United States Department of Agriculture

Soil Conservation Service

In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of Kandiyohi County, Minnesota

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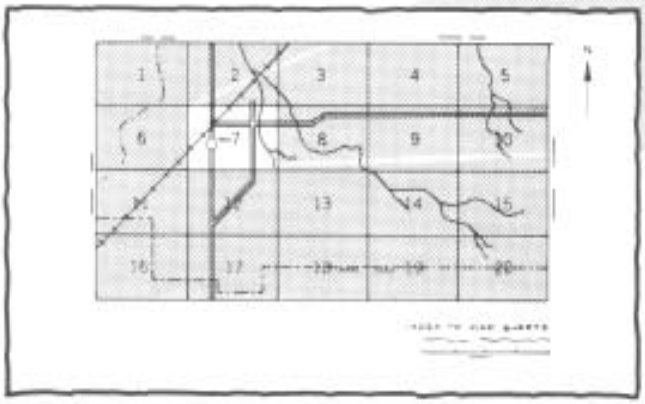

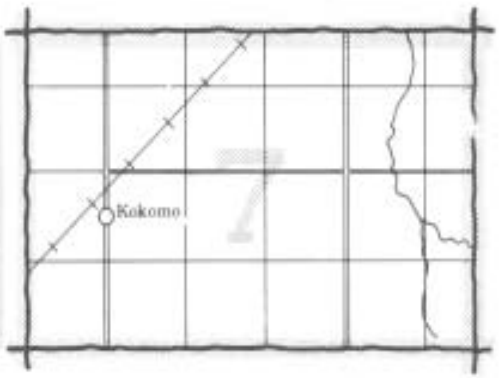

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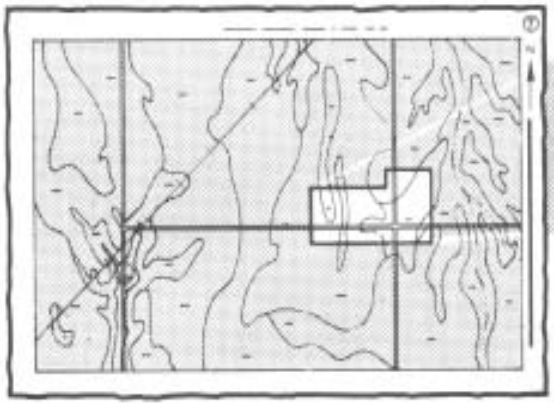

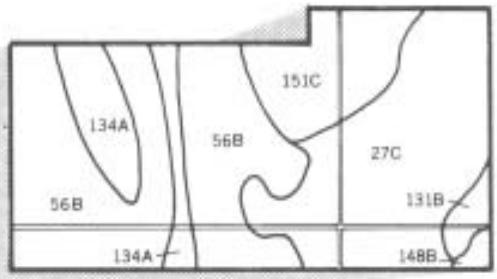

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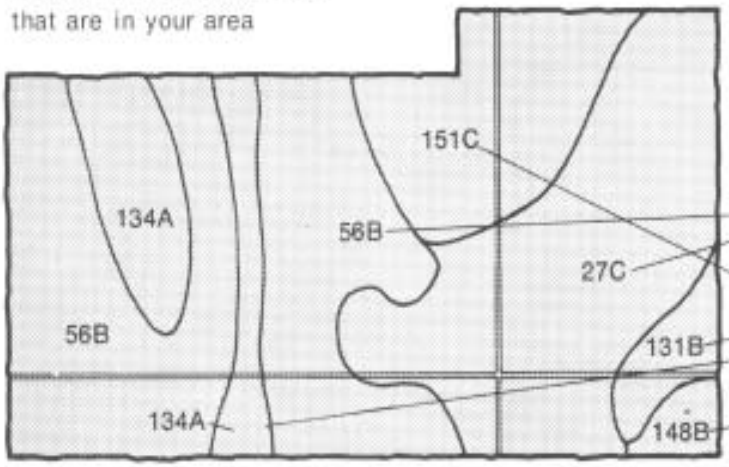

Symbols

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- 134A
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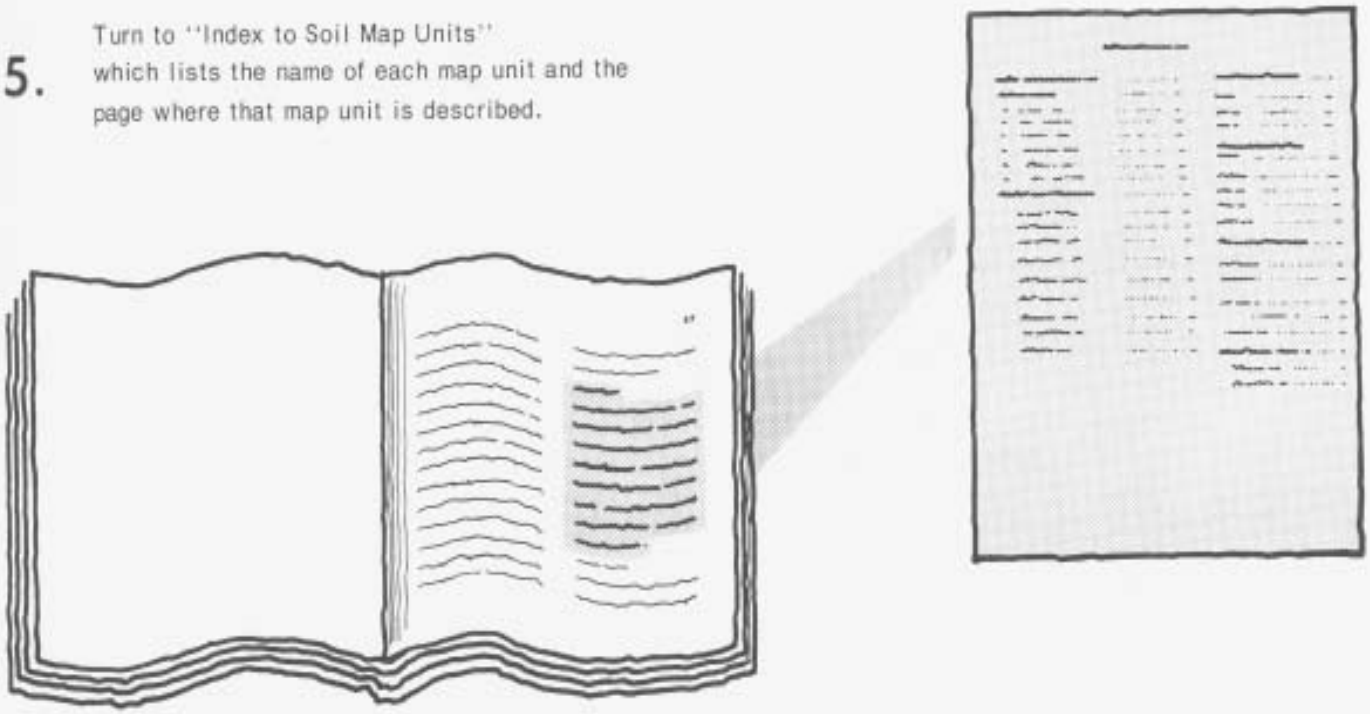
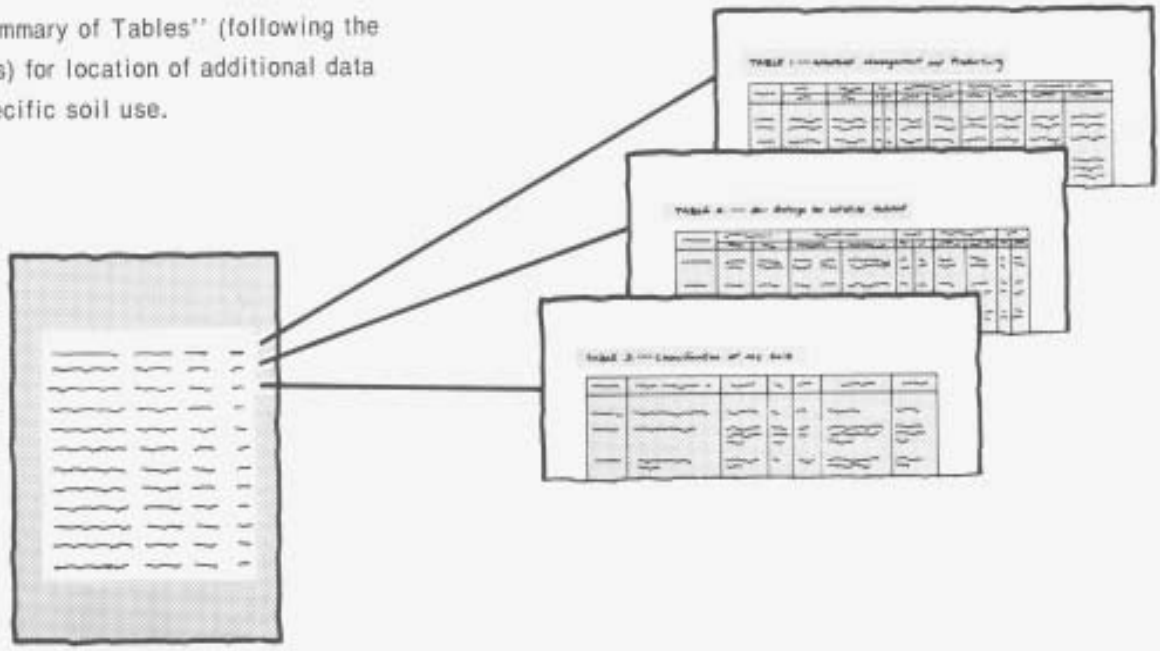
- 151C

