in the surface soil or subsoil. The very poorly drained Okoboji soils are in depressions.

The soils in this association generally are intensively cultivated. They are well suited to all of the crops commonly grown in the county. Corn and soybeans are the principal crops. Cash grain farming is the dominant farm enterprise. The only areas used for pasture and hay are a few small fields adjoining small streams. Some marshes have not been drained and are used for wildlife habitat.

The main management concerns are maintaining the existing drainage system and tilth and controlling erosion. Most areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. Soil blowing is a hazard, especially in large bare areas that have been plowed in the fall. In these areas ditches beside roads and on farmsteads can become filled with snow or soil. Water erosion is a serious hazard in the steeper areas. Erosion-control measures are needed in some areas of the Bode soils, particularly those that are adjacent to drainageways. Terraces, contour farming, and a system of conservation tillage that leaves crop residue on the surface slow runoff, reduce the hazard of erosion, and increase the rate of water infiltration. Farming on the contour and terracing are difficult in places because of the complex pattern of slopes.

Because of a high content of clay and a low content of sand, the soils remain wet and sticky for long periods following rains. They should be tilled at the optimum moisture content. If worked when too wet, they become cloddy and hard as they dry out. If tilled when too dry, they are hard and cannot be easily worked.

3. Canisteo-Clarion-Nicollet Association

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

This association consists of nearly level soils on flats and in swales and gently undulating to gently rolling soils on rises, knolls, and low hills. Many areas were marshes and intermittent ponds before a drainage system was installed. Slopes range from 0 to 9 percent.

This association makes up about 16 percent of the county. It is about 30 percent Canisteo and similar soils, 25 percent Clarion soils, 15 percent Nicollet and similar soils, and 30 percent soils of minor extent (fig. 3).

Canisteo soils are poorly drained and nearly level and are on flats and in swales. Clarion soils are well drained and gently sloping to strongly sloping and are on knolls and side slopes. Nicollet soils are somewhat poorly drained and very gently sloping and are on rises.

Typically, the surface layer of the Canisteo soils is black, calcareous silty clay loam about 9 inches thick. The subsurface layer also is black, calcareous silty clay loam about 9 inches thick. The subsoil is friable, calcareous, mottled clay loam about 16 inches thick. The upper part is dark gray, and the lower part is olive gray. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

Typically, the surface layer of the Clarion soils is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 6 inches thick. The subsoil is brown and yellowish brown, friable loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

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

Minor in this association are the poorly drained, noncalcareous Webster soils on upland flats and in swales; the poorly drained, highly calcareous Harps soils on the rims of depressions; the very poorly drained Okoboji and Palms soils in the depressions; and the well drained, calcareous Storden soils on knolls and side slopes.

The soils in this association generally are used for cultivated crops. Corn is grown annually in the large drained depressions, but corn and soybeans generally are grown in rotation in the rest of the association. The soils generally are well suited to all of the cultivated crops commonly grown in the county. The soils in depressions, however, have a high content of organic matter and a high water table, both of which make weed and disease control difficult.

The main management concerns are maintaining the existing drainage system and controlling erosion. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. Measures that control water erosion are needed on the more sloping soils. In places farming on the contour and terracing are somewhat difficult

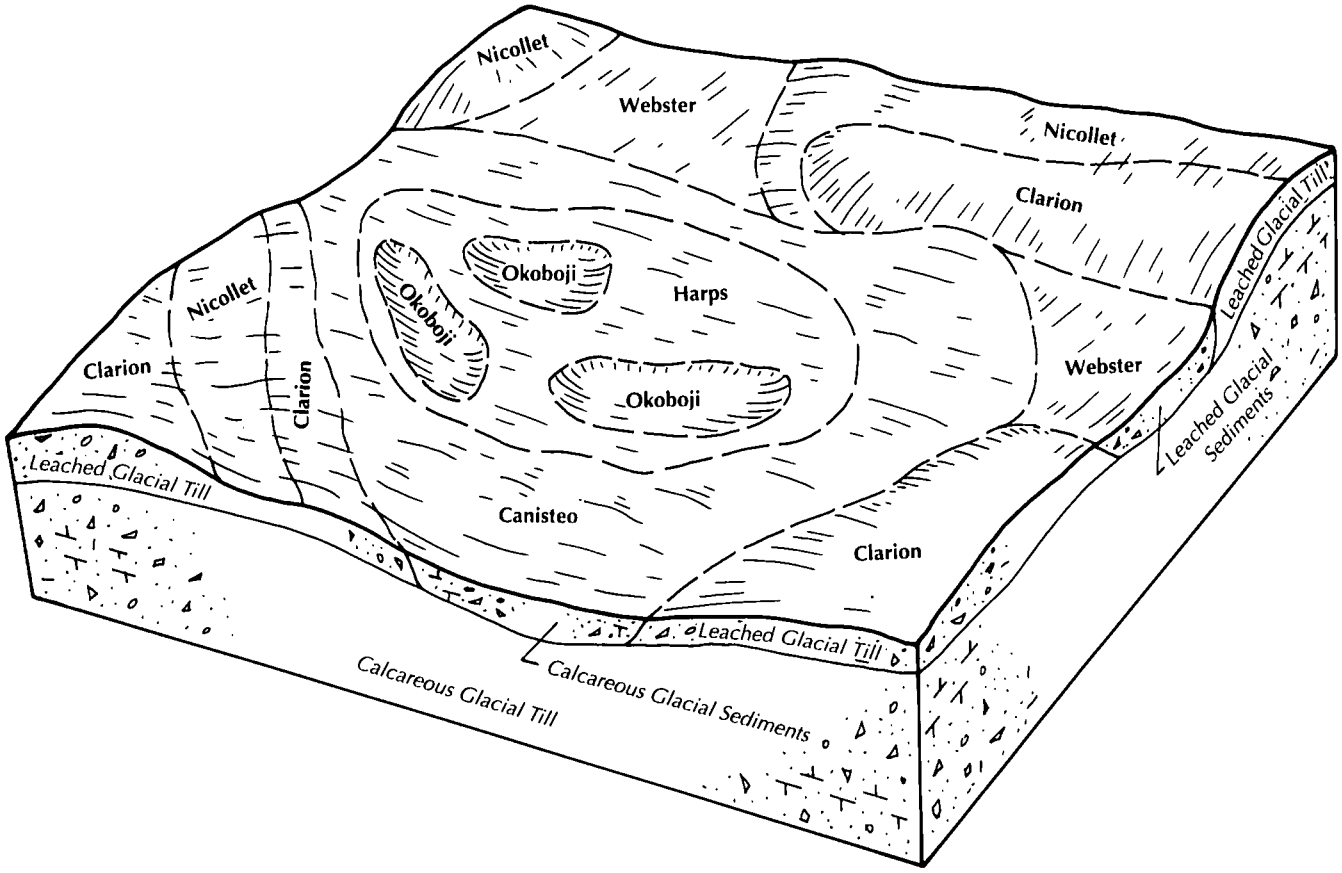


Figure 3.—Typical pattern of soils and parent material in the Canisteo-Clarion-Nicollet association.

because of the irregular pattern of slopes. In large bare areas that have been plowed in the fall, soil blowing is a hazard.

4. Clarion-Storden-Webster Association

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

This association consists of soils on flats, knolls, and side slopes. There are many scattered potholes in the nearly level soils. These areas are drained by tile and surface outlets. Slopes range from 0 to 50 percent.

This association makes up about 9 percent of the county. It is about 35 percent Clarion soils, 15 percent Storden soils, 15 percent Webster and similar soils, and 35 percent soils of minor extent.

Clarion soils are well drained and gently sloping and moderately sloping and are on knolls and side slopes. Storden soils are well drained and moderately sloping to very steep and are on knolls and ridgetops. Webster soils are poorly drained and nearly level and are on flats and in swales.

Typically, the surface layer of the Clarion soils is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 6 inches thick. The subsoil is brown and yellowish brown, friable loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Storden soils is dark grayish brown, calcareous loam about 6 inches thick. It is mixed with some streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam in the upper part and light olive brown, mottled, calcareous loam in the lower part.

Typically, the surface layer of the Webster soils is black silty clay loam about 8 inches thick. The subsurface layer is about 12 inches thick. The upper part is black silty clay loam, and the lower part is black clay loam. The subsoil is friable, mottled clay loam about 13 inches thick. The upper part is dark gray, and

the lower part is dark gray and olive gray. The substratum to a depth of about 60 inches is light olive gray, mottled, calcareous loam.

Minor in this association are the poorly drained, highly calcareous Harps soils on the rims of depressions; the well drained Lester soils on knolls and convex side slopes; the very poorly drained Okoboji soils in depressions; the somewhat poorly drained Nicollet soils on low rises; and the somewhat excessively drained Zenor soils on knolls and ridgetops.

Most areas are used for cultivated crops or livestock enterprises. Corn and soybeans are grown on the less sloping soils. The steeper soils are used for hay and pasture. The Clarion and Webster soils are well suited to all of the cultivated crops commonly grown in the county, and the Storden soils are moderately suited. Many areas of the Storden soils and the minor Zenor soils are better suited to hay, pasture, and wildlife habitat than to cultivated crops because of variable yields and the hazard of erosion.

The main management needs are erosion control on the sloping soils and measures that maintain the existing drainage system in the nearly level soils. Most of the poorly drained areas are drained by tile lines and some by drainage ditches. Surface drains and tile intakes are used to remove ponded water from depressions. Terraces, contour farming, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Farming on the contour and terracing are difficult in some areas, however, because of the irregular pattern of slopes. Soil blowing is a serious hazard, especially when the higher crests and nose slopes are plowed in the fall and at other times when the surface is bare.

5. Wadena-Coland Association

Nearly level to moderately sloping, well drained and poorly drained, loamy soils formed in alluvium that in some areas is underlain by sand and gravel; on outwash plains, bottom land, and stream terraces

This association consists of soils on bottom land, on broad outwash plains, and on stream terraces. In some areas the bottom land is covered with grasses or marsh vegetation. Some areas support a few scattered trees. Many areas are cut by meandering channels and oxbows. Slopes range from 0 to 9 percent.

This association makes up about 5 percent of the county. It is about 40 percent Wadena soils, 25 percent Coland soils, and 35 percent soils of minor extent.

Wadena soils are well drained and nearly level to moderately sloping and are on rises on stream terraces and outwash plains. Coland soils are poorly drained and nearly level and are on bottom land.

Typically, the surface layer of the Wadena soils is very dark brown loam about 9 inches thick. The subsurface layer is loam about 12 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil is brown, friable loam about 11 inches thick. The upper part of the substratum is brown, calcareous gravelly coarse sand. The lower part to a depth of about 60 inches is yellowish brown, calcareous sand.

Typically, the surface layer of the Coland soils is black, friable clay loam about 9 inches thick. The subsurface layer is friable clay loam about 38 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is mottled dark gray and olive gray loam.

Minor in this association are the Biscay, Cylinder, and Talcot soils. The poorly drained, nearly level Biscay and Talcot soils are on stream terraces. They have sand and gravel in the substratum. Also, Talcot soils are calcareous. The somewhat poorly drained Cylinder soils are on slightly convex rises on stream terraces.

Most of this association is used for cultivated crops, hay, or rotation pasture. A small acreage is permanent pasture, idle land, or wildlife habitat. Most of the soils on outwash plains are used for corn, soybeans, oats, hay, or rotation pasture. About half of the acreage of Coland soils is used for cultivated crops, and half is used as pasture. In places the Coland soils are cut by meandering channels and are too frequently flooded and remain flooded too long for crop production. Some areas that are low and wet are managed as wildlife habitat. The Coland soils have a high content of organic matter and a high available water capacity. The Wadena soils generally have a low to moderate content of organic matter and a low or moderate available water capacity. Crop yields vary but in most years are only moderate or, at best, moderately high because of droughtiness.

The main management concerns are flooding on the alluvial soils and water erosion, soil blowing, and droughtiness in the areas of outwash. There are few management alternatives on the alluvial soils. A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing and water erosion and conserves moisture in the areas of outwash.

6. Hayden-Storden-Hanlon Association

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

This association consists of undulating soils on ridgetops, very steep soils on side slopes, and nearly

level soils on bottom land. Slopes range from 0 to 50 percent.

This association makes up about 2 percent of the county. It is about 25 percent Hayden soils, 20 percent Storden soils, 10 percent Hanlon soils, and 45 percent soils of minor extent.

Hayden soils are well drained and gently sloping and are on ridgetops and very steep side slopes. Storden soils are well drained and moderately sloping to very steep and are on knolls and side slopes. Hanlon soils are moderately well drained and nearly level and are on bottom land.

Typically, the surface layer of the Hayden soils is dark gray loam about 7 inches thick. The subsurface layer is about 8 inches thick. The upper part is dark grayish brown loam, and the lower part is brown loam. The subsoil is friable clay loam about 35 inches thick. The upper part is dark yellowish brown, and the lower part is light olive brown. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Typically, the surface layer of the Storden soils is dark grayish brown, calcareous loam about 6 inches thick. It is mixed with some streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown loam in the upper part and light olive brown, mottled, calcareous loam in the lower part.

Typically, the surface layer of the Hanlon soils is very dark brown fine sandy loam about 12 inches thick. The subsurface layer is very dark brown and very dark grayish brown fine sandy loam about 40 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, very friable fine sandy loam.

Minor in this association are the poorly drained Coland and somewhat poorly drained Spillville soils on bottom land, the moderately well drained Terril soils on foot slopes, and the well drained Wadena and somewhat poorly drained Cylinder soils on terraces.

Many of the steeper soils in this association are wooded. Generally, they are used as pasture rather than woodland, but a few small tracts are managed as woodland. Where tillage is possible on the sloping soils, hay is grown in rotation with corn. Row crops are grown in gently sloping areas on ridgetops and in areas on bottom land where flooding is controlled. Fields are commonly small and irregular in shape.

The steep and very steep soils are unsuitable for cultivated crops, but the soils on bottom land and terraces are well suited. The slope and the hazard of erosion are the major management concerns. The main management needs on the bottom land are flood control and a drainage system. Some of the soils on terraces have a moderate or low available water capacity and are slightly droughty unless summer rainfall is frequent.

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. Coland-Terril complex, 1 to 5 percent slopes, is an example.

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

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

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

Soil Descriptions

4—Knoke silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Individual areas range from 2 to 10 acres in size and are elliptical.

Typically, the surface layer is black silty clay loam about 16 inches thick. The subsurface layer also is black silty clay loam. It is about 10 inches thick. The subsoil is black, friable silty clay loam about 19 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. The soil is calcareous throughout.

Permeability is moderately slow, and runoff is ponded. Available water capacity is very high. The soil has a seasonal high water table near or above the surface. The 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 potassium. Tilth generally is fair.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains

Figure 4.—Ponding in small depressions in an area of Okoboji silty clay loam, 0 to 1 percent slopes.

remove excess subsurface water. Even if the soil is drained, special care generally is needed to maintain tilth in the surface layer. The availability of plant nutrients is limited by an excessive amount of lime in the soil. Soil structure tends to be weak and breaks down if the soil is cultivated when too wet. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIIw.

6—Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding (fig. 4). Individual areas are dominantly 2 to 10 acres in size but range to 50 acres. They are elliptical.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam. It is about 19 inches thick. The subsoil is very dark gray, mottled, firm silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam.

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

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain

and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Special care generally is needed to maintain tilth in the surface layer. Chisel plowing increases the rate of water infiltration by making the surface more pervious to water. Cultivating when the soil is too wet causes surface compaction and cloddiness.

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

The land capability classification is IIIw.

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

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black, very dark brown, very dark grayish brown, and dark brown loam about 29 inches thick. The subsoil to a depth of about 60 inches is brown, friable loam and sandy loam.

Permeability 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 a very low or low supply of available potassium. Tilth generally is good.

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

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

The land capability classification is IIe.

48—Knoke mucky silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in large upland depressions, many of which formerly were shallow lakes. It is subject to ponding. Individual areas range from 5 to more than 30 acres in size and are irregularly shaped.

Typically, the surface layer is black mucky silty clay loam about 8 inches thick. The subsurface layer is about 25 inches thick. The upper part is very dark gray mucky silty clay loam, the next part is black mucky silty clay loam, and the lower part is black silty clay loam. The subsoil is black, friable silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is gray, very dark gray, and dark gray, mottled silty clay loam. The soil is calcareous throughout.

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

This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. An adequate subsurface and surface drainage system is needed. The availability of plant nutrients is limited by an excessive amount of lime in the soil, which commonly is evidenced by stunted soybeans that have yellow leaves. Applications of phosphorus and potassium fertilizer are needed. In some areas applications of ferrous sulfate or other iron compounds also are needed. Special care generally is needed to maintain tilth in the surface layer. Cultivating when the soil is wet hastens the breakdown of soil structure.

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

The land capability classification is IIIw.

52B—Bode clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and convex side slopes in the uplands. Slopes typically are short. Individual areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown clay loam about 10 inches thick. The subsoil is friable clay loam about 15 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous loam. In places plowing has mixed

part of the subsoil with the surface soil.

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

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

Erosion is a slight hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or surface mulch helps to control erosion.

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 in the uplands. Slopes typically are short. Individual areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of subsoil material. The subsoil is friable clay 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 light olive brown and grayish brown loam.

Included with this soil in mapping are some small areas of Storden soils. These soils are calcareous throughout. They are in high convex areas. They make up about 10 percent of the unit.

Permeability is moderate in the Bode soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is fair.

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

Erosion is a moderate hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or surface mulch helps to control erosion.

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 in the uplands. Slopes typically are short. Individual areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown clay loam about 7 inches thick. It is mixed with streaks and pockets of subsoil material. The subsoil is friable clay 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 light olive brown and grayish brown loam.

Included with this soil in mapping are some small areas of Storden soils. These soils are calcareous throughout. They are in high convex areas. They make up about 10 percent of the unit.

Permeability is moderate in the Bode soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is fair.

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

Erosion is a severe hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. A permanent plant cover or surface mulch helps to control erosion.

The land capability classification is IIIe.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on low

ridges and slightly concave side slopes in the uplands. Individual areas range from 2 to 15 acres in size and are oblong, but some are 50 acres or more and are irregularly shaped.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark brown loam about 9 inches thick. The subsoil is about 18 inches thick. The upper part is dark grayish brown, friable loam, and the lower part is dark grayish brown and grayish brown, mottled, friable clay loam. The substratum to a depth of about 60 inches is olive, mottled, calcareous loam.

Included with this soil in mapping are small areas of poorly drained soils. These soils are lower on the landscape than the Nicollet soil. They make up about 10 percent of the unit.

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

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

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

The land capability classification is I.

62C2—Storden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained, calcareous soil is on knolls and convex side slopes along streams and upland drainageways. Slopes generally are short. Individual areas range from 2 to 10 acres in size and are irregularly shaped or long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. The upper part of the substratum is yellowish brown loam. The lower part to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the substratum has strata of silt loam and sandy loam.

Included with this soil in mapping are some areas where the slope is less than 5 or more than 9 percent. Also included are some small areas of sandy or gravelly soils on knobs. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 1.7 to 2.7 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. If erosion is controlled and fertility improved, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a severe hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terraces are practical in some areas but are not feasible in areas where slopes are short. Applications of a large amount of phosphorus and potassium fertilizer are needed because of a high content of lime in the soil. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

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

The land capability classification is IIIe.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Individual areas generally range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. It is mixed with some streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and light olive brown, mottled, calcareous loam. In some areas it has strata of sandy loam.

Included with this soil in mapping are some areas where the slope is more than 14 percent. Also included are some small areas of sandy or gravelly soils on knobs. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The

content of organic matter is about 1.7 to 2.7 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

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

Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Forage stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

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

The land capability classification is IIIe.

62E2—Storden loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Individual areas generally are 2 to 10 acres in size. They are long and narrow.

Typically, the surface layer is brown, calcareous loam about 5 inches thick. The substratum to a depth of about 60 inches is light olive brown, yellowish brown, and light yellowish brown, calcareous loam. In some areas it has strata of silt loam and sandy loam.

Included with this soil in mapping are some areas where the slope is less than 14 percent. These areas make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 1.7 to 2.7 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

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

This soil is suited to row crops that are occasionally grown to renovate pastures. The pastures commonly are renovated by planting the row crop one year and reestablishing the pasture the next year. Forage stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

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

The land capability classification is IVe.

62F—Storden loam, 18 to 25 percent slopes. This steep, well drained, calcareous soil is on convex side slopes along streams and upland drainageways. Slopes generally are short. Individual areas generally range from 10 to 20 acres in size and are long and narrow.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is light olive brown, yellowish brown, and light yellowish brown, calcareous loam.

Included with this soil in mapping are some areas where the slope is less than 18 percent. These areas make up about 10 percent of the unit.