THIS SOIL SURVEY

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



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



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

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

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Kandiyohi County Soil and Water Conservation District.

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

Cover: Ridge planting in an area of the Wadenill-Sunburg loams, 2 to 6 percent slopes.

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Foreword

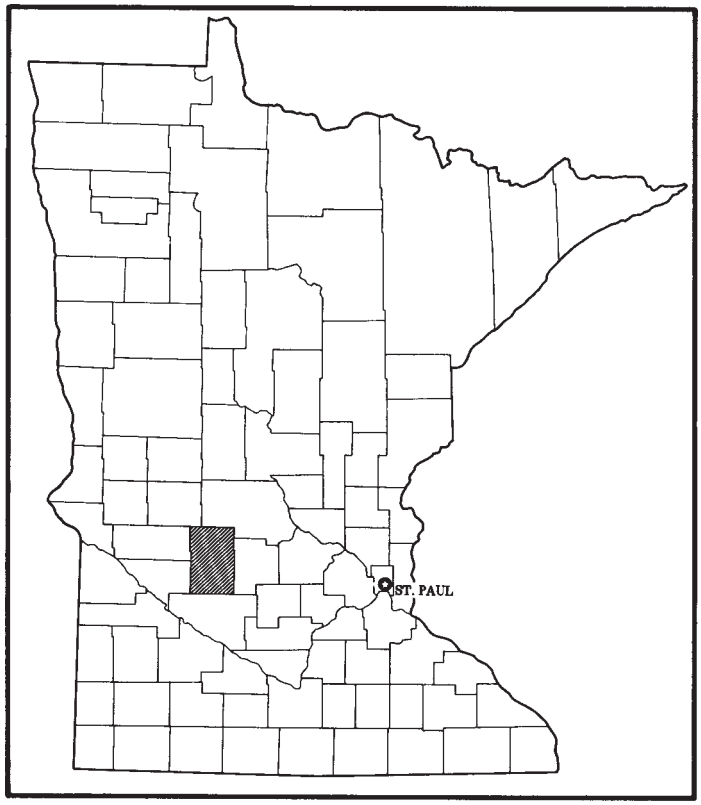
This soil survey contains information that can be used in land-planning programs in Kandiyohi County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact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

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

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

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

Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Kandiyohi County in Minnesota.

Soil Survey of Kandiyohi County, Minnesota

By Allan G. Giencke, Soil Conservation Service

Fieldwork by Allan G. Giencke and Thomas C. Jackson,
Soil Conservation Service, and
Ronald R. Schwartz, Minnesota Agricultural Experiment Station

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

KANDIYOHI COUNTY is the west-central part of Minnesota. It has an area of 551,682 acres, or about 860 square miles. This acreage includes more than 50,000 acres of water. Willmar is the county seat. In 1980, it had a population of 15,895. In the same year, the population of the county was 36,763.

The southern half of the county is a gently undulating till plain characterized by dark, loamy soils. The northern half is dominantly a rolling moraine characterized by dark and light colored, loamy soils. A gently undulating outwash plain characterized by dark, loamy and sandy soils is in the the northernmost part of the county.

The first settlers established residence in the county in 1856. Early settlement was slow. In 1858, the state legislature authorized the formation of Kandiyohi County, but the county consisted of only the southern 12 townships. In 1870, Kandiyohi County and Monongalia County were combined to form the present Kandiyohi County. The county was named by the Sioux Indians. The name means "land abounding in buffalo fish."

Farming is the main enterprise in the county. Corn, soybeans, small grain, and hay are the most common crops. Cattle, hogs, and turkeys are raised on the farms. Dairy farming is common, especially in the northern half of the county.

General Nature of the County

This section gives general information concerning the county. It describes climate; physiography, relief, and drainage; transportation facilities and markets; water supply; and farming.

Climate

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

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Willmar in the period 1951 to 1980. 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 14 degrees F, and the average daily minimum temperature is 5 degrees. The lowest temperature on record, which occurred at Willmar on January 9, 1977, is -41 degrees. In summer the average temperature is 70 degrees, and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred at Willmar on June 14, 1979, is 102 degrees.

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

The total annual precipitation is about 28 inches. Of this, nearly 21 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 6.82 inches at Willmar on June 17, 1977. Thunderstorms occur on about 38 days each year. Tornadoes and severe thunderstorms strike occasionally. They are local in extent and of short duration and result in slight damage in narrow belts. Hailstorms sometimes occur in scattered small areas during the warmer months.

The average seasonal snowfall is about 47 inches. The greatest snow depth at any one time during the period of record was 40 inches. On the average, 42 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 75 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

Physiography, Relief, and Drainage

The northern half of Kandiyohi County is part of the Alexandria Moraine Complex (*5*). This moraine probably is a terminal moraine formed during the advance of the Wadena Lobe (*4*). A large outwash plain adjoins the terminal moraine in the north-central part of the county. The southern half of the county is a till plain formed during the advance of the Des Moines Lobe. This plain has a mantle of silty lake deposits in the southeastern part of the county (*10*).