Permeability is moderate in the Storden soil, and runoff is rapid. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are used for pasture. Some support

bluegrass or native grasses. Because erosion is a severe hazard, this soil is generally unsuitable for cultivated crops. It is better suited to grasses and legumes for hay and pasture, but it is too erodible for unlimited grazing. Operating farm machinery is hazardous because of the slope. In areas where farm machinery can be used, fertilizer can be applied and pastures renovated.

If this soil is used for windbreaks or ornamental plantings, erosion is a severe hazard before the trees and shrubs are established. It can be controlled, however, by temporary cover crops or surface mulch. Planting is difficult because of the slope.

The land capability classification is VIe.

90—Okoboji mucky silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Individual areas are irregularly shaped. Most range from 5 to 25 acres in size, but some are 40 acres or more.

Typically, the surface layer is black mucky silty clay loam about 13 inches thick. The subsurface layer is black silty clay loam about 19 inches thick. The subsoil is very dark gray, friable silty clay loam about 10 inches thick. The substratum to a depth of about 60 inches is dark gray silty clay loam. In places the surface layer is muck.

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

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

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

The land capability classification is IIIw.

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

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is clay loam about 9 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is about 21 inches of dark gray and olive gray, friable clay loam and loam. The substratum to a depth of about 60 inches is light olive gray and gray, mottled loam. The soil is calcareous throughout.

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

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the rate of water infiltration by making the surface more pervious to water. Returning crop residue to the soil and regularly adding other organic material help to control soil blowing and prevent surface crusting and increase the rate of water infiltration. The availability of plant nutrients is limited by an excessive amount of lime in the soil. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIw.

107—Webster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales or slightly convex areas in the uplands. Individual areas generally range from 5 to 25 acres in size and are long and narrow, but some are as large as 100 acres and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer also is black silty clay loam. It is about 12 inches thick. The subsoil is about 13 inches thick. The upper part is dark gray, mottled, friable silty clay loam, and the lower part is olive gray, friable clay loam. The substratum to a depth of about 60 inches is light olive gray, mottled loam. In places the surface layer is clay loam.

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

Permeability is moderate in the Webster soil, and

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

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

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

The land capability classification is IIw.

108—Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is mainly on slightly convex slopes on benches, but in a few areas it is on uplands. Individual areas are irregularly shaped. Generally, those on benches are 5 to 20 acres in size and those on uplands are 2 to 3 acres.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown, friable loam; the next part is brown, friable loam; and the lower part is dark yellowish brown, very friable loamy coarse sand. The substratum to a depth of about 60 inches is grayish brown sand and gravel. In some places loamy sand or sand and gravel are as shallow as 18 inches. In other places the lower part of the subsoil is sandy loam or sandy clay loam.

Included with this soil in mapping are some areas of sandy and gravelly soils on small knobs and some small areas of poorly drained soils on the lower parts of the landscape. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

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

The land capability classification is IIs.

108B—Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex slopes on stream terraces. Individual areas generally range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 15 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable loamy coarse sand. The substratum to a depth of about 60 inches is grayish brown gravelly sand. In some areas, the surface layer is sandy loam and the slope is more than 5 percent.

Permeability is moderate in the upper part of the profile 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 a very low or low supply of available potassium. Tilth generally is good.

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

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion.

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

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

The land capability classification is IIe.

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

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. It is mixed with some streaks and pockets of dark brown subsoil material. The subsoil is about 24 inches thick. It is dominantly dark brown and brown, friable loam. In the lower few inches, however, it is yellowish brown, very friable loamy coarse sand. The substratum to a depth of about 60 inches is grayish brown sand and gravel. In some places the depth to calcareous gravelly loamy coarse sand is only about 15 inches. In other places the surface layer and the subsoil are sandy loam or sandy clay loam.

Permeability is moderate in the upper part of the profile and very rapid in the substratum. Runoff is medium. Available water capacity is low. The content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Some areas are cultivated, and some are used for pasture. This soil is poorly suited to corn and soybeans. It is moderately suited to small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Also, the soil is seasonally droughty because of the sandy and gravelly substratum. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. If terraces are built, the cuts should not expose the sand and gravel substratum and as much topsoil as possible should be returned to the site. Good tilth generally can be easily maintained. Returning other organic material to the soil improves fertility, conserves moisture, and helps to control erosion.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the susceptibility to erosion.

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

The land capability classification is IIIe.

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

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is clay loam about 37 inches thick. The upper part is black, and the lower part is very dark gray. The substratum to a depth of about 60 inches is olive gray, mottled loam. In some places the surface layer is silty clay loam. In other places it is calcareous.

Included with this soil in mapping are small areas of sandy soils, generally at the slightly higher elevations. These soils make up about 10 percent of the unit.

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

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

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

The land capability classification is IIw.

138B—Clarion loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and side slopes in the uplands. Individual areas range from 2 to 10 acres in size and are long and narrow, but a few are more than 50 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown loam about 6 inches thick. The subsoil is brown and yellowish brown, friable loam about 24 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places plowing has mixed part of the subsoil with the surface soil. In other places the substratum has lenses of loamy sand or sand.

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

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

Most areas are cultivated (fig. 5). This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and grassed waterways help to prevent excessive soil loss. Contour farming and terraces are practical in some areas but are not feasible in undulating areas where slopes are short. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

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

The land capability classification is IIe.

138B2—Clarion loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on knolls and side slopes in the uplands. Individual areas range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. It is mixed with some streaks and pockets of subsoil material. The subsoil is friable loam about 20 inches thick. The upper part is dark brown and brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Included with this soil in mapping are some small areas of sandy or gravelly soils on knobs. Also included are some areas of Storden soils, which are higher on the landscape than the Clarion soil. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

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

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

The land capability classification is IIe.

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

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. It is mixed with some streaks and pockets of subsoil material. The subsoil is friable loam about 18 inches thick. The upper part is dark brown, the next part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown and light olive brown, calcareous loam.

Included with this soil in mapping are some small areas of Storden soils, mainly on the steeper parts of the slopes. These soils make up about 5 percent of the unit.

Permeability is moderate in the Clarion soil, and runoff is medium. Available water capacity is high. The

Figure 5.—A cultivated area of Clarion loam, 2 to 5 percent slopes.

content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. This soil is moderately suited to corn and soybeans. It is well suited to small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. Contour farming and terraces are practical in some areas but are not feasible in undulating areas where slopes are short. Tilth generally can be easily

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

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

The land capability classification is IIIe.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes along streams and drainageways in the uplands. Slopes typically are short. Individual areas generally range from 2 to 10 acres in size, but a few are larger. They are long and narrow.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is friable loam about 14 inches thick. The upper part is brown, and the lower part is dark yellowish brown and yellowish brown. The substratum to a depth of about 60 inches is light olive brown, calcareous loam. In some areas the surface layer is thicker and darker.

Permeability is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.2 to 3.2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

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

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

The land capability classification is IIIe.

168B—Hayden loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex upland ridgetops and knolls. Individual areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is about 37 inches thick. The upper part is brown, friable loam; the next part is dark yellowish brown, firm clay loam; and the lower part is light olive brown, friable clay loam. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Included with this soil in mapping are a few small areas of soils that are wetter than the Hayden soil. These soils make up about 5 percent of the unit.

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

Many areas are cultivated. Some are used for woodland. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a moderate hazard. If erosion is controlled, row crops can be grown in most years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terraces are practical, but they are not so practical in undulating areas where slopes are short. Terrace cuts should not expose the subsoil. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to maintain tilth, and increases the rate of water infiltration.

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

A few small areas support native hardwoods. This soil is suited to trees. Seedlings survive and grow well if competing vegetation is controlled by careful site preparation or by spraying, cutting, or girdling.

The land capability classification is IIe.

168C2—Hayden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex upland side slopes and ridgetops. Individual areas range from 10 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown

loam about 8 inches thick. It is mixed with some streaks and pockets of brown clay loam from the subsoil. The subsoil is dark yellowish brown and brown, firm clay loam about 30 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, calcareous loam.

Permeability is moderate, 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 high supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. If erosion is controlled, row crops can be grown in many years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terraces are practical, but they are not so practical in undulating areas where slopes are short. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intensive management is needed on this soil than on the less eroded Hayden soils to maintain productivity and improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth and increases the runoff rate. 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 suited to trees. Eroded or formerly cultivated soils are better suited to conifers than to hardwoods. The hardwood seedlings require a better site and grow better if planted on uncultivated soils. If trees are planted, competing vegetation can be controlled by careful site preparation or by spraying or cutting.

The land capability classification is IIIe.

168D2—Hayden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex upland side slopes. Individual areas range from 5 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is grayish brown loam about 6 inches thick. It is mixed with some streaks and pockets of clay loam subsoil material. The subsoil is yellowish brown, firm clay loam about 28 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, calcareous loam.

Permeability is moderate, 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 high supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is fair.

Most areas are cultivated. A few are used for woodland or pasture. This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. If erosion is controlled, row crops can be grown in some years. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas contour farming and terraces are practical, but they are not so practical in undulating areas where slopes are short. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intensive management is needed on this soil than on the less eroded Hayden soils to maintain productivity and improve tilth.

This soil is suited to trees. Eroded or formerly cultivated soils are better suited to conifers than to hardwoods. The hardwood seedlings require a better site and grow better if planted on uncultivated soils. If trees are planted, competing vegetation can be controlled by careful site preparation or by spraying or cutting.

The land capability classification is IIIe.

168E—Hayden loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex upland side slopes. Individual areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is yellowish brown, firm clay loam about 24 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Storden soils on the upper side slopes. These soils are calcareous throughout. Also included are some areas where slopes are steep. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the Hayden soil, and runoff is rapid. 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 high supply

of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are used for hay and pasture. This soil is poorly suited to corn, soybeans, and small grain and moderately suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovation and reseeding. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few small areas support native hardwoods. This soil is suited to trees. Erosion and the equipment limitation are the main management concerns. Carefully selecting sites for logging trails or roads and laying out the trails or roads on the contour help to control erosion. Because of the slope, operating some equipment is difficult or hazardous.

The land capability classification is IVe.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on uplands and alluvial terraces. Individual areas range from 2 to 20 acres in size and are irregularly shaped or oval.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 11 inches thick. The subsoil is about 26 inches thick. The upper part is brown and dark yellowish brown, very friable fine sandy loam, and the lower part is yellowish brown, very friable loamy fine sand. The substratum to a depth of about 60 inches is yellowish brown fine sand.

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

Most areas are cultivated. Some are used for pasture or hay. Many small areas are cropped along with larger areas of adjacent soils that are better suited to crops. This soil is moderately suited to corn, soybeans, and small grain and to grasses or legumes for hay and pasture. Droughtiness is a limitation in most years unless rainfall is timely. Also, soil blowing is a hazard in areas where cultivated crops are grown. Windblown sand grains can damage newly seeded crops on this soil and on the adjoining soils unless the surface is protected by a plant cover. A system of conservation tillage that leaves crop residue on the surface, cover crops, and grassed waterways help to prevent excessive soil loss. The soil is poorly suited to terracing because the underlying coarse textured material is too close to the surface. Terrace cuts should not expose the coarse textured material in terrace channels. The soil warms up quickly in the spring, thus stimulating early plant growth. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the available water capacity.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and causes deterioration of the plant community. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during excessively wet or dry periods help to keep the pasture in good condition.

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

The land capability classification is IIIe.

175C—Dickinson fine sandy loam, 5 to 9 percent slopes. This moderately sloping, somewhat excessively drained soil is on convex upland slopes and stream terraces. Individual areas range from 4 to 20 acres in size and are broad and irregularly shaped.

Typically, the surface layer is very dark brown fine sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown and dark brown fine sandy loam about 9 inches thick. The subsoil is about 18 inches thick. The upper part is brown, very friable sandy loam, and the lower part is dark yellowish brown, very friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown fine sand. In some areas loamy glacial till is at a depth of about 40 inches or more.

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

Most areas are cultivated or used for hay and pasture. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, soil blowing and water erosion are hazards. Stripcropping, a system of conservation tillage that leaves crop residue on the surface, contour farming, terraces, or a combination of these practices help to prevent excessive soil loss. The soil is droughty in periods of below normal rainfall. Tilth generally can be easily

maintained. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain tilth.

If this soil is used for pasture, overgrazing causes surface compaction and increases the runoff rate. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during dry periods help to keep the pasture in good condition.

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

The land capability classification is IIIe.

201B—Coland-Terril complex, 1 to 5 percent slopes. These nearly level and gently sloping soils are on alluvial fans and in narrow drainageways in the uplands. The poorly drained Coland soil is near stream channels and is subject to flooding. The moderately well drained Terril soil is at the base of upland slopes along the boundary of the mapped areas. Individual areas of this unit range from 5 to 30 acres in size and are long and narrow. They are about 50 percent Coland soil and 40 percent Terril soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black clay loam about 17 inches thick. The subsurface layer also is black clay loam. It is about 29 inches thick. The subsoil is very dark gray, friable clay loam about 18 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled loam.

Typically, the Terril soil has a surface layer of very dark brown loam about 14 inches thick. The subsurface layer is very dark grayish brown loam about 22 inches thick. The subsoil to a depth of about 60 inches is dark brown and brown, friable loam.

Included with these soils in mapping are small areas of soils in depressions. These included soils are subject to ponding. They make up about 5 to 10 percent of the unit.

Permeability is moderate in the Coland and Terril soils. Runoff is slow on the Coland soil and medium on the Terril soil. Available water capacity is high in both soils. The Coland soil has a seasonal high water table. It has a high shrink-swell potential. The content of organic matter is about 5 to 7 percent in the surface layer of the Coland soil and 3 to 4 percent in the surface layer of the Terril soil. The subsoil of the Coland soil generally has a medium supply of available phosphorus and a very low or low supply of available potassium. The subsoil of the Terril soil has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is fair in the Coland soil and good in the Terril soil.

Most areas are cultivated. Many small areas are cropped along with areas of the adjacent soils. Some areas are used for pasture. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Wetness and brief periods of flooding are the main management concerns. Some areas receive runoff from side slopes and thus are subject to siltation. Diversions and channel improvements help to control floodwater and the runoff from the adjacent side slopes. Grassed waterways help to control erosion and prevent gullying. A drainage system improves the timeliness of fieldwork and helps to maintain tilth.

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces 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.

203—Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces. Slopes generally are plane or concave but in places are slightly convex. Individual areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 11 inches thick. The subsoil is friable loam about 16 inches thick. The upper part is dark grayish brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown and grayish brown sand and gravelly sand. In some areas it is loamy sand or sand in which the content of gravel is less than 5 percent.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It has a high water table during wet periods but becomes droughty after fairly brief dry periods. Tile drains generally are not needed because of the droughtiness during much of the growing season. Tilth generally can be easily

maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

Drought is a hazard if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Generally, the trees and shrubs that can withstand the seasonal wetness as well as the droughtiness should be selected for planting. A surface mulch conserves moisture. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and if irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIs.

221—Palms muck, 0 to 1 percent slopes. This level, very poorly drained soil is in depressions on uplands. It is subject to ponding. Individual areas are dominantly 10 to 40 acres in size but range to 300 acres. They are circular.

Typically, the surface layer is black muck about 16 inches thick. The subsurface layer also is black muck. It is about 28 inches thick. The substratum to a depth of about 60 inches is dark gray, calcareous silt loam.

Included with this soil in mapping are soils having organic layers that are less than 16 inches thick. These soils are in landscape positions similar to those of the Palms soil. They make up about 15 percent of the unit.

Permeability is moderately rapid in the organic layers of the Palms soil and moderate in the substratum. The soil has a seasonal high water table near or above the surface. 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. Tilth generally is good.

If adequately drained by tile, this soil is moderately suited to corn, soybeans, and specialty crops and to grasses for hay and pasture. Undrained areas are well suited to wetland wildlife habitat. Lodging is a problem if small grain is grown on this soil. Legumes commonly are winter killed or drowned. If cultivated crops are grown, soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the surface throughout the year and winter cover crops help to prevent excessive soil loss. Early frost is a hazard in the fall. Subsidence can occur in this organic soil. It should be considered when the depth of tile is determined.

Wetness is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings. Installing a drainage system and selecting species that can withstand wetness help to overcome this limitation.

The land capability classification is IIIw.

236B—Lester loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on knolls and convex side slopes along streams in the uplands. Individual areas range from 2 to 10 acres in size, but a few are larger than 20 acres. They are irregularly shaped.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsoil is about 31 inches thick. The upper part is dark yellowish brown, friable loam; the next part is dark yellowish brown and yellowish brown, firm clay loam; 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 loam.

Included with this soil in mapping are some areas of nearly level, somewhat poorly drained soils. These soils make up about 5 percent of the unit.

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

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

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

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

The land capability classification is IIe.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes along streams in the uplands. Individual areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish

brown loam about 8 inches thick. It is mixed with some streaks and pockets of dark yellowish brown clay loam subsoil material. The subsoil is dark yellowish brown and yellowish brown clay loam about 30 inches thick. It is dominantly firm, but in the upper few inches it is friable. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In uncultivated areas, the surface layer is very dark gray loam about 5 inches thick and the subsurface layer is dark grayish brown loam about 6 inches thick.

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

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

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

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

The land capability classification is IIIe.

236D2—Lester loam, 9 to 14 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes along streams in the uplands. Individual areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. It is mixed with some streaks and pockets of dark yellowish brown clay loam subsoil material. The subsoil is dark yellowish brown and yellowish brown clay loam about 30 inches thick. It is dominantly firm, but in the upper few inches it is friable. The substratum to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In uncultivated areas, the surface layer is very dark gray loam about 5 inches thick and the subsurface layer is dark grayish brown loam about 6 inches thick.

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

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

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

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

The land capability classification is IIIe.

259—Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil generally is in low areas on stream terraces. Individual areas are irregularly shaped. They generally range from 5 to 20 acres in size, but some are 40 acres or more.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark gray loam about 12 inches thick. The subsoil is olive gray, mottled, friable loam about 14 inches thick. The substratum to a depth of about 60 inches is olive gravelly sand with mottles.

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

phosphorus and potassium. Tilth generally is fair.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It not only is seasonally wet but also is slightly droughty during some periods because of the gravelly substratum. Tile drains remove excess water. In some years, however, the drainage system removes the water that the crop needs later in the growing season. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

The seasonal high water table is the main limitation if this soil is used for the trees and shrubs grown as windbreaks or ornamental plantings, but the droughtiness also is a limitation in some years. Almost any species suited to the climate can be grown if a drainage system is installed to reduce the wetness and irrigation water is applied as needed to overcome the droughtiness.

The land capability classification is IIw.

288—Ottosen clay loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil is on slightly convex knolls in the uplands. Individual areas range from 2 to 10 acres in size, but a few are 25 acres or more. They are irregularly shaped.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 6 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable clay loam about 20 inches thick. The substratum to a depth of about 60 inches is light brownish gray, mottled, calcareous loam and loam. In places the subsoil has thin layers of silty clay.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The seasonal wetness can delay fieldwork, but it can be overcome by installing tile drains. Tilth generally can be easily maintained. Cultivating or grazing when the soil is wet, however, causes surface compaction. Returning crop residue to the soil or regularly adding other organic material helps to control erosion and prevent surface crusting and increases the rate of water infiltration.

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

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 on stream benches. Individual areas generally range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer also is very dark brown loam about 8 inches thick. The subsoil is very dark grayish brown to brown, friable loam and sandy loam about 20 inches thick. The substratum to a depth of about 60 inches is grayish brown gravelly sand.

Included with this soil in mapping are some areas of sandy and gravelly soils on small knobs and some small areas of poorly drained soils on the lower parts of the landscape. Included soils make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the substratum. Available water capacity is moderate, and runoff is slow. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the sandy and gravelly substratum. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility, conserves moisture, and helps to control soil blowing.

If this soil is used for pasture, overgrazing reduces the extent of the protective plant cover and increases the susceptibility to soil blowing.

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

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 stream terraces. Individual areas range from 5 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown loam

about 8 inches thick. The subsurface layer is very dark brown loam about 7 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 17 inches thick. The substratum to a depth of about 60 inches is yellowish brown, calcareous loamy sand that contains fine gravel. In places the depth to sand or gravel is more than 40 inches.

Permeability is moderate in the upper part of the profile 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 a very low or low supply of available potassium. Tilth generally is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, a cropping sequence that includes grasses and legumes, and contour farming help to prevent excessive soil loss.

If this soil is used for pasture, overgrazing causes surface compaction and increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture in good condition.

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

The land capability classification is IIe.

339—Truman silt loam, 0 to 2 percent slopes. This gently sloping, well drained soil is on or adjacent to outwash plains. Individual areas are irregular in shape, and most areas range from 3 to 10 acres in size.