The highest point in the county is Mt. Tom, a peak in Sibley State Park. It has an elevation of 1,375 feet above sea level. The lowest point, about 1,060 feet, is in the area where Chetomba Creek leaves the county. The southern part of the county is 1,070 to 1,130 feet above sea level. Most of the moraine in the northern part is at an elevation of 1,150 to 1,300 feet. The chief outwash plain in the north-central part is at an elevation of 1,200 to 1,310 feet.

The drainage network in the county began to form as the glacial ice melted about 10,000 years ago. Most drainage channels have a low gradient and are weakly incised or unincised. Much of the natural drainage network has been augmented by county ditches, field ditches, and tile lines, especially in the southern part of the county.

The county has 12 watersheds, 10 of which originate within the county. The main watersheds that flow into the Mississippi River are the North and Middle Forks of the Crow River, in the northeast, and the South Fork of the Crow River, in the southeast. The main watersheds that flow into the Minnesota River are Chetomba Creek, in the southwest; Hawk Creek, in the west-central part of the county; and Shakopee Creek, in the northeast.

Transportation Facilities and Markets

The major highways in the county are U.S. Highways 71 and 12 and State Highways 23, 7, 9, 55, 104, and 40. Blacktop and gravel county and township roads serve the rural communities.

Two railroads serve the county. One of these serves most of the towns and has a main yard in Willmar. The other crosses the extreme northeast part of the county.

Livestock and turkeys are generally shipped to market by truck. Willmar has a large turkey-processing plant. Most of the milk produced in the county is shipped by bulk truck to processing plants.

Water Supply

Wells supply most of the drinking water in the county. The quality and quantity are directly related to the aquifer from which the water is drawn.

In areas where the parent material is glacial till, the aquifers are confined sand and gravel layers that vary in thickness. Some layers are too thin to provide the desired quantity of water. Generally, the thicker the layer, the more the yield of water. These aquifers occur in a random pattern and can vary greatly within short distances. Some are under pressure and function as artesian wells if tapped. Most are under less pressure, and the water cannot rise or rises only partially up the well casing. The aquifers are slowly recharged by precipitation and ground water flow. Once tapped, they generally provide an ample and dependable supply of water, but they may be depleted if the withdrawal rate exceeds the recharge rate, as is often the case during periods of drought.

The domestic wells in the areas of glacial outwash are generally shallow and tap only the surface aquifers. The base of these aquifers generally rests on the top of buried glacial till. The aquifers are recharged by precipitation and snowmelt. They generally do not yield the quantity of water needed for large irrigation systems. Deeper aquifers within the underlying glacial till are often tapped for this purpose. Some wells in the county are more than 400 feet deep and have tapped water within fractured or eroded bedrock.

The well water in the county generally is of good quality. It is quite hard, however, because of dissolved calcium, magnesium, and sulfates. Soluble iron also is common.

Farming

The total number of farms in Kandiyohi County has remained fairly stable since 1970. In 1980, the county had 1,660 farms, which averaged about 275 acres in size. During the past few years, the acreage used for corn, soybeans, and wheat has been increasing while the acreage used for oats and hay has been decreasing. In 1970, corn for grain was grown on about 93,300 acres, soybeans on 77,800 acres, wheat on 3,900 acres, oats on 58,700 acres, and hay on 40,000 acres. In 1982, corn for grain was grown on 146,700 acres, soybeans on 97,200 acres, wheat on 37,700 acres, oats on 35,200 acres, and hay on 29,400 acres. The number of beef cattle and hogs has remained fairly constant since 1970, but the number of milk cows has decreased. Kandiyohi County led the state in the production of turkeys in 1980.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area

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

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

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

General Soil Map Units

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

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

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

As a result of improvements in the classification of soils, particularly modifications and refinements in soil series concepts, some of the boundaries and soil names on the general soil map of Kandiyohi County do not match those on the maps of adjacent counties published at an earlier date.

Soil Descriptions

Nearly Level to Very Steep, Loamy, Sandy, and Mucky Soils on Uplands

These soils formed dominantly in loamy and sandy outwash and in organic deposits. They are excessively drained to very poorly drained. They are used dominantly as cropland.

1. Regal-Osakis Association

Nearly level, poorly drained and moderately well drained, loamy soils that formed in glacial outwash; on outwash plains

This association is in a broad outwash valley that is characterized by braided streams. Many narrow, elongated rises and swales parallel the North Fork of the Crow River. Shallow, low-gradient drainageways and ditches help to drain the association. Slopes typically range from 0 to 3 percent.

This association makes up about 2 percent of the county. It is about 37 percent Regal soils, 30 percent Osakis soils, and 33 percent minor soils (fig. 1).

The poorly drained Regal soils are on broad flats and in swales. Typically, the surface soil is black and very dark gray, calcareous loam about 14 inches thick. The subsoil is grayish brown, mottled, calcareous sandy clay loam about 4 inches thick. The underlying material to a depth of 60 inches is olive gray, mottled, calcareous gravelly loamy sand and gravelly coarse sand.

The moderately well drained Osakis soils are on broad flats and rises. Typically, the surface soil is very dark brown and very dark grayish brown sandy loam about 12 inches thick. The subsoil is dark brown sandy loam and loamy coarse sand about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled, calcareous gravelly coarse sand and coarse sand.

The minor soils in this association are the very poorly drained Biscay and Palms soils in depressions and drainageways and the well drained Estherville soils on rises.

Most of this association is used for corn, small grain, and hay. Many areas of the very poorly drained minor soils are only partly drained and are too wet for cultivated crops. They are used for pasture or wildlife habitat. The main management needs in farmed areas are improving the drainage of the wet Regal soils and overcoming the droughtiness of the Osakis soils. Soil blowing is a hazard if the surface is bare.

Most of this association is poorly suited to sanitary facilities and building site development because of a high water table and a poor filtering capacity in the coarse textured underlying material.

2. Estherville-Hawick-Lena Association

Nearly level to very steep, well drained and excessively drained, loamy and sandy soils that formed in glacial outwash and nearly level, very poorly drained, mucky soils that formed in organic deposits; on outwash plains and ground moraines

This association is on broad outwash plains characterized by many sluggish drainageways and basins. The soils in the basins are primarily organic. Many low-gradient ditches help to drain the association. Although the association has some broad flats, slopes are mainly short and complex. They commonly range from 0 to 18 percent, but in a few areas they are as much as 35 percent.

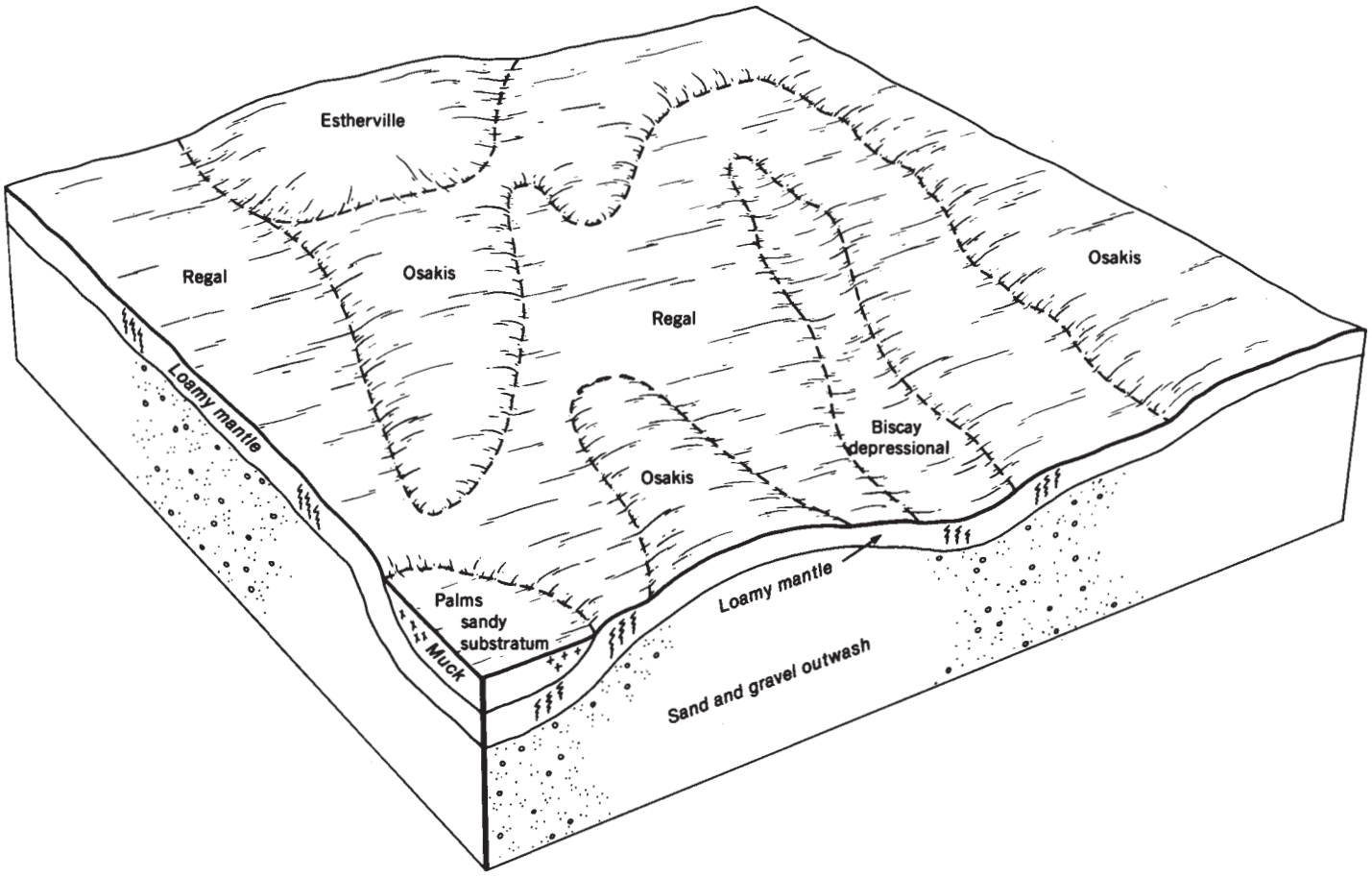


Figure 1.—Pattern of soils and parent material in the Regal-Osakis association.

This association makes up about 11 percent of the county. It is about 43 percent Estherville soils, 20 percent Hawick soils, 10 percent Lena soils, and 27 percent minor soils (fig. 2).

The well drained Estherville soils are on broad flats and convex side slopes. Typically, the surface soil is black and very dark grayish brown coarse sandy loam and sandy loam about 13 inches thick. The subsoil is dark brown sandy loam and gravelly loamy coarse sand about 11 inches thick. The underlying material to a depth of 60 inches is brown, calcareous coarse sand and gravelly coarse sand.

The excessively drained Hawick soils are on the steepest peaks and ridges. Typically, the surface soil is black and very dark brown gravelly loamy coarse sand about 17 inches thick. The subsoil is dark brown, calcareous gravelly loamy coarse sand about 5 inches thick. The underlying material to a depth of 60 inches is yellowish brown and brown, calcareous gravelly coarse sand and coarse sand.

The very poorly drained Lena soils are in large basins. Typically, they are black and very dark gray, calcareous muck to a depth of at least 60 inches.

The minor soils in this association are the very poorly drained Palms soils in basins and depressions, the poorly drained Biscay and Regal soils in swales and on toe slopes, the moderately well drained Osakis soils on rises, and the well drained Wadena soils on toe slopes and in swales.

Most of this association is used for corn, small grain, and hay. Some specialty crops are grown in irrigated areas. Many areas of the very poorly drained minor soils are too wet for cultivated crops and are used for pasture or wildlife habitat. The main management needs in farmed areas are overcoming the drought hazard and protecting the surface from soil blowing. Many areas are well suited to irrigation. Improved drainage is needed in many low lying areas, but improving drainage is difficult because good outlets are generally not available. Soil blowing is a hazard if the surface is unprotected.

Most of this association is well suited to building site development. It is poorly suited to sanitary facilities, however, because of a poor filtering capacity, which can result in the pollution of ground water.

Undulating to Very Steep, Loamy and Sandy Soils on Uplands

These soils formed in loamy glacial till or sandy outwash. They are well drained and excessively drained. They are used dominantly as woodland.

3. Koronis-Hawick-Sunburg Association

Undulating to very steep, well drained and excessively drained, loamy and sandy soils that formed in glacial till and outwash; on ground moraines and outwash plains

This association is on ground moraines characterized by scattered pockets of collapsed outwash and many areas of water or organic soils in small basins. Most of the association was forested in the past. Slopes tend to be short and complex. They range from 2 to 35 percent.

This association makes up about 7 percent of the county. It is about 30 percent Koronis soils, 20 percent Hawick soils, 15 percent Sunburg soils, and 35 percent minor soils.

The well drained Koronis soils are on ridges, knolls, and convex side slopes. Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown sandy clay loam about 22 inches thick. The underlying material to a depth of 60 inches is light olive brown, calcareous fine sandy loam.

The excessively drained Hawick soils are on convex and plane slopes in scattered areas throughout the association. Typically, the surface soil is black and very dark brown gravelly loamy coarse sand about 11 inches thick. The subsoil is dark brown, calcareous gravelly loamy coarse sand about 5 inches thick. The underlying material to a depth of more than 60 inches is yellowish brown and brown, calcareous gravelly coarse sand and coarse sand.

The well drained Sunburg soils are on the more sloping knobs and ridges. Typically, the surface layer is dark brown, calcareous loam about 8 inches thick. The underlying material to a depth of 60 inches is yellowish