Typically, the surface layer is very dark brown silt loam about 10 inches thick. The subsurface layer is silt loam about 26 inches thick. The upper part is very dark grayish brown, and the lower part is dark brown. The subsoil is silt loam about 24 inches thick. It is friable. The upper part is brown, the next part is dark yellowish brown, and the lower part is yellowish brown. In places the substratum is sandy loam.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tilth generally can be easily maintained.

The land capability classification is I.

355—Luther loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in flat or slightly convex areas on uplands. Individual areas range from 5 to 20 acres in size, but a few areas are 50 acres or more. They are irregularly shaped.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsurface layer is grayish brown and dark grayish brown loam about 15 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable and firm clay loam about 30 inches thick. The substratum to a depth of about 60 inches is dark grayish brown, mottled, calcareous loam.

Included with this soil in mapping are areas of poorly drained soils. These soils are lower on the landscape than the Luther soil. They make up about 25 percent of the unit.

Permeability is moderately slow in the Luther soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 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. Tilth generally is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In periods of above average rainfall, a few of the more level areas are wet.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Restricted use during wet periods helps to keep the pasture in good condition.

Some areas support native hardwoods. The hazards or limitations that affect planting are slight if the proper species are selected and competing vegetation is controlled or removed.

The land capability classification is I.

356G—Storden-Hayden complex, 25 to 50 percent slopes. These very steep, well drained soils are on upland side slopes adjacent to major streams. Most areas are dissected by many gullies and deep drainageways. Individual areas range from 5 to 30 acres in size and are irregularly shaped. They are about 40 percent Storden loam and about 40 percent Hayden loam. The calcareous Storden soils are on west- and south-facing slopes. The Hayden soils are on north- and east-facing side slopes and ridgetops. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Storden soil is dark brown, calcareous loam about 9 inches thick. The substratum to a depth of about 60 inches is dark

yellowish brown, mottled, calcareous loam.

Typically, the surface layer of the Hayden soil is very dark grayish brown loam about 3 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, friable loam and clay loam. The substratum to a depth of about 60 inches is yellowish brown, friable, calcareous loam.

Included with these soils in mapping are some areas of soils that are severely eroded. Also included are small areas of gravelly outwash that has a lower available water capacity than the Storden and Hayden soils. Included soils make up less than 20 percent of the unit.

Permeability is moderate in the Storden and Hayden soils, and runoff is rapid. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer of the Storden soil and 2 to 3 percent in the surface layer of the Hayden soil. The substratum of the Storden soil has a very low supply of available phosphorus and potassium, and the subsoil of the Hayden soil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth generally is good in both soils.

Most areas are wooded or are used as permanent pasture. These soils are moderately suited to trees, poorly suited to pasture, and well suited to woodland wildlife (fig. 6). They are not suited to cultivation. A few areas have been cleared for pasture, but forage production is low. The soils are susceptible to severe erosion if not protected. Erosion can be kept to a minimum by maintaining a good ground cover.

Erosion is a severe hazard if these soils are used for the trees and shrubs grown as windbreaks or ornamental plantings. Temporary cover crops or a cover of mulch helps to control erosion.

The land capability classification is VIIe.

388—Kossuth silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flats, in swales, and in low-gradient drainageways. Individual areas generally range from 5 to 40 acres in size and are long and narrow, but a few are 100 acres or more and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark gray silty clay loam about 13 inches thick. The subsoil is olive gray, friable silty clay loam about 17 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam.

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

Permeability is moderately slow in the upper part of the Kossuth soil and moderate in the lower part. Runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The 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. Tilth generally is fair.

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

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

The land capability classification is IIw.

485—Spillville loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land. It is subject to flooding. Individual areas range from 5 to about 20 acres in size and are long and narrow.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black, very dark brown, very dark gray, and very dark grayish brown loam about 42 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam. In places the surface layer is sandy loam.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Some areas are used for pasture or hay. Overgrazing or grazing when the soil is too wet causes surface

Figure 6.—An area of Storden-Hayden complex, 25 to 50 percent slopes, used as woodland and as wildlife habitat.

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 IIw.

506—Wacousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Individual areas range from 10 to 40 acres in size, but a few are as large as 70 acres. They are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 6 inches thick. The subsoil is olive gray, mottled, friable silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous silty clay loam and silt loam. In some places the surface layer is mucky silty clay loam. In other places the substratum has lenses of loamy sand and sand.

Permeability is moderate, and runoff is ponded. Available water capacity is very high. The soil has a seasonal high water table near or above the surface. The 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. Tilth generally is fair.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas deep cuts are needed to provide suitable outlets. Maintaining tilth generally is difficult. Cultivating when the soil is too wet causes cloddiness and a poor seedbed.

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

The land capability classification is IIIw.

507—Canisteo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is on flats and in swales on uplands. Individual areas range from 10 to 100 acres in size, but a few are 300 acres or more. They are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer also is black, calcareous silty clay loam about 9 inches thick. The subsoil is friable, calcareous, mottled clay loam about 16 inches thick. The upper part is dark gray, and the lower part is olive gray. The substratum to a depth of about 60 inches is olive gray, mottled, calcareous loam. In places the surface layer is not calcareous.

Included with this soil in mapping are some small areas of the very poorly drained Okoboji soils in depressions and the highly calcareous Harps soils around the depressions. Included soils make up about 10 percent of the unit.

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

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the rate of water infiltration by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIw.

508—Calcousta silty clay loam, 0 to 1 percent slopes. This level, very poorly drained, calcareous soil is in upland depressions. It is subject to ponding. Individual areas range from 10 to 20 acres in size, but a few are as large as 70 acres. They are irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 6 inches thick. The subsoil is olive gray, mottled, friable silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled silty clay loam. The soil is calcareous throughout. In some places the surface layer is mucky silty clay loam. In other places the substratum has lenses of loamy sand and sand.

Permeability is moderate, and runoff is ponded. Available water capacity is very high. The soil has a seasonal high water table near or above the surface. The 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 potassium. Tilth generally is fair.

Most areas are cultivated. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove excess ponded water. Tile drains remove excess subsurface water. In many areas

deep cuts are needed to provide suitable outlets. Maintaining tilth generally is difficult. Cultivation when the soil is too wet causes cloddiness and a poor seedbed. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIIw.

536—Hanlon fine sandy loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on bottom land. It is subject to flooding. Individual areas generally are 5 to 40 acres in size and are elongated.

Typically, the surface layer is very dark brown fine sandy loam about 12 inches thick. The subsurface layer to a depth of about 60 inches is very dark brown and very dark grayish brown fine sandy loam.

Included with this soil in mapping are small areas of excessively drained, stratified, sandy soils. If cropped, these soils are droughty. They make up about 5 to 10 percent of the unit.

Permeability is moderately rapid in the Hanlon soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is good.

Most areas are cultivated. If adequately protected from flooding, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Levees and dikes help to control the floodwater. Tilth generally can be easily maintained.

Pastured areas can be overstocked because this soil is somewhat droughty during extended dry periods. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIs.

559—Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in concave positions on stream terraces. Individual areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is black clay loam about 7 inches thick. The subsurface layer also is black clay loam. It is about 13 inches thick. The subsoil is about 14 inches thick. It is dark gray and olive gray, mottled, friable clay loam. The substratum to a depth of about 60 inches is olive gray gravelly loamy coarse sand. The soil is calcareous throughout.

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

Some areas are cultivated, and some are used for pasture. If drained, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The soil is seasonally wet, but it also is slightly droughty during some periods because the available water capacity is very low in the sandy and gravelly substratum. Tile drains remove excess subsurface water. In some years, however, the drainage system removes the water that the crop needs later in the growing season. Special care generally is needed to maintain tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. The high content of lime in the soil adversely affects the availability of some of the plant nutrients. Chisel plowing increases the rate of water infiltration by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIw.

638D2—Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on knobs, ridgetops, and side slopes in the uplands. Slopes typically are short. Clarion soils are on ridgetops and the lower side slopes, and the calcareous Storden soils are on convex knobs and the upper side slopes. Individual areas of this unit are about 60 percent Clarion soil and 40 percent Storden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 8 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is friable loam about 18 inches thick. The upper part is brown, and the lower part is

dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

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

Permeability is moderate in the Clarion and Storden soils, and runoff is medium. Available water capacity is high. The content of organic matter is about 2.2 to 3.2 percent in the surface layer of the Clarion soil and 1.7 to 2.7 percent in the surface layer of the Storden soil. The subsoil of the Clarion soil and the substratum of the Storden soil generally have a very low supply of available phosphorus and potassium. Tilth generally is good in both soils.

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

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, results in surface compaction and a poor stand and increases the runoff rate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

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

The land capability classification is IIIe.

828B—Zenor sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on upland knolls and side slopes in glacial outwash areas. Individual areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The subsoil is brown and dark yellowish brown, very friable sandy loam about 29 inches thick. The substratum to a depth of about 60 inches is yellowish brown gravelly sand.

Included with this soil in mapping are a few small areas of Storden soils. These soils are calcareous throughout. They are in landscape positions similar to those of the Zenor soil. They make up about 10 percent of the unit.

Permeability is moderately rapid in the upper part of the Zenor soil and very rapid in the lower part. Runoff is slow. Available water capacity is moderate. 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 a very low supply of available potassium. Tilth generally is fair.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It tends to be droughty. A system of conservation tillage that leaves crop residue on the surface, contour farming, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture.

If this soil is used for pasture, overgrazing increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture in good condition.

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

The land capability classification is IIIe.

828C2—Zenor sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, somewhat excessively drained soil is on upland knolls and side slopes in glacial outwash areas. Individual areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is brown and yellowish brown, very friable sandy loam about 20 inches thick and contains fine gravel. The substratum to a depth of about 60 inches is yellowish brown and brownish yellow gravelly loamy sand.

Included with this soil in mapping are a few small areas of Storden soils. These soils are calcareous throughout. They are in positions on the landscape similar to those of the Zenor soil. They make up about 15 percent of the unit.

Permeability is moderately rapid in the upper part of the Zenor soil and very rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a low supply of

available phosphorus and a very low supply of available potassium. Tilth generally is fair.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It tends to be droughty. A system of conservation tillage that leaves crop residue on the surface, contour farming, stripcropping, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture. More intensive management is needed on this soil than on the less eroded Zenor soils to maintain productivity and improve tilth.

If this soil is used for pasture, overgrazing increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture in good condition.

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

The land capability classification is IIIe.

829D2—Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on side slopes and knolls in upland glacial outwash areas. The somewhat excessively drained Zenor soil makes up about 60 percent of the unit, and the well drained, calcareous Storden soil makes up about 40 percent. Individual areas are irregular in shape and range from 2 to 25 acres in size. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Zenor soil has a surface layer of dark brown sandy loam about 7 inches thick. It is mixed with some streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, very friable sandy loam about 20 inches thick. The substratum to a depth of about 60 inches is yellowish brown gravelly coarse sand.

Typically, the Storden soil has a surface layer of dark brown, calcareous loam about 7 inches thick. It is mixed with some streaks and pockets of yellowish brown substratum material. The substratum to a depth of about 60 inches is yellowish brown and brownish yellow, calcareous loam.

Permeability is moderately rapid in the upper part of the Zenor soil and very rapid in the lower part. It is moderate in the Storden soil. Runoff is medium on both soils. Available water capacity is moderate in the Zenor soil and high in the Storden soil. The content of organic matter is about 1 to 2 percent in the surface layer of the Zenor soil and 1.7 to 2.7 percent in the surface layer of the Storden soil. The supply of available phosphorus is low in the subsoil of the Zenor soil and very low in the substratum of the Storden soil. The supply of available potassium is very low in both soils. Tilth generally is fair.

Most areas are cultivated. Some are used for pasture. These soils are poorly suited to corn, soybeans, and small grain and are moderately suited to grasses and legumes for hay and pasture. Erosion is a severe hazard. It can be controlled, however, by contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops. Returning crop residue to the soil or regularly adding other organic material improves fertility and helps to control erosion and conserve moisture.

A cover of pasture plants or hay is effective in controlling erosion. Pastures commonly are renovated by planting a cultivated crop one year and reestablishing the pasture the next year. Forage stands can be maintained for a period of years if grazing is controlled, the pasture is reseeded, and fertilizer is applied as needed.

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

The land capability classification is IVe.

956—Harps-Okoboji complex, 0 to 1 percent slopes. These nearly level soils are in depressions and the adjacent rims of depressions in the uplands. The poorly drained, calcareous Harps soil is on the rims of depressions. The very poorly drained Okoboji soil is in depressions. It is subject to ponding. Individual areas range from 5 to more than 300 acres in size and are irregularly shaped. They are about 45 percent Harps soil and about 40 percent Okoboji soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Harps soil is black clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 12 inches thick. The subsoil is light olive gray and olive gray, mottled, friable loam about 21 inches thick. The substratum to a depth of about 60 inches is light olive gray, mottled loam. The soil is calcareous throughout.

Typically, the surface layer of the Okoboji soil is black silty clay loam about 16 inches thick. The subsurface layer also is black silty clay loam. It is about 11 inches thick. The subsoil is dark gray and gray, mottled, friable silty clay loam about 15 inches thick. The substratum to a depth of about 60 inches is light gray and gray, mottled silty clay loam.

Included with these soils in mapping are small areas of the poorly drained, calcareous Canisteo soils on flats and in swales. These included soils make up about 15 percent of the unit.

Permeability is moderate in the Harps soil and moderately slow in the Okoboji soil. Runoff is slow on the Harps soil and ponded on the Okoboji soil. Both soils have a seasonal high water table. Available water capacity is high in the Harps soil and very high in the Okoboji soil. The shrink-swell potential is high in the Okoboji soil. The content of organic matter is about 4.5 to 5.5 percent in the surface layer of the Harps soil and 9 to 12 percent in the surface layer of the Okoboji soil. The subsoil of both soils has a very low supply of available phosphorus and potassium. Tilth generally is fair.

Most areas are cultivated. If drained, these soils are moderately suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Surface drains remove ponded water. Tile drains remove excess subsurface water. Cultivation when the soil is too wet causes surface compaction and cloddiness. Returning crop residue to the soil helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The availability of plant nutrients is limited by an excessive amount of lime in the Harps soil. In some areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used and applications of iron compound are needed.

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

The land capability classification is IIIw.

1135—Coland clay loam, channeled, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains along the larger streams. It is subject to flooding. Individual areas range from 10 to 50 acres in size and are long and narrow.

Typically, the surface layer is black clay loam about 17 inches thick. The subsurface layer is clay loam about 29 inches thick. The upper part is black, and the lower part is very dark gray. The upper part of the substratum is dark gray clay loam. The lower part to a depth of about 60 inches is gray loam. In places the surface soil is only 18 inches thick. In some places the surface layer is silty clay loam. In other places it is calcareous.

Included with this soil in mapping are small areas of sandy soils, generally at the slightly higher elevations. These soils make up about 10 percent of the unit.

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

Almost all of the acreage is used for pasture or woodland. This soil is generally unsuited to corn, soybeans, and small grain and is poorly suited to grasses and legumes for hay and pasture. The frequent flooding is the main hazard. Also, many areas are inaccessible to farm machinery because of the old stream channels. The grasses and legumes planted for hay and pasture should be those that can withstand the wetness and the flooding.

This soil is well suited to wetland wildlife habitat. It is poorly suited to trees. The species planted should be those that are tolerant of the flooding.

The land capability classification is Vw.

1221—Palms muck, ponded, 0 to 1 percent slopes. This level, very poorly drained soil is in upland depressions. It is subject to ponding. Individual areas range from 2 to 10 acres in size and are circular.

Typically, a few inches of partly decomposed plant residue is at the surface. The surface layer is black muck about 10 inches thick. The subsurface layer also is black muck. It is about 20 inches thick. The subsoil is about 13 inches thick. The upper part is very dark gray, friable silt loam, and the lower part is very dark gray, friable silty clay loam. The substratum to a depth of about 60 inches is very dark gray and olive gray clay loam.

Permeability is moderately rapid in the upper organic layers and moderate in the lower part of the profile. Runoff is ponded. Available water capacity is very high. The soil has a seasonal high water table near or above the surface. 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 supports aquatic vegetation. It is suited to wetland wildlife habitat (fig. 7). The trees and shrubs planted in areas of wildlife habitat should be those that are tolerant of an extremely wet soil.

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

The land capability classification is Vw.

Figure 7.—An area of Palms muck, ponded, 0 to 1 percent slopes, used as a wildlife refuge.

1507—Brownton silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in shallow swales on uplands. Individual areas range from 10 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 15 inches thick. The subsurface layer is calcareous silty clay loam about 13 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is gray, mottled, firm silty clay loam about 11 inches thick. The substratum to a depth of about 60 inches is olive gray, calcareous, mottled clay loam. In places the surface layer is not calcareous.

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

Permeability is slow in the Brownton soil, and runoff

is slow to ponded. Available water capacity is high. The soil has a seasonal high water table. The 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. Tilth generally is fair.

Most areas are cultivated. If drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Tile drains remove excess subsurface water. Special care generally is needed to maintain tilth in the surface layer. Cultivating when the soil is too wet causes surface compaction and cloddiness. Chisel plowing increases the rate of water infiltration by making the surface more pervious to water. Returning crop residue to the soil or regularly adding other organic material helps to control soil blowing and prevent surface crusting and increases the rate of water infiltration. The high content of lime in the soil adversely affects the availability of plant nutrients. In areas where soybeans are grown, varieties that are resistant to iron chlorosis should be used.

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

The land capability classification is IIw.

1536—Hanlon fine sandy loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on natural levees and first bottoms that are dissected by meandering stream channels. It is subject to flooding. Individual areas generally are more than 25 acres in size and are elongated.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown fine sandy loam about 30 inches thick. The subsoil is very dark grayish brown, very friable sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is dark grayish brown sandy loam. In places the soil is overlain by recently deposited, stratified sandy sediments.

Included with this soil in mapping are small areas of Coland and Spillville soils. These soils have more clay throughout than the Hanlon soil and are wetter. They make up about 20 percent of the unit.

Permeability is moderately rapid in the Hanlon soil, and runoff is slow. Available water capacity is high. The soil has a seasonal high water table. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is good.

Most areas are used as woodland or pasture. This soil generally is unsuited to cultivated crops because of meandering stream channels and the hazard of flooding. Levees and dikes help to control the floodwater. Tile drains function satisfactorily if adequate outlets are available.

Pastured areas can be overstocked because this soil is somewhat droughty during extended dry periods. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is Vw.

1585—Spillville-Coland complex, channeled, 0 to 2 percent slopes. These nearly level soils are on flood plains that are dissected by meandering stream channels. They are subject to flooding. The somewhat poorly drained Spillville soil makes up about 50 percent of the unit, and the poorly drained Coland soil makes up about 30 percent. Individual areas range from 5 to 30 acres in size and are long and narrow. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Spillville soil is black loam about 16 inches thick. The subsurface layer is black, very dark brown, and very dark grayish brown, friable loam about 30 inches thick. The substratum to a depth of about 60 inches is dark grayish brown loam.

Typically, the surface layer of the Coland soil is black clay loam about 17 inches thick. The subsurface layer is clay loam about 29 inches thick. The upper part is black, and the lower part is gray. The substratum to a depth of about 60 inches is olive gray clay loam.

Included with these soils in mapping are areas of Hanlon soils. These included soils contain more sand than the Spillville and Coland soils. They are in landscape positions similar to those of the Spillville and Coland soils. They make up about 15 percent of the unit.

Permeability is moderate in the Spillville and Coland soils, and runoff is slow. The soils have a seasonal high water table. Available water capacity is high. The shrink-swell potential is high in the Coland soil. The content of organic matter is about 4 to 5 percent in the surface layer of the Spillville soil and 5 to 7 percent in the surface layer of the Coland soil. The subsoil of both soils generally has a low supply of available phosphorus and a very low supply of available potassium. Tilth generally is fair.

Most areas of these soils are used as pasture. A few areas are far from the present stream channel and are not flooded frequently. Most areas of these soils are unsuited to cultivated crops but are moderately suited to pasture.

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces 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 Vw.

4000—Urban land. This map unit is on nearly level bottom land and nearly level and gently sloping uplands and terraces in and around Webster City. Individual areas range from 5 to more than 30 acres in size and are rectangular or irregularly shaped.

This map unit is covered by streets, parking lots, buildings, shopping centers, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. In many areas the structures are built on cut or fill material that is 2 to more than 4 feet thick. Most areas are drained by sewer systems, gutters, and drainage tile.

No land capability classification is assigned.