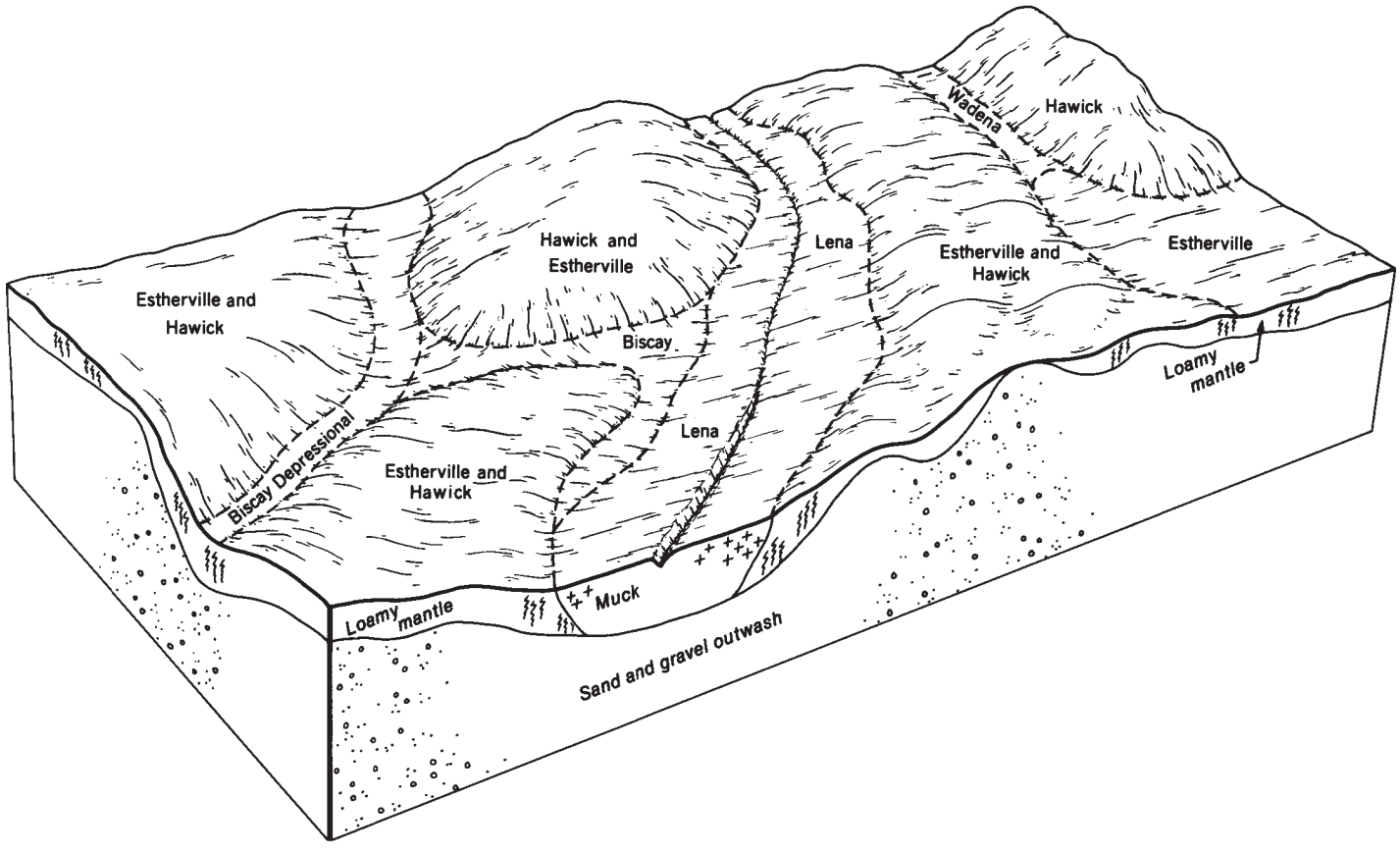


Figure 2.—Pattern of soils and parent material in the Estherville-Hawick-Lena association.

brown and brown, calcareous fine sandy loam. It has an accumulation of lime in the upper part.

The minor soils in this association include the very poorly drained Aquolls, Histosols, and Glencoe soils in depressions and basins; the poorly drained Delft soils in swales and on toe slopes; and the well drained Estherville and Wadenill soils on knolls and side slopes.

Most of this association is used as woodland or pasture. Some of the less sloping areas have been cleared of trees and are cultivated. Much of the association is poorly suited or unsuited to cultivated crops because of the slope or droughtiness.

This association is well suited to recreational uses and to habitat for big and small game and wetland waterfowl. It is scenic and is well suited to the development of paths and trails. Sibley State Park is within this association.

Most of this association is poorly suited to building site development and sanitary facilities because of the slope and the coarse textured underlying material.

Nearly Level to Very Steep, Loamy Soils on Uplands

These soils formed in loamy glacial till and local alluvium. They are well drained or poorly drained. They are used dominantly as cropland.

4. Wadenill-Sunburg-Delft Association

Nearly level to very steep, well drained and poorly drained, loamy soils that formed in glacial till and local alluvium; on ground moraines and till plains

This association is on moraines and till plains characterized by relatively short, complex slopes and many wet swales. It has numerous marshes and ponds. Most of the deep lakes in the county are in areas of this association. Slopes typically range from 2 to 35 percent.

This association makes up about 28 percent of the county. It is about 30 percent Wadenill soils, 28 percent Sunburg soils, 10 percent Delft soils, and 32 percent minor soils (fig. 3).

The well drained Wadenill soils are on side slopes, knolls, and ridges. Typically, the surface layer is very

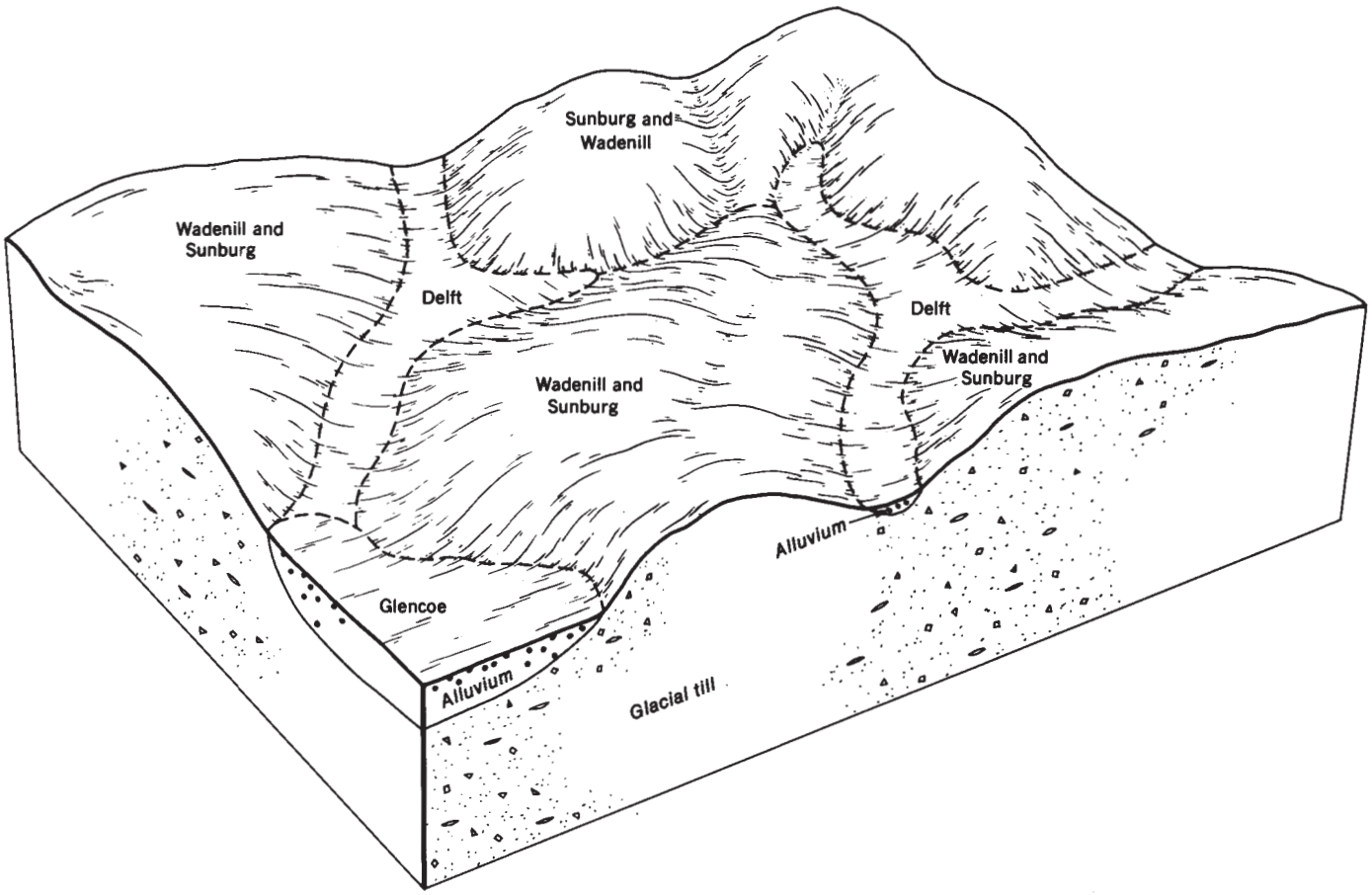


Figure 3.—Pattern of soils and parent material in the Wadenill-Sunburg-Delft association.

dark gray and very dark grayish brown fine sandy loam about 10 inches thick. The subsoil is dark yellowish brown and yellowish brown fine sandy loam about 21 inches thick. The underlying material to a depth of 60 inches is yellowish brown, calcareous fine sandy loam.

The well drained Sunburg soils are commonly on the steepest peaks and ridges. Typically, the surface layer is dark brown, calcareous loam about 8 inches thick. The underlying material to a depth of 60 inches is yellowish brown, calcareous fine sandy loam.

The poorly drained Delft soils are in swales, on toe slopes, and in drainageways. Typically, the surface soil is black and very dark gray loam and clay loam about 30 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 6 inches thick. The underlying material to a depth of 60 inches is olive gray, mottled, calcareous sandy loam.

The minor soils in this association are the very poorly drained Aquolls, Histosols, and Glencoe and Palms soils in closed basins; the poorly drained Canisteo and Harps soils on the rims of depressions; and the somewhat poorly drained and moderately well drained Grovecity soils in nearly level areas.

Most of this association is cultivated or is used for hay. Some of the steeply sloping or wet areas are used for pasture or wildlife habitat. Corn, small grain, hay, and soybeans are the main crops. Dairy farming is common, and some beef cattle and hogs are raised. The main management needs are controlling erosion on the more sloping Wadenill and Sunburg soils and improving the drainage of the wet Delft soils. The undrained marshes provide excellent habitat for wetland wildlife.

Much of this association is well suited to building site development and sanitary facilities. The slope is a limitation in the steeper areas. Seepage commonly is a limitation on sites for sanitary facilities.

Nearly Level to Hilly, Loamy and Clayey Soils on Uplands

These soils formed in loamy or clayey lacustrine sediments and in the underlying loamy glacial till. They are moderately well drained to poorly drained. They are used dominantly as cropland.

5. Guckeen-Marna Association

Nearly level to hilly, moderately well drained to poorly drained, loamy and clayey soils that formed in lacustrine material and in the underlying glacial till; on ground moraines and till plains

This association is on ground moraines and till plains that have a lacustrine mantle. The landscape is characterized by numerous circular, flat-topped hills rising above a network of poorly integrated swales, depressions, and basins. The clayey mantle is thickest on concave toe slopes and in depressions. It is thinner in convex areas on uplands. Slopes are relatively short and smooth. They range from 0 to 18 percent.

This association makes up about 7 percent of the county. It is about 35 percent Guckeen soils, 20 percent Marna soils, and 45 percent minor soils (fig. 4).

The somewhat poorly drained and moderately well drained Guckeen soils are on knolls, ridges, and side slopes. Typically, the surface soil is black and very dark grayish brown clay loam and silty clay about 14 inches thick. The subsoil is dark grayish brown, mottled, firm clay about 14 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled, firm, calcareous clay loam.

The poorly drained Marna soils are in swales and drainageways and on flats. Typically, the surface soil is black and very dark gray silty clay and clay about 20 inches thick. The subsoil is olive gray, mottled, firm clay about 8 inches thick. The underlying material to a depth of 60 inches is olive gray, mottled, firm, calcareous silty clay loam and clay loam.

The minor soils in this association are the moderately well drained Arkton soils on sharply convex peaks and ridges, the poorly drained Brownton soils on the rims of depressions, the very poorly Okoboji and Palms soils in depressions and basins, and the well drained Swanlake and Ves soils on rises and convex side slopes.

Most of this association is used for corn, small grain, hay, or soybeans. Undrained areas of the wet soils are used for pasture or wildlife habitat. Dairy farming is common, and some beef cattle and hogs are raised. The main management concerns are controlling erosion, maintaining tilth, and improving the drainage in the wet Marna soils.

Most of these soils are poorly suited to building site development and sanitary facilities. The limitations affecting sanitary facilities are the seasonal high water table and restricted permeability. The limitations affecting building site development are a high potential for frost action, the shrink-swell potential, and the wetness.

Nearly Level to Hilly, Loamy and Silty Soils on Uplands

These soils formed dominantly in loamy glacial till. They are very poorly drained to well drained. They are used dominantly as cropland.

6. Harps-Okoboji-Seaforth Association

Nearly level and undulating, poorly drained, very poorly drained, and moderately well drained, loamy and silty soils that formed in glacial till and lacustrine sediments; on till plains

This association is in areas of complex microrelief. The landscape is characterized by an intricate pattern of many small depressions and rises. In many areas the soils are mapped as complexes. Slopes are short and typically range from 0 to 4 percent.

This association makes up about 20 percent of the county. It is about 25 percent Harps soils, 15 percent Okoboji soils, 20 percent Seaforth soils, and 40 percent minor soils (fig. 5).