5010—Pits, sand and gravel. These pits are dominantly on stream benches but in some areas are on uplands. They generally are no longer mined. They 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. Most areas have a seasonal high water table. Also, the low areas are ponded during wet periods. Stones and cobbles are commonly on the surface. The content of organic matter is less than 1 percent in the surface layer. Reaction typically is moderately alkaline.

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

No land capability classification is assigned.

5040—Orthents, loamy. These nearly level to strongly sloping soils are used as borrow areas for construction. In some areas the original soil has been removed to a depth of 5 to more than 20 feet, and in other areas 4 to 10 inches of topsoil has been redistributed, commonly in an uneven pattern. The soils range from excessively drained to moderately well drained, depending on the kind of material in which the soils formed and the extent to which the borrow area is restored. Individual areas generally range from 6 to 50 acres in size.

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

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

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

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

No land capability classification is assigned.

5043—Aquents, loamy, reclaimed, 0 to 2 percent slopes. These nearly level, poorly drained soils are in areas that have been disturbed during construction and road building. Most areas are adjacent to highway overpasses and have been used as borrow areas. Individual areas range from 5 to 80 acres in size and are square.

The soil material varies, but most areas have 6 to 10 inches of dark topsoil material, which typically is loam or clay loam. Generally, most of the subsoil has been removed. The underlying layer is calcareous, loamy glacial till.

Permeability and runoff are slow. Available water capacity generally is moderate. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. Reaction typically is neutral or slightly acid in the surface layer and moderately alkaline in the underlying layer. The supply of available phosphorus and potassium is very low. Internal drainage is poor.

Most areas are used for cultivated crops. A few areas are used for hay or pasture. These soils are moderately suited to corn and soybeans. Tile drainage helps to

remove excess water. Chisel plowing in the fall increases the rate of water infiltration. Cultivating when the soils are wet causes compaction and cloddiness.

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 or 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 expenditure 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 302,000 acres in the survey area, or nearly 82 percent of the total acreage, meets the soil requirements for prime farmland. About 288,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for an estimated two-thirds of the county's total agricultural income each year.

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

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

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

Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

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

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

About 315,000 acres in Wright County, or 85 percent of the total acreage, is used for crops. The main crops are corn, soybeans, and oats. Legume hay and grass-legume hay are the major hay crops. Minor crops include sudangrass, which is used for pasture, and sorghum, which is mainly harvested for grain. The acreage used for pasture has decreased markedly in recent years as grain production has increased. Productivity could be increased and soil conservation enhanced by application of crop production technology to all of the cropland in the county. This soil survey, which gives the basic characteristics of each kind of soil, can greatly aid in the application of this technology

Because many of the soils in the county are poorly drained or very poorly drained, the major management concerns on about 50 percent of the acreage are measures that improve drainage. Biscay, Brownton, Canisteo, Coland, Kossuth, Talcot, and Webster soils are poorly drained, and Knoke, Okoboji, Palms, and Wacousta soils are very poorly drained. A drainage system is needed if these soils are cultivated. Biscay and Talcot soils are underlain by sand and gravel and are on terraces. Coland soils are on bottom land. The nearly level Brownton, Canisteo, Kossuth, and Webster soils are on uplands. Knoke, Okoboji, Palms, and Wacousta soils are in depressions.

Subsurface tile is the primary method of drainage. The tiles drain excess water into large drainage ditches, which in turn empty into natural streams (fig. 8). Shallow ditches are also used to drain some of the soils that are in depressions.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drains and a system that controls the runoff

Figure 8.—A drainage ditch in an area of Canisteo silty clay loam, 0 to 2 percent slopes. Drainage ditches provide outlets for subsurface tile drains.

from the slopes at the higher elevations and drainage tile is needed in many areas of the somewhat poorly drained and poorly drained soils that are intensively row cropped. Drains should be more closely spaced in areas of the moderately slowly permeable or slowly permeable soils than in areas of the more rapidly

permeable soils. Locating adequate outlets for tile drainage systems is difficult in many areas.

Water erosion is a hazard on the more sloping soils, such as Bode, Clarion, Lester, and Storden soils. Contour farming, terraces, and a system of conservation tillage that leaves a protective amount of crop residue on the surface help to control erosion. On short, steep, and irregular slopes, however, contour farming and terraces are not practical. In these areas a cropping system that provides a protective plant cover or a system of conservation tillage is needed.

Soil blowing is a hazard in some areas unless the surface is protected. It can damage some soils, such as Dickinson soils, in a few hours if winds are strong and the soils are dry and have no plant cover or surface mulch. Crops on these soils and on the adjacent soils are often damaged by blowing sand. Many of the nearly level soils that have more clay, such as Brownton, Canisteo, Harps, and Webster soils, also are damaged by soil blowing. The damage generally occurs when the soils are cropped to soybeans and then tilled in the fall. Maintaining a plant cover or a surface mulch and keeping the surface rough by applying proper tillage methods minimize the damage caused by soil blowing.

Loss of the surface layer through erosion is damaging for many reasons. 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 to soils that have a restricted root zone. It can result in the pollution of streams by sediment. Controlling erosion improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing the pollution of streams.

Erosion control provides a protective plant cover, reduces the runoff rate, and increases the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods can hold soil losses to an amount that will not reduce the productive capacity of the soils. On livestock farms, where part of the acreage is pasture and hayland, including legumes and grasses in the cropping system provides nitrogen and improves tilth for the following crop and reduces the hazard of erosion on the more sloping soils.

A system of conservation tillage that leaves crop residue on the surface is effective in controlling erosion. Following are examples of the major kinds of conservation tillage. No-till is a system in which the seedbed is prepared and the seed planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the surface. Strip-till, or till-plant, also is a system in which the seedbed is prepared and the seed planted in one operation. Tillage is limited to a strip not wider than one-third of the row. A protective cover is left on two-thirds of the surface. Strip-till or no-till systems can be adapted to most of the soils in the survey area. They are difficult to practice, however, on soils that have a clayey surface layer. Chisel-disk, or rotary tillage, is a system in which the soil is loosened throughout the field and part of the crop residue is incorporated into the soil. Seedbed preparation and planting may be one or separate operations. Ridge-till includes elements of both the no-till and strip-till systems. Seeds are planted on ridges 4 to 6 inches high. On poorly drained soils, ridge-till planting may improve early seedbed conditions and allow timely planting. Weed control is accomplished with a combination of herbicides and cultivation.

The fertility level varies widely in the soils of Wright County. Most of the well drained soils on uplands are naturally acid, but the Storden soils are alkaline. The poorly drained soils generally are neutral or alkaline. On acid soils applications of ground limestone are needed to promote good plant growth. The supply of available potash and phosphorus is particularly low in Harps and other wet, alkaline soils. On all soils the kinds and amounts of lime and fertilizer needed should be based on the results of soil tests, the needs of the crop, and the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime that should be applied.

Tilth is an important factor affecting the germination of seeds and the infiltration of water. Soils with good tilth generally have a high content of organic matter and are granular and porous. Regular additions of crop residue, manure, and other organic materials improve soil structure and tilth and help to prevent the formation of crust.

Fall plowing is not suitable on many of the soils in the county. Erosion is a hazard on the more sloping soils and many of the nearly level soils that have been cropped to soybeans if these soils are plowed in the fall.

Many field crops that are suited to the soils and climate in Wright County are not commonly grown. These include wheat, grain sorghum, sunflowers, potatoes, sugar beets, popcorn, pumpkins, sugar cane, peas, and sweet corn. Rye, barley, buckwheat, and flax could also be grown, and grass seed could be produced from bromegrass, redtop, bluegrass, switchgrass, big bluestem, and indiangrass.

Specialty crops are grown commercially to a limited extent in the county. Most of the well drained soils are suitable for orchards. Soils in the lower areas, however, where frost is frequent and drainage is poor, generally are poorly suited to early vegetables, small fruits, and orchards. The latest information about managing the soils for specialty crops can be obtained from local

offices of the Cooperative Extension Service and the Soil Conservation Service.

Most of the permanent pasture in the county supports bromegrass, bluegrass, and orchardgrass. Other suitable cool-season grasses include tall fescue, timothy, and reed canarygrass. Warm-season grasses that are adapted to the survey area include switchgrass, big bluestem, and indiangrass. Alfalfa and red clover are the legumes commonly grown for hay. They are also used in combination with orchardgrass, bromegrass, or timothy for hay and pasture. Birdsfoot trefoil is used in combination with bluegrass, orchardgrass, bromegrass, or tall fescue for pasture. Other legumes that are suitable for pasture are crownvetch, ladino clover, and alsike clover.

Maximum production of all pasture species can be achieved if the pasture is properly managed. Measures that prevent overgrazing are needed, especially on steep slopes, to increase the rate of water infiltration and to prevent surface compaction and gully erosion. Applications of fertilizer, weed and brush management, rotation grazing or deferred grazing, proper stocking rates, and adequate livestock watering facilities help to keep the pasture in good condition.

Erosion is a hazard if the plant cover is removed when the more sloping pastures are renovated. Interseeding grasses and legumes into the existing sod eliminates the need for removing the plant cover during seedbed preparation. If cultivated crops are to be grown prior to seeding, soil losses can be reduced by conservation tillage, contour farming, and grassed waterways.

Yields Per Acre

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

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

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

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

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

Land Capability Classification

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the 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, wildlife habitat, or recreation.

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

Windbreaks and Environmental Plantings

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

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

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

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

Recreation

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 sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

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

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

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

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking

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

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

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

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

Wildlife Habitat

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. 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.

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 should 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 or 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 kinds 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 evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and 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, a cemented pan, 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 depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 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 or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of 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 or to a cemented pan, and flooding affect absorption of the

effluent. Large stones and bedrock or a cemented pan interfere with installation.

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

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

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

Excessive seepage resulting from rapid permeability in 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, bedrock, and cemented pans 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 or to a cemented pan, 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, a cemented pan, 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 to 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, a 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 a 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 depth to the water table is less than 1 foot. These soils 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, 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

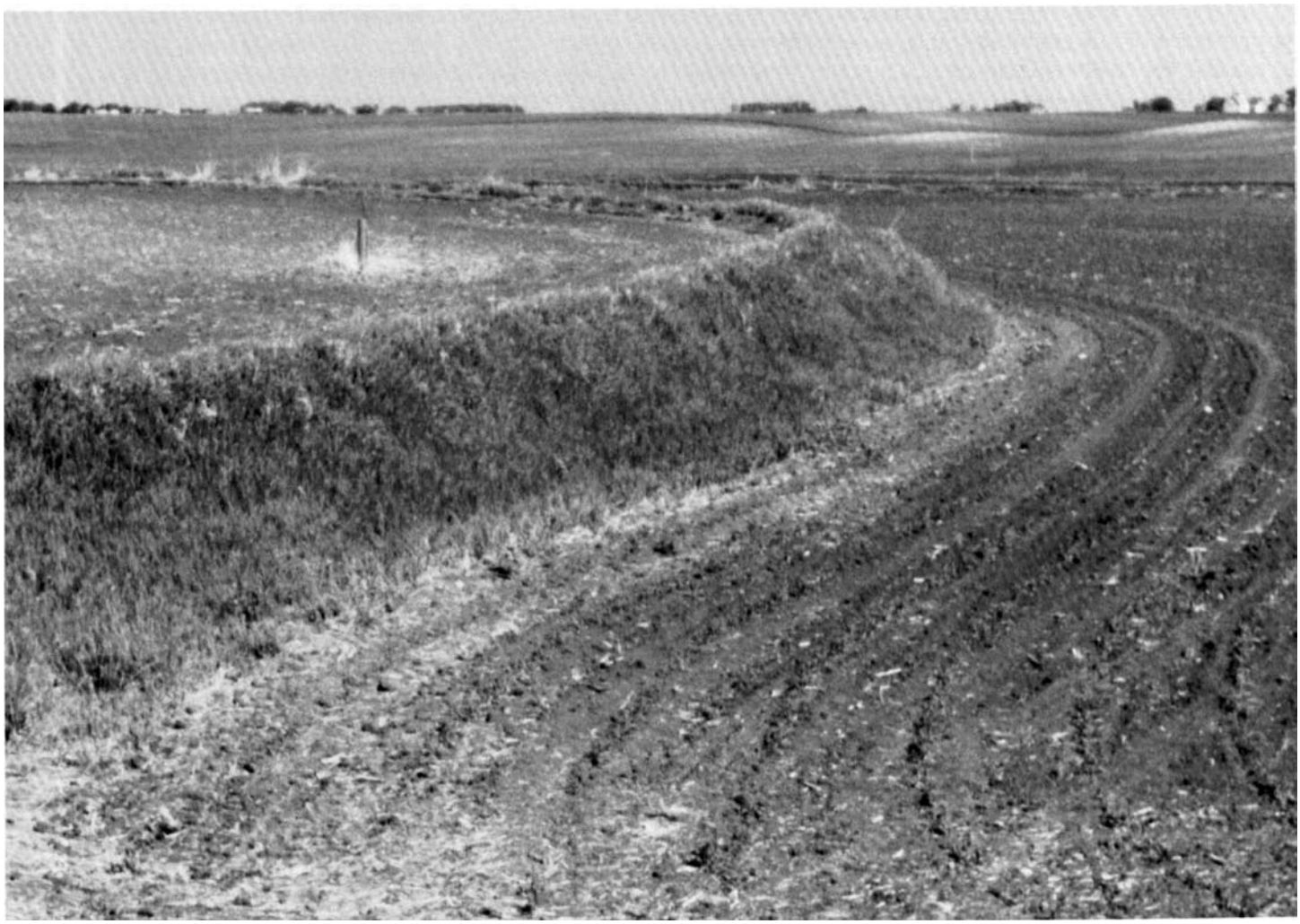


Figure 9.—A terrace constructed across a slope to reduce the hazard of erosion.

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, to a cemented pan, 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 or to a cemented pan, 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 control erosion and conserve moisture by intercepting runoff (fig. 9). Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

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

Soil Properties

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

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

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

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

Engineering Index Properties

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

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

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

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

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. Coarse sands, 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 coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, 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 loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous 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. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

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 infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

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

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

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

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

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

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

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

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but

possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(12)*. 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. Eleven 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. Generally, 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 (11)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (12)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Biscay Series

The Biscay series consists of poorly drained soils on nearly level slopes on stream terraces. These soils formed in loamy alluvium or outwash that is underlain by sand and gravel. Permeability is moderate in the

solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 650 feet east and 20 feet south of the northwest corner of sec. 12, T. 90 N., R. 23 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 25 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A1—8 to 13 inches; black (10YR 2/1) loam (about 25 percent clay), very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.
A2—13 to 20 inches; very dark gray (10YR 3/1) loam (about 25 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg1—20 to 26 inches; olive gray (5Y 4/2) loam (about 25 percent clay); discontinuous dark olive gray (5Y 3/2) coatings on faces of peds; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg2—26 to 34 inches; olive gray (5Y 4/2) loam (about 25 percent clay); few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; mildly alkaline; gradual smooth boundary.
2Cg—34 to 60 inches; olive (5Y 4/4) gravelly sand; few medium distinct light olive brown (2.5Y 5/6) mottles; single grained; loose; about 25 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to sand and gravel containing free carbonates range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches. The solum ranges from 18 to 30 percent clay.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 or 1. It is loam or clay loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loamy coarse sand or sand with varying amounts of gravel. It is commonly stratified.

Bode Series

The Bode series consists of well drained, moderately permeable soils on knobs, ridges, and convex side slopes in the uplands. These soils formed in glacial or lacustrine sediments and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Bode clay loam, 2 to 5 percent slopes, in a cultivated field; 100 feet west and 860 feet north of the center of sec. 5, T. 90 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam (about 29 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.
A1—8 to 14 inches; very dark brown (10YR 2/2) clay loam (about 29 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A2—14 to 18 inches; very dark grayish brown (10YR 3/2) clay loam (about 33 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bw1—18 to 24 inches; brown (10YR 4/3) clay loam (about 33 percent clay); weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw2—24 to 33 inches; dark yellowish brown (10YR 4/4) clay loam (about 33 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
2C—33 to 60 inches; mottled yellowish brown (10YR 5/4) and grayish brown (10YR 5/2) loam (about 24 percent clay); massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The thickness of the A horizon ranges from 7 to 18 inches. The 10- to 40-inch control section ranges from 28 to 35 percent clay.

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 and value and chroma of 3 or 4. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8.

The moderately eroded Bode soils in this survey area are taxadjuncts because the dark surface layer is too thin to qualify as a mollic epipedon.

Brownton Series

The Brownton series consists of poorly drained, slowly permeable, calcareous soils on uplands. These soils are on flats, in irregularly shaped swales surrounding depressions, and in low-gradient

drainageways. They formed in glacial or lacustrine sediments and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Brownton silty clay loam, 0 to 2 percent slopes, in a cultivated field; 100 feet east and 100 feet north of the southwest corner of sec. 16, T. 91 N., R. 24 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam (about 38 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A—8 to 15 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

AB—15 to 21 inches; very dark gray (10YR 3/1) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

Bg—21 to 32 inches; gray (5Y 5/1) silty clay loam (about 38 percent clay); common fine faint olive gray (5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

2Cg1—32 to 40 inches; light olive gray (5Y 6/2) loam (about 25 percent clay); common fine prominent strong brown (7.5YR 5/6) and common fine faint olive (5Y 5/4) mottles; massive; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

2Cg2—40 to 60 inches; olive gray (5Y 5/2) loam (about 25 percent clay); common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 44 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. The 10- to 40-inch control section ranges from 35 to 42 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or silty clay. The Bg 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 2Cg horizon has hue of 2.5Y or 5Y and value of 5 or 6. It is clay loam or loam.

Calcousta Series

The Calcousta series consists of very poorly drained, moderately permeable, calcareous soils in upland basins and depressions. These soils formed in lacustrine sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Calcousta silty clay loam, 0 to 1 percent slopes, in a cultivated field; 200 feet east and 600 feet south of the center of sec. 18, T. 92 N., R. 24 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—9 to 15 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bg—15 to 21 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); few fine distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable; some black (10YR 2/1) material filling krotovinas; slight effervescence; mildly alkaline; clear smooth boundary.

Cg1—21 to 30 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—30 to 60 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); common medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 10 to 24 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches. The 10- to 40-inch control section ranges from 24 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 0 or 1. It is silty clay loam, silt loam, or mucky silt loam. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or silt loam. The Cg horizon has value of 5 or 6 and chroma of 1 or 2. It is clay loam, silty clay loam, or silt loam.

Canisteo Series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils on uplands.

These soils are on flats, in irregularly shaped swales surrounding small depressions, and in low-gradient drainageways. They formed in glacial sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes, in a cultivated field; 390 feet east and 75 feet south of the northwest corner of sec. 12, T. 90 N., R. 26 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

A—9 to 18 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Bg1—18 to 26 inches; dark gray (10YR 4/1) clay loam (about 29 percent clay); few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; common very dark gray (10YR 3/1) tongues; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg2—26 to 34 inches; olive gray (5Y 5/2) clay loam (about 29 percent clay); few fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C—34 to 60 inches; olive gray (5Y 5/2) loam (about 24 percent clay); common medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 50 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The 10- to 40-inch control section ranges from 28 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 or 1. It is loam, clay loam, or silty clay loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 or has hue of 10YR, value of 4 or 5, and chroma of 1. It is clay loam or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam or loam.

Clarion Series

The Clarion series consists of well drained, moderately permeable soils on knobs, ridges, and convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Clarion loam, 2 to 5 percent slopes, in a cultivated field; 65 feet west and 785 feet south of the northeast corner of sec. 7, T. 91 N., R. 24 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 25 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A—8 to 14 inches; very dark brown (10YR 2/2) loam (about 25 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw1—14 to 24 inches; brown (10YR 4/3) loam (about 25 percent clay); continuous dark brown (10YR 3/3) coatings on faces of peds; weak fine granular structure; friable; neutral; gradual smooth boundary.

Bw2—24 to 38 inches; yellowish brown (10YR 5/4) loam (about 25 percent clay); weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.

C—38 to 60 inches; yellowish brown (10YR 5/4) loam (about 21 percent clay); few fine faint yellowish brown (10YR 5/6) and common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 50 inches. The thickness of the mollic epipedon ranges from 6 to 18 inches. The 10- to 40-inch control section ranges from 18 to 28 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or clay loam. The C horizon ranges from sandy loam to clay loam.

The moderately eroded Clarion soils in this survey area are taxadjuncts because the dark surface layer is too thin to qualify as a mollic epipedon.

Coland Series

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

Typical pedon of Coland clay loam, 0 to 2 percent slopes, in a cultivated field; 750 feet east and 2,320 feet north of the center of sec. 36, T. 90 N., R. 26 W.