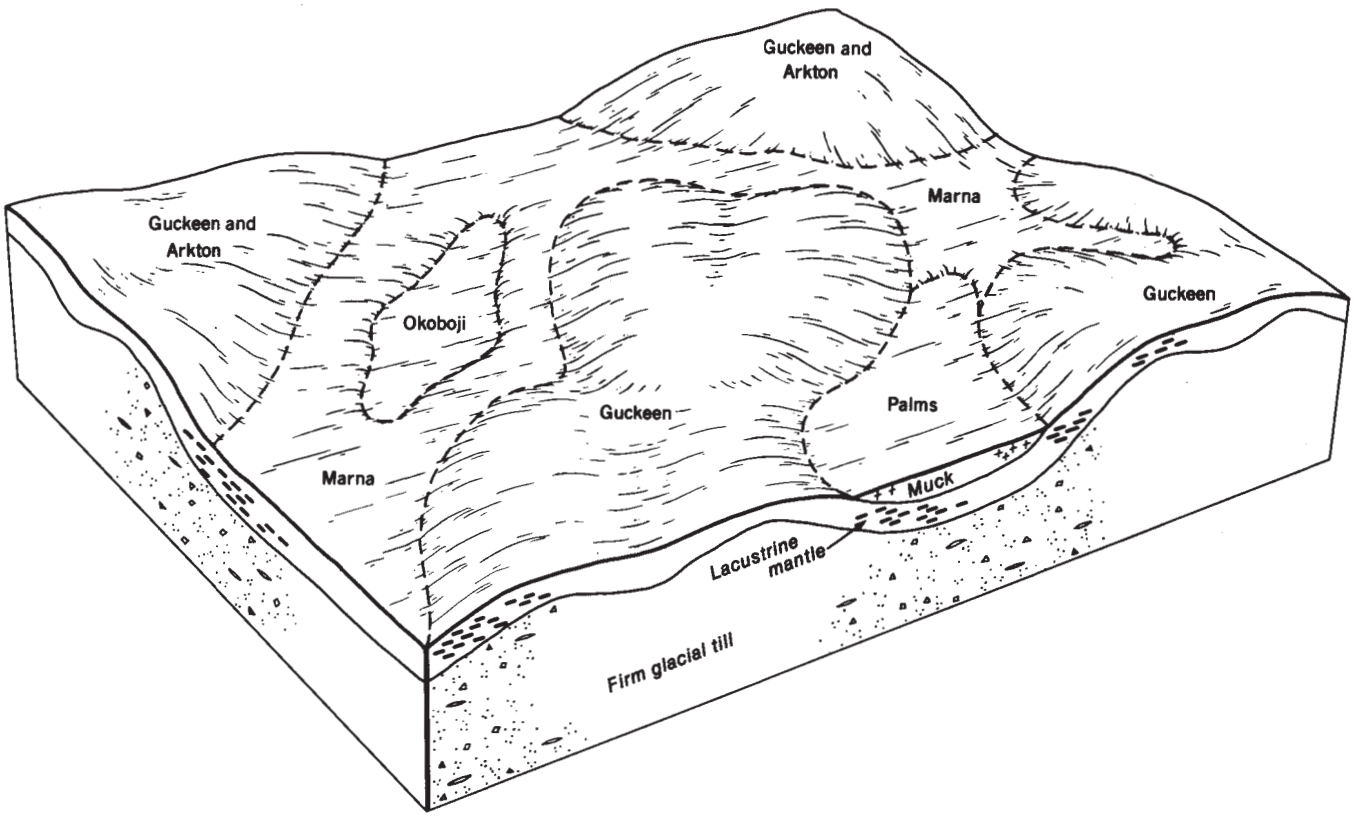


Figure 4.—Pattern of soils and parent material in the Guckeen-Marna association.

The poorly drained Harps soils are on the rims of depressions and on slight rises. Typically, the surface soil is black and very dark gray, calcareous clay loam and loam about 16 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

The very poorly drained Okoboji soils are in closed depressions that are small to large. Typically, the surface soil is black and very dark gray silty clay loam about 32 inches thick. The subsoil is olive gray, mottled silty clay loam about 11 inches thick. The underlying material to a depth of 60 inches is olive gray, mottled, calcareous silt loam.

The moderately well drained Seaforth soils are on knolls and ridges. Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is light olive brown, calcareous loam about 9 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled, calcareous loam.

The minor soils in this association include the poorly drained Canisteo soils on the rims of depressions, the moderately well drained Normania soils on low rises, and the well drained Swanlake and Ves soils on knolls, ridges, and convex side slopes.

This association is intensively cropped. Corn and soybeans are the main crops. Some hay, sugar beets, and wheat are also grown. Because of an extensive drainage system, crops can be grown in many areas that were formerly too wet for cropping. The main management needs are improving drainage in the Harps and Okoboji soils and overcoming the effects of excessive lime.

Because of the wetness, most of this association is poorly suited to sanitary facilities and is poorly suited or only fairly well suited to building site development.

7. Normania-Canisteo-Harps Association

Nearly level and undulating, moderately well drained, poorly drained, and very poorly drained, loamy soils that formed in glacial till; on till plains

This association is on low-relief till plains characterized by short, convex slopes and many small depressions. Slopes are generally 0 to 5 percent.

This association makes up about 12 percent of the county. It is about 25 percent Normania soils, 20 percent

Canisteo soils, 15 percent Harps soils, and 40 percent minor soils.

The moderately well drained Normania soils are on rises and in nearly level areas. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, mottled loam about 21 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled, calcareous loam.

The poorly drained and very poorly drained Canisteo soils are on the rims of depressions and in swales. Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous loam about 11 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled, calcareous loam.

The poorly drained Harps soils are primarily on the rims of depressions and on rises. Typically, the surface soil is black and very dark gray, calcareous clay loam and loam about 16 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 16 inches thick. The underlying material to a depth of 60 inches is light brownish gray, mottled, calcareous loam.

The minor soils in this association include the very poorly drained Okoboji and Palms soils in closed depressions, the moderately well drained Seaforth soils on rises, and the well drained Swanlake and Ves soils on ridges and knolls.

Most of this association is intensively cropped. Corn and soybeans are the main crops. Some hay, sugar beets, and wheat are also grown. An extensive drainage system has improved the suitability of these soils for farming. The main management needs are controlling erosion on the Normania soils and improving the drainage of the wet Canisteo and Harps soils.

Because of the wetness, most of this association is poorly suited to sanitary facilities and is poorly suited or only fairly well suited to building site development.