Ap—0 to 9 inches; black (N 2/0) clay loam (about 33

percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A1—9 to 17 inches; black (N 2/0) clay loam (about 33 percent clay), black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—17 to 25 inches; black (10YR 2/1) clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—25 to 35 inches; black (10YR 2/1) clay loam (about 33 percent clay), dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

AC—35 to 46 inches; very dark gray (5Y 3/1) clay loam (about 29 percent clay); weak fine prismatic structure; friable; neutral; gradual smooth boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) loam (about 25 percent clay); few fine faint light olive brown (2.5Y 5/4) mottles; massive; friable; neutral.

The thickness of the solum ranges from 36 to 48 inches. The depth to free carbonates is 48 inches or more. The mollic epipedon is 36 or more inches thick. The 10- to 40-inch control section ranges from 27 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 0 or 1. It is clay loam or silty clay loam. The AC horizon is neutral in hue or has hue of 10YR to 5Y. It has value of 2 to 4 and chroma of 0 or 1. It is clay loam or silty clay loam. Some pedons have a Bg horizon instead of an AC horizon. The Cg horizon has hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 1 or 2. It ranges from clay loam to sandy loam.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils in slightly convex positions on stream terraces. These soils formed in alluvium that is underlain by sand and gravel. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 150 feet south and 880 feet east of the northwest corner of sec. 12, T. 90 N., R. 23 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 25 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A1—8 to 14 inches; very dark brown (10YR 2/2) loam (about 25 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A2—14 to 19 inches; very dark grayish brown (2.5Y 3/2) loam (about 21 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

Bw1—19 to 23 inches; dark grayish brown (2.5Y 4/2) loam (about 15 percent clay); weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—23 to 28 inches; dark grayish brown (10YR 4/2) loam (about 10 percent clay); weak fine granular structure; very friable; neutral; clear smooth boundary.

BC—28 to 35 inches; dark yellowish brown (10YR 4/4) loam (about 10 percent clay); weak fine granular structure; very friable; about 5 percent gravel; neutral; gradual wavy boundary.

2C1—35 to 48 inches; yellowish brown (10YR 5/4) sand; single grained; loose; about 10 percent gravel; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—48 to 60 inches; grayish brown (10YR 5/2) gravelly sand; single grained; loose; about 25 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel containing free carbonates range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. The solum ranges from 22 to 32 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5. It is loam or clay loam. The 2C horizon is sand or loamy sand that has varying amounts of gravel.

Dickinson Series

The Dickinson series consists of somewhat excessively drained, moderately rapidly permeable soils on convex slopes in the uplands and on stream terraces. These soils formed in alluvial deposits that have been reworked by wind. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Dickinson fine sandy loam, 5 to 9 percent slopes, in a cultivated field; 560 feet south and 1,386 feet east of the northwest corner of sec. 22, T. 90 N., R. 26 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) fine sandy loam (about 17 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

A1—9 to 14 inches; very dark grayish brown (10YR 3/2) fine sandy loam (about 17 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

A2—14 to 18 inches; dark brown (10YR 3/3) fine sandy loam (about 17 percent clay); weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

Bw1—18 to 28 inches; brown (10YR 4/3) sandy loam (about 10 percent clay); weak fine granular structure; very friable; medium acid; gradual smooth boundary.

Bw2—28 to 36 inches; dark yellowish brown (10YR 4/4) sandy loam (about 10 percent clay); weak fine granular structure; very friable; medium acid; diffuse smooth boundary.

C—36 to 60 inches; yellowish brown (10YR 5/6) fine sand (about 4 percent clay); single grained; loose; neutral.

The thickness of the solum ranges from 24 to 50 inches. The depth to loamy sand and sand ranges from 20 to 42 inches. The depth to free carbonates is more than 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is fine sandy loam or sandy loam. The Bw horizon has value of 4 or 5 and chroma of 3 to 6. It is sandy loam or fine sandy loam. The lower part of the Bw horizon typically has a higher content of sand than the upper part. The C horizon has value of 4 or 5 and chroma of 3 to 6. It ranges from loamy fine sand to sand.

Hanlon Series

The Hanlon series consists of moderately well drained, moderately rapidly permeable soils on bottom land. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Hanlon fine sandy loam, 0 to 2 percent slopes, in a grass pasture; 300 feet north and 500 feet west of the southeast corner of sec. 4, T. 91 N., R. 23 W.

A1—0 to 12 inches; very dark brown (10YR 2/2) fine sandy loam (about 17 percent clay), very dark grayish brown (10YR 3/2) dry; continuous black (10YR 2/1) coatings on faces of peds; weak very fine subangular blocky structure; very friable; neutral; clear smooth boundary.

A2—12 to 24 inches; very dark brown (10YR 2/2) fine sandy loam (about 14 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; neutral; gradual smooth boundary.

A3—24 to 44 inches; very dark grayish brown (10YR 3/2) fine sandy loam (about 14 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; gradual smooth boundary.

A4—44 to 52 inches; very dark brown (10YR 2/2) fine sandy loam (about 14 percent clay), very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

A5—52 to 60 inches; very dark grayish brown (10YR 3/2) fine sandy loam (about 14 percent clay); weak fine granular structure; very friable; neutral.

The thickness of the solum ranges from 40 to 72 inches. The depth to free carbonates is more than 48 inches. The thickness of the mollic epipedon ranges from 40 to 60 inches. The 10- to 40-inch control section ranges from 12 to 18 percent clay and from 50 to 75 percent sand.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or sandy loam.

Harps Series

The Harps series consists of poorly drained, moderately permeable, calcareous soils on uplands. These soils are on the rims of depressions and on flats. They formed in glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Harps clay loam, 0 to 2 percent slopes, in a cultivated field; 75 feet north and 375 feet east of the southwest corner of sec. 11, T. 90 N., R. 26 W.

Ap—0 to 8 inches; black (N 2/0) clay loam (about 29 percent clay), very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

Ak—8 to 17 inches; black (10YR 2/1) clay loam (about 29 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

Bgk1—17 to 22 inches; dark gray (10YR 4/1) clay loam (about 29 percent clay); moderate fine granular structure; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

Bgk2—22 to 30 inches; olive gray (5Y 5/2) clay loam (about 29 percent clay); continuous gray (5Y 5/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few soft accumulations of calcium carbonate; violent effervescence; moderately alkaline; gradual smooth boundary.

BCg—30 to 38 inches; olive gray (5Y 5/2) loam (about 25 percent clay); weak fine subangular blocky structure; friable; few soft accumulations of calcium carbonate; few dark concretions of manganese oxide; violent effervescence; mildly alkaline; gradual smooth boundary.

Cg1—38 to 46 inches; light olive gray (5Y 6/2) loam (about 21 percent clay); few fine faint yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations of calcium carbonate; few dark concretions of manganese oxide; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg2—46 to 60 inches; gray (5Y 6/1) loam (about 21 percent clay); common medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations of calcium carbonate; few dark concretions of manganese oxide; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The 10- to 40-inch control section ranges from 22 to 32 percent clay. The calcium carbonate equivalent ranges from 15 to 40 percent.

The Ak horizon has value of 2 or 3. It is clay loam or loam. The Bgk horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is clay loam or loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It is loam or sandy clay loam.

Hayden Series

The Hayden series consists of well drained, moderately permeable soils on upland ridges and convex side slopes. These soils formed in glacial till. The native vegetation was deciduous trees. Slopes range from 2 to 50 percent.

Typical pedon of Hayden loam, 2 to 5 percent slopes, in a cultivated field; 800 feet east and 300 feet north of the southwest corner of sec. 5, T. 91 N., R. 26 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) loam (about 25 percent clay), gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

E—7 to 11 inches; dark grayish brown (10YR 4/2) loam (about 21 percent clay), light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

BE—11 to 15 inches; brown (10YR 4/3) loam (about 25 percent clay), pale brown (10YR 6/3) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—15 to 25 inches; dark yellowish brown (10YR 4/4) clay loam (about 29 percent clay); moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—25 to 39 inches; dark yellowish brown (10YR 4/4) clay loam (about 33 percent clay); weak fine prismatic structure; firm; few faint clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3—39 to 48 inches; light olive brown (2.5Y 5/4) clay loam (about 29 percent clay); weak fine subangular blocky structure; friable; few faint clay films on faces of peds; neutral; gradual wavy boundary.

C—48 to 60 inches; light olive brown (2.5Y 5/4) loam (about 21 percent clay); massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 54 inches. The argillic horizon has 25 to 35 percent clay and 30 to 45 percent sand.

The A horizon has value of 2 to 4 and chroma of 1 or 2. It is loam or silt loam. The E horizon has value of 4 or 5 and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 5. It is clay loam or loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It is loam or clay loam.

Knoke Series

The Knoke series consists of very poorly drained, moderately slowly permeable, calcareous soils in depressions on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Knoke silty clay loam, 0 to 1 percent slopes, in a cultivated field; 168 feet north and 1,100 feet east of the southwest corner of sec. 9, T. 92 N., R. 23 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry;

weak fine granular structure; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—8 to 16 inches; black (N 2/0) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; weak medium granular structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—16 to 26 inches; black (N 2/0) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few snail shells; many soft accumulations of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

Bw—26 to 34 inches; black (N 2/0) silty clay loam (about 38 percent clay), gray (10YR 5/1) dry; weak medium subangular blocky structure; firm; few snail shells; many soft accumulations of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

BC—34 to 45 inches; black (10YR 2/1) silty clay loam (about 33 percent clay); common fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; many soft accumulations of calcium carbonate; strong effervescence; mildly alkaline; clear smooth boundary.

Cg—45 to 60 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 24 to 48 inches. The 10- to 40-inch control section ranges from 35 to 40 percent clay.

The A horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 2 or 3 and chroma of 0 or 1. The upper part of the A horizon is silty clay loam, mucky silt loam, or mucky silty clay loam. The lower part is silty clay loam, clay loam, or silty clay. The Bw horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 4 or 5 and chroma of 2 or less. It is silty clay loam, clay loam, or silty clay. The Cg horizon ranges from loam to silty clay loam.

Kossuth Series

The Kossuth series consists of poorly drained soils on uplands. These soils are on flats, in irregularly shaped swales, and in narrow drainageways. They formed in glacial or lacustrine sediments and in the underlying glacial till. Permeability is moderately slow in the solum and moderate in the substratum. The native vegetation was 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; 2,600 feet east and 120 feet north of the southwest corner of sec. 17, T. 90 N., R. 25 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam (about 38 percent clay), black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A—8 to 14 inches; black (N 2/0) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—14 to 21 inches; very dark gray (10YR 3/1) silty clay loam (about 38 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg1—21 to 30 inches; olive gray (5Y 4/2) silty clay loam (about 35 percent clay); discontinuous very dark gray (5Y 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bg2—30 to 38 inches; olive gray (5Y 5/2) silty clay loam (about 33 percent clay); discontinuous dark gray (5Y 4/1) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

2Cg—38 to 60 inches; olive gray (5Y 5/2) loam (about 25 percent clay); common medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 26 to 48 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The A horizon ranges from 36 to 42 percent clay. The 10- to 40-inch control section ranges from 32 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR or 5Y. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or silty clay. The Bg 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 clay loam. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is clay loam or loam.

Lester Series

The Lester series consists of well drained, moderately permeable soils on ridges and side slopes

in the uplands. These soils formed in glacial till. The native vegetation was mixed prairie grasses and deciduous trees. Slopes range from 2 to 9 percent.

Typical pedon of Lester loam, 2 to 5 percent slopes, in a cultivated field; 400 feet north and 1,600 feet east of the southwest corner of sec. 5, T. 91 N., R. 16 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam (about 25 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

BE—9 to 13 inches; dark yellowish brown (10YR 4/4) loam (about 21 percent clay); weak fine subangular blocky structure; friable; discontinuous pale brown (10YR 6/3) silt coatings on faces of peds; slightly acid; clear smooth boundary.

Bt1—13 to 20 inches; dark yellowish brown (10YR 4/4) clay loam (about 29 percent clay); moderate fine subangular blocky structure; firm; common distinct dark brown (10YR 3/3) clay films on faces of peds; few shale fragments; medium acid; clear smooth boundary.

Bt2—20 to 32 inches; yellowish brown (10YR 5/4) clay loam (about 33 percent clay); moderate fine subangular blocky structure; firm; few distinct dark brown (10YR 3/3) clay films on faces of peds; few dark concretions of iron oxide; common shale fragments; medium acid; clear smooth boundary.

BC—32 to 40 inches; light olive brown (2.5Y 5/4) clay loam (about 29 percent clay); few fine distinct brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; friable; common shale fragments; few dark concretions of manganese oxide; slightly acid; abrupt smooth boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) loam (about 21 percent clay); few fine faint grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; common shale fragments; few dark concretions of manganese oxide; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The 10- to 40-inch control section ranges from 26 to 35 percent clay. The clay ratio of the B horizon to the A horizon ranges from 1.2 to 1.4.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The E horizon, if it occurs, has value of 3 or 4 and chroma of 1 or 2. It is loam or silt loam. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is clay loam or loam. The C horizon has value of 4 to 6 and chroma of 3 to 6. It is loam or clay loam.

Luther Series

The Luther series consists of somewhat poorly drained, moderately slowly permeable soils on nearly level uplands. These soils formed in glacial till. The native vegetation was deciduous trees. Slopes range from 0 to 2 percent.

Typical pedon of Luther loam, 0 to 2 percent slopes, in a cultivated field; 500 feet south and 375 feet east of the center of sec. 36, T. 90 N., R. 26 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) loam (about 25 percent clay), gray (10YR 5/1) dry; moderate fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

E1—5 to 9 inches; grayish brown (10YR 5/2) loam (about 21 percent clay), light gray (10YR 7/1) dry; moderate fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

E2—9 to 15 inches; grayish brown (10YR 5/2) loam (about 21 percent clay), light gray (10YR 7/1) dry; moderate medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

E3—15 to 20 inches; dark grayish brown (10YR 4/2) loam (about 21 percent clay), light gray (10YR 7/1) dry; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—20 to 30 inches; dark grayish brown (10YR 4/2) clay loam (about 33 percent clay); few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; few dark concretions of manganese oxide; medium acid; gradual smooth boundary.

Bt2—30 to 40 inches; grayish brown (10YR 5/2) clay loam (about 33 percent clay); few fine distinct strong brown (7.5YR 5/6) and few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; firm; few distinct clay flows in root channels; few dark concretions of manganese oxide; medium acid; gradual smooth boundary.

Bt3—40 to 50 inches; grayish brown (10YR 5/2) clay loam (about 29 percent clay); common fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; few faint clay flows in root channels; friable; few dark concretions of manganese oxide; slightly acid; gradual wavy boundary.

C—50 to 60 inches; dark grayish brown (10YR 4/2) loam (about 21 percent clay); many medium prominent yellowish brown (10YR 5/6) mottles; massive; friable; many dark concretions of

manganese oxide; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 36 to 60 inches. The 10- to 40-inch control section ranges from 24 to 35 percent clay.

The A and E horizons have value of 4 or 5 and chroma of 1 or 2. They are loam or silt loam. The B horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 or 3.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on uplands. These soils are on rises and slightly concave side slopes. They formed in glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet loam, 1 to 3 percent slopes, in a cultivated field; 100 feet south and 670 feet west of the center of sec. 27, T. 90 N., R. 26 W.

Ap—0 to 9 inches; black (10YR 2/1) loam (about 25 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A—9 to 18 inches; very dark brown (10YR 2/2) loam (about 25 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

BA—18 to 24 inches; dark grayish brown (10YR 4/2) loam (about 25 percent clay); continuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw1—24 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam (about 29 percent clay); discontinuous 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 36 inches; grayish brown (2.5Y 5/2) clay loam (about 29 percent clay); few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.

C—36 to 60 inches; olive (5Y 5/3) loam (about 21 percent clay); few fine faint olive yellow (2.5Y 6/8) and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The 10- to 40-inch control section ranges from 24 to 35 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam. 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 in depressions on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes, in a cultivated field; 700 feet east and 300 feet north of the southwest corner of sec. 10, T. 93 N., R. 23 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—8 to 16 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak medium granular structure; friable; neutral; gradual smooth boundary.

A2—16 to 27 inches; black (10YR 2/1) silty clay loam (about 38 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg—27 to 40 inches; very dark gray (5Y 3/1) silty clay loam (about 38 percent clay); common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; neutral; clear smooth boundary.

Cg1—40 to 48 inches; olive gray (5Y 4/2 and 5/2) silty clay loam (about 33 percent clay); common fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Cg2—48 to 60 inches; olive gray (5Y 4/2) silty clay loam (about 33 percent clay); few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches. The 10- to 40-inch control section ranges from 35 to 40 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 0 or 1. It is silty clay loam, mucky silty clay loam, silt loam, or mucky silt loam. The Bg 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 Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It ranges from silty clay loam to loam.

Ottosen Series

The Ottosen series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. These soils are on low rises and slightly concave side slopes. They formed in glacial or lacustrine sediments and in the underlying glacial till. The native vegetation was prairie grasses. Slopes range from 1 to 3 percent.

Typical pedon of Ottosen clay loam, 1 to 3 percent slopes, in a cultivated field; 750 feet east and 150 feet south of the northwest corner of sec. 10, T. 90 N., R. 25 W.

Ap—0 to 8 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; clear smooth boundary.

A—8 to 14 inches; black (10YR 2/1) clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.

BA—14 to 19 inches; dark grayish brown (2.5Y 4/2) clay loam (about 33 percent clay); discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine granular structure; friable; neutral; clear smooth boundary.

Bw1—19 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam (about 38 percent clay); discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw2—26 to 34 inches; grayish brown (2.5Y 5/2) clay loam (about 33 percent clay); few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

2C—34 to 60 inches; light brownish gray (2.5Y 6/2) loam (about 24 percent clay); common medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. The 10- to 40-inch control section ranges from 30 to 35 percent clay.

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

Palms Series

The Palms series consists of very poorly drained soils in upland basins that were formerly lakes or ponds. These soils formed in highly decomposed organic material and in the underlying lacustrine sediments. Permeability is moderately rapid in the organic material and moderate in the underlying sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Palms muck, 0 to 1 percent slopes, in a cultivated field; 1,650 feet west and 150 feet south of the northeast corner of sec. 2, T. 90 N., R. 25 W.

Oa1—0 to 16 inches; sapric material, black (10YR 2/1) broken face and rubbed, black (10YR 2/1) dry; less than 5 percent fiber; moderate fine granular structure; very friable; neutral; diffuse smooth boundary.

Oa2—16 to 30 inches; sapric material, black (10YR 2/1) broken face and rubbed, very dark gray (10YR 3/1) dry; less than 5 percent fiber; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

Oa3—30 to 44 inches; sapric material, black (N 2/0) broken face and rubbed, very dark gray (10YR 3/1) dry; less than 10 percent fiber; weak medium subangular blocky structure; friable; neutral; diffuse smooth boundary.

2Cg—44 to 60 inches; dark gray (5Y 4/1) silt loam; massive; friable; slight effervescence; moderately alkaline.

The thickness of the sapric material ranges from 16 to 50 inches. The depth to free carbonates ranges from 12 to 40 inches.

The Oa horizon is neutral in hue or has hue of 10YR. It has chroma of 2 or less. Thin layers of hemic material are in some pedons. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 7, and chroma of 1 or 2. It ranges from silty clay loam to sandy loam.

Spillville Series

The Spillville series consists of somewhat poorly drained, moderately permeable soils on bottom land. These soils formed in alluvium. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spillville loam, 0 to 2 percent

slopes, in a cultivated field; 660 feet west and 400 feet north of the center of sec. 19, T. 90 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) loam (about 21 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A1—8 to 16 inches; black (10YR 2/1) loam (about 21 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2—16 to 24 inches; very dark brown (10YR 2/2) loam (about 21 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A3—24 to 36 inches; very dark gray (10YR 3/1) loam (about 21 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A4—36 to 50 inches; very dark grayish brown (10YR 3/2) loam (about 21 percent clay); weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
C—50 to 60 inches; dark grayish brown (2.5Y 4/2) loam (about 15 percent clay); few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; neutral.

The thickness of the solum ranges from 36 to 56 inches. The depth to free carbonates is 48 inches or more. The thickness of the mollic epipedon ranges from 36 to 56 inches. The 10- to 40-inch control section ranges from 18 to 26 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Below a depth of 36 inches, it ranges from sandy loam to clay loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is loam or sandy loam.

Storden Series

The Storden series consists of well drained, moderately permeable, calcareous soils on convex knobs and side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 5 to 50 percent.

Typical pedon of Storden loam, 9 to 14 percent slopes, moderately eroded, in a cultivated field; 1,500 feet north and 200 feet east of the southwest corner of sec. 31, T. 92 N., R. 23 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam (about 21 percent clay), pale brown (10YR 6/3) dry; mixed with some streaks and pockets of yellowish brown (10YR 5/4) substratum material; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.
C1—6 to 30 inches; yellowish brown (10YR 5/4) loam (about 18 percent clay); weak fine subangular blocky structure; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.
C2—30 to 42 inches; light olive brown (2.5Y 5/4) loam (about 18 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions of manganese oxide; strong effervescence; moderately alkaline; gradual smooth boundary.
C3—42 to 60 inches; light olive brown (2.5Y 5/4) loam (about 15 percent clay); few medium prominent strong brown (7.5YR 5/8) and common fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few dark concretions of manganese oxide; strong effervescence; moderately alkaline.

The thickness of the solum is the same as that of the A horizon. Free carbonates are in all horizons. The 10- to 40-inch control section ranges from 18 to 27 percent clay.

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

Talcot Series

The Talcot series consists of poorly drained, calcareous soils in concave positions on stream terraces. These soils formed in alluvium that is underlain by sand and gravel. Permeability is moderate in the solum and very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 900 feet east and 1,300 feet south of the northwest corner of sec. 4, T. 91 N., R. 23 W.

Ap—0 to 7 inches; black (N 2/0) clay loam (about 31 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.
A1—7 to 14 inches; black (N 2/0) clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.
A2—14 to 20 inches; black (10YR 2/1) clay loam (about

33 percent clay); weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg1—20 to 26 inches; dark gray (5Y 4/1) clay loam (about 33 percent clay); very dark gray (10YR 3/1) discontinuous coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Bg2—26 to 34 inches; olive gray (5Y 5/2) clay loam (about 33 percent clay); common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few soft accumulations of calcium carbonate; about 10 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

2Cg—34 to 60 inches; olive gray (5Y 5/2) gravelly loamy coarse sand; single grained; loose; few soft accumulations of calcium carbonate; about 20 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The solum ranges from 27 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or clay loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from sandy clay loam to silty clay loam. The Cg horizon is loamy sand or sand with varying amounts of gravel.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on foot slopes in the uplands. These soils formed in local alluvium derived from glacial till. The native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Terril loam, 2 to 5 percent slopes, in a cultivated field; 200 feet south and 2,200 feet east of the northwest corner of sec. 9, T. 91 N., R. 23 W.

Ap—0 to 7 inches; black (10YR 2/1) loam (about 20 percent clay), very dark gray (10YR 3/1) dry; fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—7 to 14 inches; black (10YR 2/1) loam (about 24 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A2—14 to 22 inches; very dark brown (10YR 2/2) loam (about 23 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—22 to 29 inches; very dark grayish brown (10YR 3/2) loam (about 18 percent clay), grayish brown (10YR 5/2) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

AB—29 to 36 inches; dark brown (10YR 3/3) loam (about 18 percent clay); discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw—36 to 45 inches; brown (10YR 4/3) loam (about 15 percent clay); weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

BC—45 to 60 inches; brown (10YR 4/3) sandy loam (about 10 percent clay); weak medium subangular blocky structure; very friable; neutral.

The thickness of the solum ranges from 36 to 72 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches. The 10- to 40-inch control section ranges from 18 to 26 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has value and chroma of 3 or 4. It is loam or clay loam. The lower part of the B horizon and the C horizon are loam or sandy loam.

Truman Series

The Truman series consists of well drained, moderately permeable soils on glacial lake plains and moraines. These soils formed in glacial till. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

The Truman soils in this survey area are taxadjuncts because they have a thicker surface layer and a thicker solum than is definitive for the series.

Typical pedon of Truman silt loam, 0 to 2 percent slopes, in a cultivated field; 2,050 feet south and 300 feet east of the northwest corner of sec. 12, T. 93 N., R. 24 W.

Ap—0 to 10 inches; very dark brown (10YR 2/2) silt loam (about 25 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A1—10 to 27 inches; very dark grayish brown (10YR 3/2) silt loam (about 25 percent clay), dark grayish

brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2—27 to 36 inches; dark brown (10YR 3/3) silt loam (about 25 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
BA—36 to 41 inches; brown (10YR 4/3) silt loam (about 25 percent clay); discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
Bw1—41 to 53 inches; dark yellowish brown (10YR 4/4) silt loam (about 25 percent clay); weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.
Bw2—53 to 60 inches; yellowish brown (10YR 5/4) silt loam (about 25 percent clay); weak medium subangular blocky structure; friable; neutral.

The thickness of the solum and the depth to free carbonates range from 36 to 72 inches. The thickness of the mollic epipedon ranges from 24 to 42 inches. The 10- to 40-inch control section ranges from 21 to 33 percent clay.

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

Wacousta Series

The Wacousta series consists of very poorly drained, moderately permeable soils in upland basins and depressions. These soils formed in lacustrine sediments. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

Typical pedon of Wacousta silty clay loam, 0 to 1 percent slopes, in a cultivated field; 255 feet north and 1,600 feet east of the southwest corner of sec. 11, T. 93 N., R. 23 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.
A—9 to 15 inches; black (N 2/0) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
Bg—15 to 21 inches; olive gray (5Y 5/2) silty clay loam (about 33 percent clay); common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; very dark gray (10YR 3/1) organic coatings along root channels; neutral; clear wavy boundary.
Cg1—21 to 43 inches; olive gray (5Y 5/2) silty clay loam (about 29 percent clay); common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; very dark gray (10YR 3/1) organic coatings along root channels; strong effervescence; moderately alkaline; gradual smooth boundary.
Cg2—43 to 60 inches; olive gray (5Y 5/2) silt loam (about 25 percent clay); few fine distinct dark brown (7.5YR 4/4) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 12 to 24 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches. The 10- to 40-inch control section ranges from 24 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 and chroma of 0 or 1. It is silty clay loam, silt loam, or mucky silt loam. The Bg horizon has value of 4 to 6 and chroma of 1 or 2. It is silty clay loam or silt loam. The Cg horizon has value of 5 or 6 and chroma of 1 or 2. It is clay loam, silty clay loam, or silt loam.

Wadena Series

The Wadena series consists of well drained soils in convex positions on stream terraces. These soils formed in alluvium that is underlain by sand and gravel. Permeability is moderate in the upper part of the profile and very rapid in the lower part. The native vegetation was prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 520 feet south and 1,980 feet east of the northwest corner of sec. 20, T. 93 N., R. 26 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam (about 25 percent clay), very dark grayish brown (10YR 3/2) dry; weak medium granular structure; friable; neutral; gradual smooth boundary.
A—8 to 16 inches; very dark brown (10YR 2/2) loam (about 21 percent clay), very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw1—16 to 22 inches; very dark grayish brown (10YR 3/2) loam (about 21 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bw2—22 to 32 inches; dark grayish brown (10YR 4/2)

grading to dark brown (10YR 4/3) loam (about 20 percent clay); weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
2Bw3—32 to 36 inches; grayish brown (10YR 5/2) grading to brown (10YR 5/3) sandy loam (about 10 percent clay); weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.
2C—36 to 60 inches; grayish brown (10YR 5/2) gravelly sand; single grained; loose; about 15 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to sand and gravel containing free carbonates range from 24 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches. The solum ranges from 18 to 30 percent clay.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam in the upper part and sandy loam, sandy clay loam, or 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 loamy sand or sand with varying amounts of gravel. It is commonly stratified.

Webster Series

The Webster series consists of poorly drained, moderately permeable soils on uplands. These soils are on flats, in swales, and in low-gradient drainageways. They formed in glacial sediments. The native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes, in a cultivated field; 75 feet east and 1,620 feet south of the center of sec. 3, T. 91 N., R. 26 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam (about 29 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.
A1—8 to 14 inches; black (N 2/0) silty clay loam (about 33 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.
A2—14 to 20 inches; black (10YR 2/1) silty clay loam (about 33 percent clay), very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.
Bg1—20 to 26 inches; dark gray (5Y 4/1) silty clay loam (about 33 percent clay); few fine distinct grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.
Bg2—26 to 33 inches; olive gray (5Y 5/2) clay loam (about 29 percent clay); discontinuous dark gray (5Y 4/1) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Cg—33 to 60 inches; light olive gray (5Y 6/2) loam (about 24 percent clay); few fine prominent yellowish brown (10YR 5/8) mottles; massive; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 42 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The 10- to 40-inch control section ranges from 28 to 35 percent clay.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 0 or 1. It is silty clay loam or clay loam. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. The Cg horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 2 or 3. It is loam or clay loam.

Zenor Series

The Zenor series consists of somewhat excessively drained soils on convex knobs and side slopes in the uplands. These soils formed in glacial outwash. Permeability is moderately rapid in the solum and is very rapid in the substratum. The native vegetation was prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Zenor sandy loam, 2 to 5 percent slopes; 1,200 feet south and 200 feet west of the center of sec. 15, T. 90 N., R. 23 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam (about 14 percent clay), dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
Bw1—10 to 16 inches; brown (10YR 4/3) sandy loam (about 11 percent clay); weak fine subangular blocky structure parting to weak fine granular; very friable; neutral; gradual smooth boundary.
Bw2—16 to 24 inches; brown (10YR 4/3) sandy loam (about 11 percent clay); weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.
Bw3—24 to 39 inches; dark yellowish brown (10YR 4/4) sandy loam (about 11 percent clay); weak fine granular structure; very friable; about 10 percent gravel; neutral; gradual wavy boundary.
C—39 to 60 inches; yellowish brown (10YR 5/4)

gravelly sand; single grained; loose; about 25 percent gravel; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 16 inches.

The A horizon has value and chroma of 2 or 3. It is sandy loam or loam. The Bw horizon has value of 4 or 5 and chroma of 3 to 5. It is loam or sandy loam. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 5 to 7, and chroma of 3 to 6. It is loamy sand, gravelly loamy sand, gravelly sand, or sand.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical properties and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material *(6)*. Human activities also affect soil formation.

Climate and plant and animal life are the active factors in the formation of the soil. They act on unconsolidated parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. A long period generally is needed for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

The accumulation of parent material is the first step in the formation of a soil. Most soils formed in material that was transported from the site of the parent material and redeposited at a new location through the action of glacial ice, water, wind, and gravity. The principal kinds of parent material in Wright County are glacial drift, alluvium, and lacustrine deposits.

The area that is now Wright County was subject to three stages of glaciation—the Nebraskan, the Kansan, and the Wisconsin. Many of the soils in the county formed mainly in glacial till deposited by the most recent of these, the Wisconsin Glaciation. The county is near the center of the Des Moines Lobe of this glaciation *(7, 8)*. The glacial till in this lobe was deposited by the Cary substage of the glaciation. Radiocarbon dates from the base of the till in the southern part of the lobe indicate that this deposition occurred about 13,000 to 14,000 years ago. The youth of the Cary substage also is indicated by a poorly developed surface drainage system and by numerous closed depressions.

Glacial drift is rock material transported and deposited by glacial ice, including the material sorted by meltwater. It includes glacial till, glacial sediments, and glacial outwash. Glacial till is unsorted sediment in which particles range in size from boulders to clay *(7)*. Glacial sediments are the loamy materials that have been sorted to some extent by water. The fact that these sediments are in potholes or other low areas indicates that some of the sorting and deposition has occurred since the time of glaciation as well as during the Ice Age. Glacial outwash is the sandy and gravelly material sorted by glacial meltwater and deposited in valleys or other areas where water was concentrated.

Clarion, Lester, Nicollet, and Storden soils formed in glacial till. Canisteo, Harps, and Webster soils, which are in the lower areas on the landscape, formed in glacial till and in glacial sediments or reworked glacial till. Okoboji, Palms, and Wacousta soils formed in alluvial sediments derived from till that in many places washed in from nearby slopes. Zenor soils formed in loamy material that overlies glacial outwash.

Alluvium is sediment deposited by water along major and minor streams and drainageways and on benches. Coland, Hanlon, and Spillville soils formed in alluvium on bottom land that is subject to flooding. The texture of the alluvium varies widely because of differences in the material from which it was derived and the manner in which it was deposited. Alluvium that has been transported only a short distance is called local alluvium. Local alluvium retains many characteristics of the soils in the areas from which it was transported. Terril soils formed in local alluvium. They generally are at the base of slopes, below the soils that formed in glacial till. They have textures similar to those of the soils that are higher on the slopes.

Biscay, Cylinder, Talcot, and Wadena soils formed in loamy alluvium underlain by sand and gravel. They are mainly on terraces near streams, but some are in the lower areas in the uplands. The material in which these

soils formed probably was deposited by the meltwater from the receding Cary glacial ice.

Lacustrine deposits were probably deposited by the still water of lakes near the margin of the glacial ice rather than by rapidly moving meltwater. Bode, Brownton, Kossuth, and Ottosen soils formed in lacustrine deposits and in the underlying glacial till. They are mainly 24 to about 36 inches deep over glacial till.

Climate

The soils in Wright County formed under a variety of climatic conditions. In the post-Cary glaciation period, 10,500 to 13,000 years ago, the climate was cool and the vegetation was dominantly conifers. During the period beginning about 10,500 years ago and ending about 8,000 years ago, a warming trend changed the vegetation from conifers to mixed hardwoods. Beginning about 8,000 years ago, the climate became warmer and drier and herbaceous prairie vegetation became dominant. A change from a dry to a more moist climate began about 3,000 years ago. The soils in the county formed under the influence of this subhumid, midcontinental climate.

Because it is nearly uniform throughout the survey area, the climate has not resulted in major differences among the soils in the county. The influence of the general climate of the region, however, is modified by local conditions. For example, soils on the south-facing slopes formed under a microclimate that is warmer and drier than the average climate in nearby areas. The climate under which poorly drained or very poorly drained soils in the lower areas or in depressions have been forming is wetter and colder than that in most of the surrounding areas.

Climate indirectly affects soil formation through the effects of temperature and other climatic factors on the plant and animal life on and in the soil. Changes in temperature activate the weathering of parent material by water and air. As the parent material weathers, changes caused by physical and chemical actions take place. Rainfall affects the amount of leaching in the soil and the kinds of plants that grow on the soil.

Plant and Animal Life

Plant and animal life are important factors of soil formation. Plants are especially significant. Soil formation really begins with the growth of vegetation. As plants grow and die, they add organic material to the upper layers of the soil material. Native grasses have a myriad of fibrous roots that penetrate the soil to a depth of 10 to 20 inches and add large amounts of organic material to the surface layer. Trees commonly feed on plant nutrients deep in the subsoil. Consequently, they add little organic matter to the surface layer other than that added by fallen leaves and dead trees. Much of the organic matter from dead trees remains on the surface.

Most of the soils of Wright County formed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Clarion and Nicollet are examples of soils that formed under prairie grasses. Webster and Canisteo are examples of soils that formed under prairie grasses and water-tolerant plants. Hayden soils are examples of soils that formed under trees. Soils that formed under prairie grasses contain a large amount of organic matter derived from roots and have a thick, dark surface layer. Soils that formed under trees have a dark surface layer that generally is less than 5 inches thick and have a lighter colored subsurface layer. If the surface and subsurface layers are mixed by plowing, the new surface layer is lighter colored than that of soils that formed under prairie grasses. Lester soils have properties both of soils that formed entirely under prairie grasses and of soils that formed entirely under forest. They probably formed under both types of vegetation. They have properties of a true forest soil, but they have a surface layer that is somewhat thicker than that of a true forest soil.

All living organisms, including vegetation, animals, bacteria, and fungi, affect soil formation. The vegetation chiefly determines the color of the surface layer and the content of organic matter and nutrients in the soil. Earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation and thereby release plant nutrients.

Relief

Relief can cause important differences among soils. Indirectly, it influences soil formation through its effect on drainage. The soils in Wright County range from level to very steep. Many level soils have a seasonal high water table. Much of the rainfall runs off the surface of the more sloping soils and thus does not penetrate the surface.

Slope influences the thickness and color of the A horizon and the thickness of the solum. Storden, Clarion, and Nicollet soils, for example, formed in similar parent material but vary in thickness and color of the A horizon. The moderately sloping to very steep Storden soils have an A horizon that is thinner and lighter colored than that in the gently sloping to strongly sloping Clarion soils and the very gently sloping Nicollet soils. Also, Storden soils have a thinner solum and are shallower to carbonates than the Clarion and Nicollet soils. In soils that vary widely in degree of slope, such

as the gently sloping to strongly sloping Clarion soils, the depth to carbonates and the thickness of the solum decrease as the percentage of slope increases.

Relief influences the color of the B horizon through its effect on drainage and aeration. The subsoil of a well drained soil generally is brownish because oxidized iron compounds are well distributed throughout the horizon. Clarion soils are an example. The subsoil of a poorly drained or very poorly drained, poorly aerated soil generally is grayish and mottled. The nearly level, poorly drained Webster soils and the level, very poorly drained Okoboji soils are examples. Nicollet soils are somewhat poorly drained and have a grayish brown B horizon. Their profile characteristics indicate that their drainage class is between that of a well drained soil and that of a poorly drained soil.

Time

Time is necessary for relief, climate, and plant and animal life to change the parent material. If these factors continue to be active for a long period, very similar kinds of soil form in widely different kinds of parent material. Soil formation, however, is generally interrupted by geologic events that expose new parent material. In Wright County new parent material was added to the uplands at least four times. The bedrock was covered by glacial drift from two glaciers, and then loess was deposited. Another glacier subsequently deposited the present surface material.

According to radiocarbon dates from its base in the southern part of the Des Moines Lobe, Cary glacial drift was deposited about 14,000 years ago *(7)*. Therefore, all of the soils that formed in the drift are no more than 14,000 years old. In much of Iowa, including parts of Wright County, geologic erosion has beveled and in places removed material from side slopes and deposited new sediments downslope *(9)*. The surfaces of nearly level upland divides are older than the slopes that truncate the divides. Thus, the soils on these side slopes, such as Clarion and Lester soils, are less than 14,000 years old. Further dating indicates that these soils are less than 3,000 years old. The sediments that were washed from side slopes accumulated downslope as local alluvium. Some of the alluvium at the base of the slopes is less than 3,000 years old *(9)*. Coland, Spillville, and Terril soils are examples of soils that formed in this alluvium.

Human Activities

Important changes take place in the soil after it is drained and cultivated. Some of these changes have little effect on soil productivity, but others have drastic effects. Changes caused by erosion generally are most significant. Some of the cultivated soils in the county, particularly the steeper ones, have lost much of the original surface layer through sheet erosion. Because low relief is common, however, many of the soils have not been affected by erosion.

Management practices have increased the productivity of some soils and have reclaimed areas that otherwise are not suitable for crops. Crops can be grown, for example, in many areas where subsurface drains have sufficiently lowered the water table. Applications of commercial fertilizer have overcome the deficiencies in plant nutrients and thus have increased the productivity of many soils.

References

(1) Anonymous. 1915. History of Wright County, Iowa: Its people, development, and industries. B.P. Bowen and Co., Inc., vol. 1, 1,061 pp.

(2) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(3) American Society for Testing and Materials. 1988. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(4) Iowa Department of Agriculture. 1987. Iowa agricultural statistics for 1987. Div. Agric. Stat., 111 pp.

(5) Iowa Development Commission. 1986. Iowa, 1986 statistical profile. 112 pp.

(6) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(7) Ruhe, Robert V. 1969. Quaternary landscapes in Iowa. Iowa State Univ. Press, 255 pp., illus.

(8) Ruhe, Robert V., and W.H. Scholtes. 1959. Important elements in the Wisconsin glacial stage: A discussion. J. Geol. 67: 585-593.

(9) Ruhe, Robert V., R.B. Daniels, and J.G. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. U.S. Dep. Agric. Tech. Bull. 1349, 242 pp., illus.

(10) Stevenson, W.H., and P.E. Brown. 1923. Soil survey of Wright County, Iowa. U.S. Dep. Agric. and Iowa Agric. Exp. Stn., 64 pp., illus.

(11) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(12) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

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:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

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.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various

sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most

mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

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, or clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

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.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

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 rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate

1.25 to 1.75 ..... moderately high
1.75 to 2.5 ..... high
More than 2.5 ..... very high

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or 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, 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 with hue of 10YR, 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.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

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.

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.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

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.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

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.

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.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

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.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow 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, in millimeters, of separates 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.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 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.

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, that are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along 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.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-87 at Clarion, Iowa)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	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	23.5	4.1	13.8	48	-25	0	0.67	.20	1.05	2	7.6
February	30.2	11.3	20.8	55	-23	0	.89	.22	1.42	3	6.7
March	40.5	22.0	31.3	75	-8	20	1.86	.94	2.66	5	8.5
April	58.5	36.1	47.3	88	15	79	2.95	1.62	4.11	6	1.6
May	71.6	47.6	59.6	92	27	316	3.93	2.69	5.05	8	.0
June	80.5	57.2	68.9	96	40	567	4.71	2.34	6.76	7	.0
July	84.0	61.5	72.8	98	45	707	4.16	1.77	6.18	6	.0
August	81.4	58.6	70.0	95	40	620	3.84	2.11	5.35	6	.0
September	73.7	49.4	61.6	92	29	348	3.24	1.33	4.84	6	.0
October	62.2	38.4	50.3	86	17	132	2.31	.89	3.50	5	.2
November	44.2	25.1	34.7	70	-2	8	1.50	.45	2.35	4	3.3
December	29.2	11.7	20.5	57	-21	0	1.05	.45	1.54	3	7.7
Yearly:											
Average	56.6	35.3	46.0	---	---	---	---	---	---	---	---
Extreme	---	---	---	99	-27	---	---	---	---	---	---
Total	---	---	---	---	---	2,797	31.11	25.82	35.88	61	35.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-87 at Clarion, 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. 26	May 8	May 18
2 years in 10 later than--	Apr. 21	May 2	May 13
5 years in 10 later than--	Apr. 10	Apr. 23	May 3
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 4	Sept. 25	Sept. 15
2 years in 10 earlier than--	Oct. 10	Sept. 29	Sept. 20
5 years in 10 earlier than--	Oct. 20	Oct. 8	Sept. 29

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-87 at Clarion, 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	170	148	130
8 years in 10	177	155	136
5 years in 10	192	167	148
2 years in 10	207	180	160
1 year in 10	214	187	167

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
4	Knoke silty clay loam, 0 to 1 percent slopes	580	0.2
6	Okoboji silty clay loam, 0 to 1 percent slopes	14,050	3.8
27B	Terril loam, 2 to 5 percent slopes	1,365	0.4
48	Knoke mucky silty clay loam, 0 to 1 percent slopes	540	0.1
52B	Bode clay loam, 2 to 5 percent slopes	16,300	4.4
52C2	Bode clay loam, 5 to 9 percent slopes, moderately eroded	5,915	1.6
52D2	Bode clay loam, 9 to 14 percent slopes, moderately eroded	685	0.2
55	Nicollet loam, 1 to 3 percent slopes	37,500	10.1
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	1,205	0.3
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	2,150	0.6
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded	1,035	0.3
62F	Storden loam, 18 to 25 percent slopes	245	0.1
90	Okoboji mucky silty clay loam, 0 to 1 percent slopes	1,850	0.5
95	Harps clay loam, 0 to 2 percent slopes	19,400	5.3
107	Webster silty clay loam, 0 to 2 percent slopes	37,950	10.3
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	2,950	0.8
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	5,300	1.4
108C2	Wadena loam, 24 to 32 inches to sand and gravel, 5 to 9 percent slopes, moderately eroded	655	0.2
135	Coland clay loam, 0 to 2 percent slopes	7,250	2.0
138B	Clarion loam, 2 to 5 percent slopes	31,100	8.4
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded	200	0.1
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	12,040	3.3
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	660	0.2
168B	Hayden loam, 2 to 5 percent slopes	415	0.1
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded	305	0.1
168D2	Hayden loam, 9 to 14 percent slopes, moderately eroded	300	0.1
168E	Hayden loam, 14 to 18 percent slopes	530	0.1
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	330	0.1
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	150	*
201B	Coland-Terril complex, 1 to 5 percent slopes	3,950	1.1
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	2,300	0.6
221	Palms muck, 0 to 1 percent slopes	840	0.2
236B	Lester loam, 2 to 5 percent slopes	800	0.2
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	535	0.1
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded	225	0.1
259	Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,850	1.0
288	Ottosen clay loam, 1 to 3 percent slopes	25,650	7.0
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,100	0.8
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	960	0.3
339	Truman silt loam, 0 to 2 percent slopes	280	0.1
355	Luther loam, 0 to 2 percent slopes	310	0.1
356G	Storden-Hayden complex, 25 to 50 percent slopes	820	0.2
388	Kossuth silty clay loam, 0 to 2 percent slopes	15,750	4.3
485	Spillville loam, 0 to 2 percent slopes	510	0.1
506	Wacousta silty clay loam, 0 to 1 percent slopes	525	0.1
507	Canisteo silty clay loam, 0 to 2 percent slopes	58,380	15.7
508	Calcousta silty clay loam, 0 to 1 percent slopes	625	0.2
536	Hanlon fine sandy loam, 0 to 2 percent slopes	1,150	0.3
559	Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	7,350	2.0
638D2	Clarion-Storden complex, 9 to 14 percent slopes, moderately eroded	410	0.1
828B	Zenor sandy loam, 2 to 5 percent slopes	595	0.2
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded	4,635	1.3
829D2	Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded	2,210	0.6
956	Harps-Okoboji complex, 0 to 1 percent slopes	7,450	2.0
1135	Coland clay loam, channeled, 0 to 2 percent slopes	880	0.2
1221	Palms muck, ponded, 0 to 1 percent slopes	710	0.2
1507	Brownton silty clay loam, 0 to 2 percent slopes	17,304	4.7
1536	Hanlon fine sandy loam, channeled, 0 to 2 percent slopes	280	0.1
1585	Spillville-Coland complex, channeled, 0 to 2 percent slopes	1,520	0.4
4000	Urban land	400	0.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
5010	Pits, sand and gravel	560	0.2
5040	Orthents, loamy	350	0.1
5043	Aquents, loamy, reclaimed, 0 to 2 percent slopes	55	*
	Water	800	0.2
	Total	369,024	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
27B	Terril loam, 2 to 5 percent slopes
52B	Bode clay loam, 2 to 5 percent slopes
55	Nicollet loam, 1 to 3 percent slopes
95	Harps clay loam, 0 to 2 percent slopes (where drained)
107	Webster silty clay loam, 0 to 2 percent slopes (where drained)
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
135	Coland clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion loam, 2 to 5 percent slopes
138B2	Clarion loam, 2 to 5 percent slopes, moderately eroded
168B	Hayden loam, 2 to 5 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
201B	Coland-Terril complex, 1 to 5 percent slopes (where drained)
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
259	Biscay 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
339	Truman silt loam, 0 to 2 percent slopes
355	Luther loam, 0 to 2 percent slopes
388	Kossuth silty clay loam, 0 to 2 percent slopes (where drained)
485	Spillville loam, 0 to 2 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes (where drained)
536	Hanlon fine sandy loam, 0 to 2 percent slopes
559	Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
1507	Brownton 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*
4---------- Knoke	IIIw	107	34	75	3.2	2.6	4.4	5.4
6---------- Okoboji	IIIw	113	36	79	3.4	2.8	4.6	5.7
27B---------- Terril	IIe	142	45	99	6.0	3.5	5.8	10.0
48---------- Knoke	IIIw	107	34	75	3.2	2.6	4.4	5.4
52B---------- Bode	IIe	138	44	97	5.8	3.4	5.7	9.7
52C2---------- Bode	IIIe	129	41	90	5.4	3.2	5.3	9.0
52D2---------- Bode	IIIe	120	38	84	5.0	3.0	4.9	8.4
55---------- Nicollet	I	153	49	107	6.1	3.8	6.3	10.2
62C2---------- Storden	IIIe	121	39	85	5.1	3.0	5.0	8.5
62D2---------- Storden	IIIe	112	36	78	4.7	2.8	4.6	7.9
62E2---------- Storden	IVe	95	30	67	4.0	2.3	3.9	6.7
62F---------- Storden	VIe	---	---	---	3.7	2.2	3.6	6.2
90---------- Okoboji	IIIw	117	37	82	3.5	2.9	4.8	5.9
95---------- Harps	IIw	123	39	86	3.7	3.0	5.0	6.2
107---------- Webster	IIw	142	45	99	4.3	3.5	5.8	7.1
108---------- Wadena	IIs	96	31	67	4.0	2.4	3.9	6.7
108B---------- Wadena	IIe	93	30	65	3.9	2.3	3.8	6.5
108C2---------- Wadena	IIIe	84	27	59	3.5	2.1	3.4	5.9
135---------- Coland	IIw	133	43	93	4.0	3.3	5.5	6.7

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
138B---------- Clarion	IIe	142	45	99	6.0	3.5	5.8	10.0
138B2---------- Clarion	IIe	138	44	97	5.8	3.4	5.7	9.7
138C2---------- Clarion	IIIe	133	43	93	5.6	3.3	5.5	9.3
138D2---------- Clarion	IIIe	124	40	87	5.2	3.1	5.1	8.7
168B---------- Hayden	IIe	123	39	86	5.2	3.0	5.0	8.6
168C2---------- Hayden	IIIe	114	36	80	4.8	2.8	4.7	8.0
168D2---------- Hayden	IIIe	105	34	74	4.4	2.6	4.3	7.4
168E---------- Hayden	IVe	92	29	64	3.9	2.3	3.8	6.5
175B---------- Dickinson	IIIe	96	31	67	4.0	2.4	3.9	6.7
175C---------- Dickinson	IIIe	91	29	64	3.8	2.2	3.7	6.4
201B---------- Coland-Terril	IIw	130	42	91	3.9	3.2	5.3	6.5
203---------- Cylinder	IIs	134	43	94	5.4	3.3	5.5	9.0
221---------- Palms	IIIw	113	36	79	3.4	2.8	4.6	5.7
236B---------- Lester	IIe	133	43	93	5.6	3.3	5.5	9.3
236C2---------- Lester	IIIe	124	40	87	5.2	3.1	5.1	8.7
236D2---------- Lester	IIIe	115	37	81	4.8	2.8	4.7	8.1
259---------- Biscay	IIw	128	41	90	3.8	3.2	5.3	6.4
288---------- Ottosen	I	147	47	103	5.9	3.6	6.0	9.8
308---------- Wadena	IIs	112	36	78	4.7	2.8	4.6	7.9
308B---------- Wadena	IIe	109	35	76	4.6	2.7	4.5	7.7
339---------- Truman	I	147	47	103	6.2	3.6	6.0	10.3

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
355---------- Luther	I	133	43	93	5.3	3.3	5.6	8.9
356G---------- Storden-Hayden	VIIe	---	---	---	---	2.0	---	---
388---------- Kossuth	IIw	131	42	92	3.9	3.2	5.4	6.6
485---------- Spillville	IIw	146	47	102	5.8	3.6	6.0	9.8
506---------- Wacousta	IIIw	122	39	85	3.7	3.0	5.0	6.1
507---------- Canisteo	IIw	136	44	95	4.1	3.4	5.6	6.8
508---------- Calcousta	IIIw	117	37	82	3.5	2.9	4.8	5.9
536---------- Hanlon	IIs	117	37	82	4.9	2.9	4.8	8.2
559---------- Talcot	IIw	122	39	85	3.7	3.0	5.0	6.1
638D2---------- Clarion-Storden	IIIe	118	38	83	5.0	2.9	4.8	8.3
828B---------- Zenor	IIIe	87	28	61	3.7	2.1	3.6	6.1
828C2---------- Zenor	IIIe	79	25	55	3.3	1.9	3.2	5.5
829D2---------- Zenor-Storden	IVe	91	29	64	3.8	2.2	3.7	6.4
956---------- Harps-Okoboji	IIIw	118	38	83	3.5	2.9	4.8	5.9
1135---------- Coland	Vw	---	---	---	---	4.1	---	---
1221---------- Palms	Vw	---	---	---	---	0.5	---	---
1507---------- Brownton	IIw	125	40	88	3.8	3.1	5.1	6.3
1536---------- Hanlon	Vw	---	---	---	---	2.8	---	---
1585---------- Spillville-Coland	Vw	---	---	---	---	3.8	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
4---------- Knoke	---	Siberian peashrub, cotoneaster, lilac, northern whitecedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
6---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
27B---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian olive, Amur maple, blue spruce, northern whitecedar, eastern redcedar.	Eastern white pine, green ash.	---
48---------- Knoke	---	Siberian peashrub, cotoneaster, lilac, northern whitecedar.	White spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
52B, 52C2, 52D2--- Bode	---	Redosier dogwood, lilac, gray dogwood, Siberian peashrub.	Eastern redcedar, Amur maple, hackberry, northern whitecedar, blue spruce, Russian olive.	Eastern white pine, green ash.	---
55---------- Nicollet	---	Redosier dogwood, lilac.	Northern whitecedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
62C2, 62D2, 62E2, 62F---------- Storden	American plum-----	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive.	Siberian elm------	---
90---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
95---------- Harps	---	Lilac, northern whitecedar, Siberian peashrub.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
107---------- Webster	---	Redosier dogwood, American plum, cotoneaster.	Hackberry, Amur maple, northern whitecedar, tall purple willow, white spruce.	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
108, 108B, 108C2--Wadena	Siberian peashrub, lilac.	Eastern redcedar, Russian olive, hackberry, Manchurian crabapple.	Jack pine, eastern white pine, bur oak, green ash.	---	---
135--Coland	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
138B, 138B2, 138C2, 138D2--Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
168B, 168C2, 168D2, 168E--Hayden	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian olive, Amur maple, northern whitecedar, blue spruce.	Eastern white pine, green ash.	---
175B, 175C--Dickinson	Siberian peashrub	Eastern redcedar, radiant crabapple, Washington hawthorn, autumn olive, Amur honeysuckle, lilac.	Eastern white pine, Austrian pine, red pine, jack pine.	---	---
201B*:					
Coland	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian olive, Amur maple, blue spruce, northern whitecedar, eastern redcedar.	Eastern white pine, green ash.	---
203--Cylinder	---	Redosier dogwood, lilac.	Blue spruce, northern whitecedar, Amur maple, white spruce.	Austrian pine, eastern white pine, green ash, 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
221--- Palms	Whitebelle honeysuckle, common ninebark.	Amur honeysuckle, Amur privet, silky dogwood, nannyberry viburnum.	Tall purple willow	Golden willow, black willow.	Imperial Carolina poplar.
236B, 236C2, 236D2--- Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern whitecedar, Amur maple, Russian olive, blue spruce.	Eastern white pine, green ash.	---
259--- Biscay	---	Redosier dogwood, American plum, cotoneaster.	Northern whitecedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
288--- Ottosen	---	Redosier dogwood, lilac.	Northern whitecedar, 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, eastern white pine, bur oak, green ash.	---	---
339--- Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac.	Northern whitecedar, blue spruce, hackberry, Russian olive, eastern redcedar, Amur maple.	Eastern white pine, green ash.	---
355--- Luther	---	Redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern whitecedar.	Hackberry, green ash, Austrian pine, eastern white pine.	Silver maple.
356G*: Storden---	American plum-----	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive.	Siberian elm------	---
Hayden---	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian olive, Amur maple, northern whitecedar, blue spruce.	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
388---------- Kossuth	---	Redosier dogwood, American plum.	Northern whitecedar, tall purple willow, Amur maple, hackberry, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
485---------- Spillville	---	Amur honeysuckle, Amur privet, silky dogwood, American cranberrybush.	Austrian pine, white fir, blue spruce, Washington hawthorn, northern whitecedar.	Norway spruce-----	Eastern white pine, pin oak.
506---------- Wacousta	---	Northern whitecedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
507---------- Canisteo	---	Washington hawthorn, nannyberry viburnum, cotoneaster.	Osageorange, green ash, eastern redcedar, northern whitecedar, white spruce.	Black willow------	---
508---------- Calcousta	---	Northern whitecedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
536---------- Hanlon	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
559---------- Talcot	Lilac----------	Siberian peashrub	Hackberry, ponderosa pine, blue spruce, Russian olive, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
638D2*: Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive.	Siberian elm------	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
828B, 828C2----- Zenor	Siberian peashrub, lilac.	Manchurian crabapple, hackberry, eastern redcedar.	Honeylocust, bur oak, jack pine, green ash, Russian olive, eastern white pine.	---	---
829D2*: Zenor----------	Siberian peashrub, lilac.	Manchurian crabapple, hackberry, eastern redcedar.	Honeylocust, bur oak, jack pine, green ash, Russian olive, eastern white pine.	---	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive.	Siberian elm------	---
956*: Harps----------	---	Lilac, northern whitecedar, Siberian peashrub.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Okoboji----------	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
1135---------- Coland	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
1221. Palms					
1507---------- Brownton	---	Siberian peashrub, honeysuckle, lilac, northern whitecedar.	White spruce, hackberry, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
1536---------- Hanlon	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
1585*: Spillville-------	---	Amur honeysuckle, Amur privet, silky dogwood, American cranberrybush.	Austrian pine, white fir, blue spruce, Washington hawthorn, northern whitecedar.	Norway spruce-----	Eastern white pine, pin oak.

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
1585*: Coland	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
4000*. Urban land					
5010*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
4 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
6 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
27B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
48 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
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.
55 Nicollet	Slight	Slight	Moderate: slope.	Slight	Slight.
62C2 Storden	Slight	Slight	Severe: slope.	Slight	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
90 Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
95 Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
108 Wadena	Slight	Slight	Slight	Slight	Slight.
108B Wadena	Slight	Slight	Moderate: slope.	Slight	Slight.
108C2 Wadena	Slight	Slight	Severe: slope.	Slight	Slight.
135 Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
138B, 138B2 Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
138C2---- Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
138D2---- Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
168B---- Hayden	Slight	Slight	Moderate: slope.	Slight	Slight.
168C2---- Hayden	Slight	Slight	Severe: slope.	Slight	Slight.
168D2---- Hayden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
168E---- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
175B---- Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
175C---- Dickinson	Slight	Slight	Severe: slope.	Slight	Slight.
201B*: Coland----	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Terril----	Slight	Slight	Moderate: slope.	Slight	Slight.
203---- Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
221---- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
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.
259---- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
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.

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
339---------- Truman	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
355---------- Luther	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
356G*:					
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
388---------- Kossuth	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
485---------- Spillville	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
506---------- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
507---------- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
536---------- Hanlon	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
559---------- Talcot	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
638D2*:					
Clarion----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
Storden----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
828B---------- Zenor	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Moderate: droughty.
828C2---------- Zenor	Slight----------	Slight----------	Severe: slope.	Slight----------	Moderate: droughty.
829D2*:					
Zenor----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: droughty, slope.
Storden----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
956*:					
Harps----------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
956*:					
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1135 Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1221 Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
1507 Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
1536 Hanlon	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
1585*:					
Spillville	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
4000*. Urban land					
5010*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
4--- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
6--- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
27B--- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
48--- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
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.
55--- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62C2, 62D2, 62E2--- Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
62F--- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
90--- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
95--- Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107--- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
108, 108B--- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
108C2--- Wadena	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
135--- Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B, 138B2--- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C2, 138D2--- Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168B--- Hayden	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168C2, 168D2, 168E- Hayden	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							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
175B---------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
175C---------- Dickinson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
201B*:										
Coland----------	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Terril----------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
203---------- Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
221---------- Palms	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
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.
259---------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	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.
339---------- Truman	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
355---------- Luther	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
356G*:										
Storden----------	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Hayden----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
388---------- Kossuth	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
485---------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
506---------- Wacousta	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
507---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
508---------- Calcousta	Good	Good	Fair	Good	Good	Good	Good	Good	Good	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
536---------- Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
559---------- Talcot	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
638D2*:										
Clarion----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
828B---------- Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828C2---------- Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
829D2*:										
Zenor----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
956*:										
Harps----------	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Okoboji----------	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
1135---------- Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1221---------- Palms	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1507---------- Brownton	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1536---------- Hanlon	Very poor.	Poor	Good	Good	Good	Poor	Fair	Poor	Good	Poor.
1585*:										
Spillville--------	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Coland----------	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
4 Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
6 Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
27B Terril	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
48 Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
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.
55 Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
62C2 Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
90 Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: 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
108, 108B--------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
108C2------------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
135--------------- Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
138B, 138B2------- 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.
168B-------------- Hayden	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
168C2------------- Hayden	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
168D2------------- Hayden	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
168E-------------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
175B-------------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
175C-------------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
201B*: Coland-----------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Terril-----------	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
203--------------- Cylinder	Severe: cutbanks cave, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.
221--------------- Palms	Severe: excess humus, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding.	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
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.
259---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
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.
339---------- Truman	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength, frost action.	Slight.
355---------- Luther	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: frost action, shrink-swell.	Moderate: wetness.
356G*:						
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
388---------- Kossuth	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
485---------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
506---------- Wacousta	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.

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
536--- Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
559--- Talcot	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
638D2*:						
Clarion---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
828B--- Zenor	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Moderate: droughty.
828C2--- Zenor	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight---	Moderate: droughty.
829D2*:						
Zenor---	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Storden---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
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.
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.	Severe: subsides, ponding.	Severe: subsides, ponding.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
1507--- Brownton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
1536--- Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1585*:						
Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.
4000*. Urban land						
5010*. Pits						
5040*. Orthents						
5043*. Aquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
4 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: ponding, too clayey, hard to pack.
6 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
27B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
48 Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: ponding, too clayey, hard to pack.
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.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62C2 Storden	Slight	Severe: slope.	Slight	Slight	Good.
62D2 Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
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
108, 108B Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
108C2 Wadena	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
135 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
138B, 138B2 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.
168B Hayden	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
168C2 Hayden	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
168D2 Hayden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
168E Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
175B Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
175C Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
201B*: Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
203 Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.

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
221---------- Palms	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
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.
259---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
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.
339---------- Truman	Slight----------	Moderate: seepage.	Slight----------	Slight----------	Good.
355---------- Luther	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
356G*:					
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hayden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
388---------- Kossuth	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
485---------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
506---------- Wacousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
507---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
508---------- Calcousta	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.

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
536---------- Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
559---------- Talcot	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
638D2*:					
Clarion----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
828B---------- Zenor	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
828C2---------- Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
829D2*:					
Zenor----------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Storden----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
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.
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.
1507---------- Brownton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1536---------- Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1585*: Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
4000*. Urban land					
5010*. Pits					
5040*. Orthents					
5043*. Aquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
4 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
6 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
27B Terril	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
48 Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
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.
55 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
62C2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
62D2 Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
62E2, 62F Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
90 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
95 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
107 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
108, 108B, 108C2 Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
135---------- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138B2, 138C2---- Clarion	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
138D2---------- Clarion	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
168B, 168C2---------- Hayden	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
168D2---------- Hayden	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
168E---------- Hayden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
175B, 175C---------- Dickinson	Good----------	Probable----------	Improbable: too sandy.	Good.
201B*: Coland----------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Terril----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
203---------- Cylinder	Fair: wetness.	Probable----------	Probable----------	Poor: small stones.
221---------- Palms	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
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.
259---------- Biscay	Fair: wetness.	Probable----------	Probable----------	Poor: area reclaim.
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.
339---------- Truman	Fair: low strength.	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
355---------- Luther	Fair: wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
356G*:				
Storden----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hayden----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
388---------- Kossuth	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones.
485---------- Spillville	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
506---------- Wacousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
507---------- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
508---------- Calcousta	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
536---------- Hanlon	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
559---------- Talcot	Fair: wetness.	Probable----------	Probable----------	Fair: small stones, area reclaim, thin layer.
638D2*:				
Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
828B, 828C2---------- Zenor	Good----------	Probable----------	Improbable: too sandy.	Fair: small stones, thin layer.
829D2*:				
Zenor----------	Good----------	Probable----------	Improbable: too sandy.	Fair: small stones, thin layer, slope.
Storden----------	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
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.
1135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1221 Palms	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
1507 Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
1536 Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1585*:				
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
4000*. Urban land				
5010*. Pits				
5040*. Orthents				
5043*. Aquents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
4---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
6---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
27B---- Terril	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
48---- Knoke	Slight	Severe: hard to pack, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding, erodes easily.	Wetness, erodes easily.
52B, 52C2---- Bode	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
52D2---- 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.
62C2---- Storden	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
62D2, 62E2, 62F---- Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
90---- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Not needed	Not needed.
95---- Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
107---- Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
108, 108B, 108C2---- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Favorable.
135---- Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
138B, 138B2, 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.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
168B, 168C2---- Hayden	Moderate: seepage, slope.	Slight----	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
168D2, 168E---- Hayden	Severe: slope.	Slight----	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
175B, 175C---- Dickinson	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Favorable.
201B*:						
Coland----	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness----	Wetness.
Terril----	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable----	Favorable.
203---- Cylinder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Favorable.
221---- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness, rooting depth.
236B, 236C2---- Lester	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
236D2---- 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.
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.
339---- Truman	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
355---- Luther	Moderate: seepage.	Severe: piping, wetness.	Severe: slow refill.	Frost action---	Wetness----	Favorable.
356G*:						
Storden----	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Hayden----	Severe: slope.	Slight----	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
388---- Kossuth	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness----	Wetness.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
485---------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
506---------- Wacousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Not needed-----	Not needed.
507---------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
508---------- Calcousta	Moderate: seepage.	Severe: piping, ponding.	Moderate: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
536---------- Hanlon	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Soil blowing---	Favorable.
559---------- Talcot	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
638D2*:						
Clarion----------	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Storden----------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
828B, 828C2------- Zenor	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
829D2*:						
Zenor----------	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
Storden----------	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, 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.
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, soil blowing.	Wetness, rooting depth.
1507---------- Brownton	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness--------	Wetness, percs slowly.
1536---------- Hanlon	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Soil blowing---	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
1585*:						
Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
4000*. Urban land						
5010*. Pits						
5040*. Orthents						
5043*. Aquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
4----------	0-16	Silty clay loam	MH, CH	A-7	0	100	100	90-100	80-95	55-70	25-40
Knoke	16-45	Silty clay loam, mucky silty clay loam, silty clay.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	45-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
6----------	0-16	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
Okoboji	16-40	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	40-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
27B----------	0-14	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
Terril	14-36	Loam, clay loam	CL, CL-ML	A-6, A-7	0-5	95-100	90-100	70-90	60-80	30-45	10-25
	36-60	Clay loam, loam, sandy loam.	CL, SC, SM-SC, CL-ML	A-6, A-4	0-5	95-100	90-100	65-95	35-85	20-40	5-20
48----------	0-8	Mucky silty clay loam.	OH, MH	A-7	0	100	100	95-100	90-95	60-90	10-30
Knoke	8-33	Silty clay loam, mucky silty clay loam, silty clay.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	33-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
52B----------	0-14	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
Bode	14-33	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	33-60	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-------	0-7	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-90	55-80	35-50	15-25
Bode	7-27	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	75-90	55-80	35-50	15-25
	27-60	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----------	0-18	Loam----------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-100	55-85	30-45	10-25
Nicollet	18-36	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
	36-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
62C2, 62D2, 62E2, 62F----------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
Storden	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
90----------	0-13	Mucky silty clay loam.	MH	A-7	0	100	100	95-100	90-95	60-90	10-30
Okoboji	13-32	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	32-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
95----------	0-17	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	35-55	15-35
Harps	17-38	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
	38-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
107---------- Webster	0-14	Silty clay loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	14-33	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
	33-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
108, 108B, 108C2---------- Wadena	0-13	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	13-28	Loam, sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	28-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
135---------- Coland	0-17	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	17-46	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
138B---------- Clarion	0-14	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-38	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	38-60	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
138B2, 138C2, 138D2---------- Clarion	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	8-26	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	26-60	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
168B---------- Hayden	0-11	Loam----------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	11-48	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	48-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
168C2, 168D2, 168E---------- Hayden	0-8	Loam----------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	8-38	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	38-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
175B---------- Dickinson	0-14	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	14-25	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	25-36	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
	36-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
175C---------- Dickinson	0-14	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	14-25	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	25-36	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
	36-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
201B*:											
Coland----------	0-17	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	17-46	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
Terril----------	0-14	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	14-36	Loam, clay loam	CL, CL-ML	A-6, A-7	0-5	95-100	90-100	70-90	60-80	30-45	10-25
	36-60	Clay loam, loam, sandy loam.	CL, SC, SM-SC, CL-ML	A-6, A-4	0-5	95-100	90-100	65-95	35-85	20-40	5-20
203---------- Cylinder	0-19	Loam----------	CL	A-6	0	100	90-100	80-100	50-75	30-40	10-20
	19-35	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	35-60	Gravelly sand, loamy sand, sand.	SP-SM, SM	A-1, A-2, A-3	0-10	65-95	65-95	20-55	5-25	---	NP
221---------- Palms	0-44	Sapric material	PT	---	---	---	---	---	---	---	---
	44-60	Clay loam, silty clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
236B, 236C2, 236D2---------- Lester	0-9	Loam----------	ML, CL, CL-ML	A-6, A-4	0-5	95-100	90-100	80-95	50-70	30-40	5-15
	9-40	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	40-60	Loam, clay loam	CL, CL-ML, ML	A-6	0-5	95-100	90-100	75-90	50-70	30-40	10-20
259---------- Biscay	0-20	Loam----------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	20-34	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	34-60	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
288---------- Ottosen	0-14	Clay loam--------	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
	14-34	Clay loam, silty clay loam.	CL, CH	A-7	0	95-100	95-100	90-100	65-85	40-55	20-30
	34-60	Loam----------	CL	A-4, A-6	0-5	90-100	90-100	80-95	60-75	25-40	8-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
308, 308B-------- Wadena	0-16	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	16-36	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
	36-60	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
339---------- Truman	0-27	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	27-41	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-100	25-45	5-20
	41-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
355---------- Luther	0-5	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
	5-20	Loam, silt loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
	20-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	75-90	50-65	25-40	15-25
356G*:											
Storden----------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Hayden----------	0-8	Loam----------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	8-38	Clay loam, loam	CL	A-7, A-6	0	95-100	90-100	80-95	55-75	30-50	15-26
	38-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-100	75-90	35-70	20-35	8-15
388---------- Kossuth	0-14	Silty clay loam	CL	A-7	0	95-100	95-100	80-85	75-85	40-50	20-30
	14-38	Silty clay loam, clay loam.	CL, CH	A-7	0	95-100	95-100	80-85	75-85	45-65	25-35
	38-60	Loam----------	CL	A-4, A-6	0-5	95-100	90-100	70-85	50-70	25-40	8-20
485---------- Spillville	0-16	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	16-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
506---------- Wacousta	0-15	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-65	20-40
	15-21	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	40-60	20-35
	21-60	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	0-18	Silty clay loam	OL, CL	A-7	0	95-100	95-100	85-100	60-100	40-50	15-20
	18-34	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	34-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
508---------- Calcousta	0-15	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-65	20-40
	15-21	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	90-100	90-100	40-60	20-35
	21-60	Silty clay loam, silt loam.	CL, ML	A-6, A-4	0-5	95-100	95-100	85-100	80-90	30-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
536---------- Hanlon	0-12	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	12-44	Fine sandy loam, sandy loam.	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	44-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
559---------- Talcot	0-20	Clay loam--------	CL	A-7	0	100	100	80-90	60-85	40-50	15-25
	20-34	Clay loam, silty clay loam, loam.	CL	A-7	0	95-100	85-100	70-90	60-85	40-50	15-25
	34-60	Stratified loamy sand to gravelly loamy coarse sand.	SP, SP-SM, SW	A-1	0	65-90	50-85	20-50	2-10	---	NP
638D2*:											
Clarion---------	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	8-26	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	26-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden---------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
828B, 828C2------ Zenor	0-10	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	<25	5-10
	10-39	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	<25	5-10
	39-60	Gravelly loamy sand, gravelly sand, loamy sand.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
829D2*:											
Zenor----------	0-10	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	<25	5-10
	10-39	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	<25	5-10
	39-60	Gravelly loamy sand, gravelly sand, loamy sand.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
Storden---------	0-6	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
956*:											
Harps----------	0-17	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	35-55	15-35
	17-38	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
	38-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
Okoboji---------	0-16	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	16-40	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	40-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
1135---------- Coland	0-17	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	17-46	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
1221---------- Palms	0-44	Sapric material	PT	---	---	---	---	---	---	---	---
	44-60	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
1507---------- Brownton	0-15	Silty clay loam	MH, CH	A-7	0	100	95-100	90-100	85-95	50-65	20-35
	15-32	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
	32-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	75-90	60-75	30-50	15-25
1536---------- Hanlon	0-12	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	12-44	Fine sandy loam, sandy loam.	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	44-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
1585*:											
Spillville------	0-16	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	16-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
Coland----------	0-17	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	17-46	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
4000*. Urban land											
5010*. Pits											
5040*. Orthents											
5043*. Aquents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
4----------	0-16	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37	5	4L
Knoke	16-45	32-42	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37		
	45-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
6----------	0-16	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.37	5	4
Okoboji	16-40	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	40-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-8.4	High----------	0.37		
27B----------	0-14	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6
Terril	14-36	24-30	1.40-1.45	0.6-2.0	0.17-0.19	6.1-7.3	Low-----------	0.24		
	36-60	15-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32		
48----------	0-8	27-30	1.10-1.25	0.6-2.0	0.24-0.26	7.4-8.4	Moderate------	0.28	5	4L
Knoke	8-33	32-42	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High----------	0.37		
	33-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37		
52B----------	0-14	32-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate------	0.28	5	6
Bode	14-33	28-35	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate------	0.28		
	33-60	24-30	1.65-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
52C2, 52D2-------	0-7	32-36	1.40-1.50	0.6-2.0	0.17-0.19	6.1-7.3	Moderate------	0.28	5	6
Bode	7-27	28-35	1.50-1.70	0.6-2.0	0.15-0.19	6.1-7.3	Moderate------	0.28		
	27-60	24-30	1.65-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.28		
55----------	0-18	24-27	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6
Nicollet	18-36	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32		
	36-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low-----------	0.32		
62C2, 62D2, 62E2, 62F----------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L
Storden	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		
90----------	0-13	20-30	1.20-1.25	0.6-2.0	0.22-0.25	6.1-7.8	Moderate------	0.37	5	6
Okoboji	13-32	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37		
	32-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-8.4	High----------	0.37		
95----------	0-17	27-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L
Harps	17-38	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32		
	38-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
107----------	0-14	27-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	7
Webster	14-33	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32		
	33-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32		
108, 108B, 108C2-	0-13	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	4	6
Wadena	13-28	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low-----------	0.32		
	28-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low-----------	0.10		
135----------	0-17	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate------	0.28	5	6
Coland	17-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate------	0.28		
	46-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low-----------	0.28		
138B----------	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6
Clarion	14-38	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37		
	38-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37		

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
138B2, 138C2, 138D2----------	0-8	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6
Clarion	8-26	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37		
	26-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
168B----------	0-11	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	5
Hayden	11-48	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.37		
	48-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.28		
168C2, 168D2, 168E----------	0-8	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	5
Hayden	8-38	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.37		
	38-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.28		
175B, 175C----------	0-14	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3
Dickinson	14-25	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low----------	0.20		
	25-36	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low----------	0.20		
	36-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	Low----------	0.15		
201B*:										
Coland----------	0-17	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	17-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		
	46-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low----------	0.28		
Terril----------	0-14	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
	14-36	24-30	1.40-1.45	0.6-2.0	0.17-0.19	6.1-7.3	Low----------	0.24		
	36-60	15-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
203----------	0-19	22-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
Cylinder	19-35	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32		
	35-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
221----------	0-44	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	----------	----	5	2
Palms	44-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	0.37		
236B, 236C2, 236D2----------	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6
Lester	9-40	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.28		
	40-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.37		
259----------	0-20	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
Biscay	20-34	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	34-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
288----------	0-14	32-40	1.35-1.45	0.2-0.6	0.19-0.22	5.6-7.3	Moderate-----	0.28	5	4
Ottosen	14-34	30-40	1.45-1.55	0.2-0.6	0.17-0.19	6.1-8.4	Moderate-----	0.28		
	34-60	22-27	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28		
308, 308B----------	0-16	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	6
Wadena	16-36	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	36-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
339----------	0-27	18-27	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	Low----------	0.32	5	6
Truman	27-41	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	Low----------	0.43		
	41-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Low----------	0.43		
355----------	0-5	18-26	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	5	6
Luther	5-20	18-24	1.35-1.45	0.6-2.0	0.16-0.18	5.6-6.5	Low----------	0.32		
	20-60	24-35	1.50-1.65	0.2-0.6	0.16-0.18	5.1-7.3	High---------	0.32		

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				
356G*:										
Storden	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
Hayden	0-8	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.32	5	5
	8-38	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate	0.37		
	38-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.28		
388	0-14	32-40	1.35-1.45	0.2-0.6	0.21-0.23	6.1-7.3	High	0.28	5	4
Kossuth	14-38	32-40	1.45-1.55	0.2-0.6	0.18-0.20	6.1-7.8	High	0.28		
	38-60	23-27	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.28		
485	0-16	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.28	5	6
Spillville	16-60	14-26	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low	0.28		
506	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
Wacousta	15-21	24-35	1.25-1.30	0.6-2.0	0.18-0.20	6.6-7.8	High	0.43		
	21-60	18-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.43		
507	0-18	27-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L
Canisteo	18-34	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32		
	34-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32		
508	0-15	27-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High	0.28	5	4L
Calcousta	15-21	24-32	1.30-1.40	0.6-2.0	0.18-0.20	7.4-8.4	High	0.43		
	21-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.43		
536	0-12	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20	5	3
Hanlon	12-44	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20		
	44-60	5-10	1.55-1.70	2.0-6.0	0.11-0.13	5.6-7.3	Low	0.20		
559	0-20	27-35	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.28	4	4L
Talcot	20-34	25-35	1.25-1.35	0.6-2.0	0.17-0.20	7.4-8.4	Moderate	0.28		
	34-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.15		
638D2*:										
Clarion	0-8	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6
	8-26	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37		
	26-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
Storden	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
828B, 828C2	0-10	14-18	1.50-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low	0.20	4	3
Zenor	10-39	14-18	1.55-1.60	2.0-6.0	0.09-0.11	6.1-8.4	Low	0.20		
	39-60	2-8	1.60-1.75	>20	0.01-0.03	7.9-8.4	Low	0.10		
829D2*:										
Zenor	0-10	14-18	1.50-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low	0.20	4	3
	10-39	14-18	1.55-1.60	2.0-6.0	0.09-0.11	6.1-8.4	Low	0.20		
	39-60	2-8	1.60-1.75	>20	0.01-0.03	7.9-8.4	Low	0.10		
Storden	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37		
956*:										
Harps	0-17	27-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L
	17-38	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32		
	38-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
								K	T	
	In	Pct	g/cc	In/hr	In/in	pH				
956*:										
Okoboji	0-16	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High	0.37	5	4
	16-40	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37		
	40-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-8.4	High	0.37		
1135	0-17	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28	5	6
Coland	17-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28		
	46-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low	0.28		
1221	0-44	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	---	----	5	2
Palms	44-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low	0.37		
1507	0-15	35-40	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	High	0.28	5	4
Brownton	15-32	35-60	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	High	0.28		
	32-60	25-35	1.45-1.70	0.2-2.0	0.14-0.16	7.4-8.4	Moderate	0.28		
1536	0-12	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20	5	3
Hanlon	12-44	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20		
	44-60	5-10	1.55-1.70	2.0-6.0	0.11-0.13	5.6-7.3	Low	0.20		
1585*:										
Spillville	0-16	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.28	5	6
	16-60	14-26	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low	0.28		
Coland	0-17	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28	5	6
	17-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28		
	46-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low	0.28		
4000*.										
Urban land										
5010*.										
Pits										
5040*.										
Orthents										
5043*.										
Aquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
4--- Knoke	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
6--- Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
27B--- Terril	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
48--- Knoke	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
52B, 52C2, 52D2--- Bode	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
55--- Nicollet	B	None	---	---	2.5-5.0	Apparent	Nov-Jul	>60	---	High	High	Low.
62C2, 62D2, 62E2, 62F--- Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
90--- Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
95--- Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
107--- Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High	High	Low.
108, 108B, 108C2--- Wadena	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
135--- Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
138B, 138B2, 138C2, 138D2--- Clarion	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
168B, 168C2, 168D2, 168E--- Hayden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
175B, 175C--------- Dickinson	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
201B*:												
Coland------------	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Terril------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
203---------------- Cylinder	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
221---------------- Palms	A/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
236B, 236C2, 236D2---------- Lester	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
259---------------- Biscay	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
288---------------- Ottosen	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
308, 308B--------- Wadena	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
339---------------- Truman	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
355---------------- Luther	B	None---------	---	---	1.5-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
356G*:												
Storden-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Hayden------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
388---------------- Kossuth	B/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
485---------------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Moderate.
506---------------- Wacousta	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
507--------- Canisteo	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
508--------- Calcousta	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
536--------- Hanlon	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	Moderate	Low.
559--------- Talcot	B/D	None---------	---	---	1.0-2.5	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
638D2*:												
Clarion----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Storden----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
828B, 828C2------- Zenor	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
829D2*:												
Zenor----------	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
Storden----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
956*:												
Harps----------	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
Okoboji----------	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1135--------- Coland	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1221--------- Palms	A/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
1507--------- Brownton	C/D	None---------	---	---	1.0-2.5	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1536--------- Hanlon	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	Moderate	Low.
1585*:												
Spillville-------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Moderate.
Coland----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.

* 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
Aquents	Loamy, mixed, mesic Mollic Haplaquents
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Bode	Fine-loamy, mixed, mesic Typic Hapludolls
Brownton	Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls
Calcousta	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Kossuth	Fine-loamy, mixed, mesic Typic Haplaquolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Luther	Fine-loamy, mixed, mesic Aeric Ochraqualfs
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Typic Udorthents
Ottosen	Fine-loamy, mixed, mesic Aquic Hapludolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
*Truman	Fine-silty, mixed, mesic Typic Hapludolls
Wacousta	Fine-silty, mixed, mesic Typic Haplaquolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zenor	Coarse-loamy, mixed, mesic Typic Hapludolls

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.