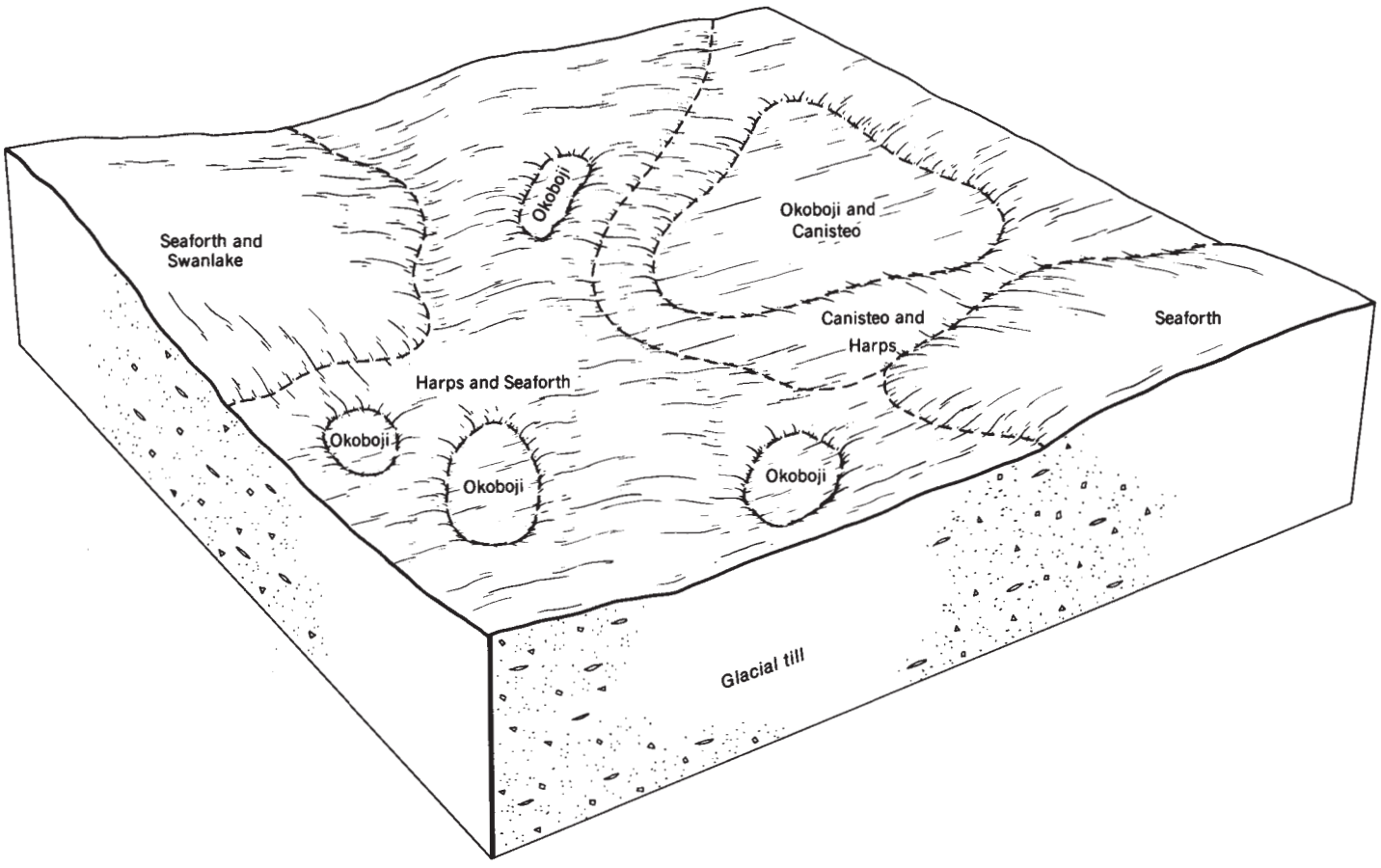


Figure 5.—Pattern of soils and parent material in the Harps-Okoboji-Seaforth association.

8. Ves-Normania-Webster Association

Nearly level to hilly, well drained, moderately well drained, and poorly drained, loamy and silty soils that formed in glacial till; on till plains

This association is on till plains characterized by short, complex slopes that are dissected by numerous swales and depressions. Slopes typically are 0 to 18 percent.

This association makes up about 5 percent of the county. It is about 25 percent Ves soils, 25 percent Normania soils, 15 percent Webster soils, and 35 percent minor soils.

The well drained Ves soils are on rises and convex side slopes. Typically, the surface layer is black loam about 10 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown clay loam, and the lower part is light yellowish brown, calcareous loam. The underlying material to a depth of 60 inches is light olive brown, calcareous loam.

The moderately well drained Normania soils are on low rises, on convex side slopes, and in nearly level areas. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, mottled loam about 21 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled, calcareous loam.

The poorly drained Webster soils are in swales and nearly level areas. Typically, the surface soil is black and very dark gray silty clay loam about 20 inches thick. The subsoil and the underlying material to a depth of more than 60 inches are grayish brown, mottled clay loam.

The minor soils in this association include the poorly drained Canisteo and Harps soils on the rims of depressions and on slight rises, the moderately well drained Seaforth soils on rises and ridges, and the well drained Swanlake soils on peaks and ridges.

Most of this association is used for corn, small grain, soybeans, or hay. Some undrained areas of the wet soils are used for pasture or wildlife habitat. The main management needs are controlling erosion on the steeper slopes and improving the drainage of the wet Webster soils.

The suitability of this association for sanitary facilities and building site development ranges from good to poor. Wetness is the main limitation.

Nearly Level, Loamy Soils on Uplands

These soils formed in loamy and sandy sediments over glacial till. They are poorly drained. They are used dominantly as cropland.

9. Fieldon-Coriff Association

Nearly level, poorly drained, loamy soils that formed in glacial outwash or deltaic sediments and in glacial till; on lake plains, outwash plains, and moraines

This association is on uplands mantled with loamy sediments. The medium textured to coarse textured sediments were deposited on glacial till by moving water. In some places the mantle is quite thick, and in other places the glacial till is exposed. The soil material varies within short distances. Slopes typically are 0 to 2 percent but in places are as much as 6 percent.

This association makes up about 1 percent of the county. It is about 25 percent Fieldon soils, 25 percent Coriff soils, and 50 percent minor soils.

Fieldon soils are on broad flats and the convex rims of depressions. Typically, the surface soil is black and very dark gray, calcareous fine sandy loam about 17 inches thick. The subsoil is grayish brown, mottled, calcareous fine sandy loam about 10 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled, calcareous fine sand.

Coriff soils are in nearly level areas, some of which are on the slightly convex rims of depressions. Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous sandy loam about 8 inches thick. The subsoil is grayish brown and light olive gray, mottled, calcareous sandy loam and loamy fine sand about 15 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled, calcareous loam.

The minor soils in this association are the poorly drained Canisteo and Harps soils on the rims of depressions and in nearly level areas, the well drained Dickinson and Estherville soils on knolls and convex side slopes, and the moderately well drained Lowlein, Osakis, and Seaforth soils on slight rises.

Most of this association is used for crops. Corn and soybeans are the main crops. Wheat and sugar beets are grown in some ares. The major management concerns are improving drainage and overcoming the effects of excessive lime.

Because of the wetness, this association is poorly suited to sanitary facilities and building site development.

Nearly Level and Undulating, Loamy and Silty Soils on Uplands

These soils formed in loamy and silty glacial till. They are poorly drained to moderately well drained. They are used dominantly as cropland.

10. Canisteo-Nicollet Association

Nearly level and undulating, very poorly drained to moderately well drained, loamy and silty soils that formed in glacial till; on till plains

This association is on low-relief till plains. Although some areas appear pitted, slopes generally are long and smooth. They are typically 0 to 5 percent.

This association makes up about 7 percent of the county. It is about 35 percent Canisteo soils, 25 percent Nicollet soils, and 40 percent minor soils.

The poorly drained and very poorly drained Canisteo soils are in nearly level areas and on the rims of depressions. Typically, the surface layer is black, mottled, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous loam about 11 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled, calcareous loam.

The somewhat poorly drained and moderately well drained Nicollet soils are on smooth rises and in nearly level areas. Typically, the surface soil is black and very dark gray silty clay loam about 18 inches thick. The subsoil is dark grayish brown, mottled clay loam about 11 inches thick. The underlying material to a depth of 60 inches is grayish brown, mottled, calcareous loam.

The minor soils in this association include the poorly drained Brownton and Harps soils on the rims of depressions and on slight rises, the very poorly drained Okoboji soils in the depressions, the moderately well drained Seaforth soils on knolls, the well drained Swanlake and Ves soils on ridges and convex side slopes, and the poorly drained Webster soils in swales and nearly level areas.

Nearly all of this association is intensively cropped. Corn and soybeans are the main crops. Wheat and sugar beets are grown in some areas. Because of an extensive drainage system of ditches and subsurface tile, the association is particularly well suited to intensive row cropping. The main management needs are improving and maintaining the drainage system in the wet Canisteo soils, improving tilth, and protecting the soils against erosion.

Because of the wetness, most of this association is poorly suited to sanitary facilities and is poorly suited or only fairly well suited to building site development.

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Detailed Soil Map Units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Guckeen clay loam, 2 to 6 percent slopes, is a phase in the Guckeen series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

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. Estherville-Hawick complex, 2 to 6 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Aquolls and Histosols, ponded, is an undifferentiated group in this survey area.

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

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

As a result of improvements in the classification of soils, particularly modifications and refinements in soil series concepts, some of the boundaries and soil names on detailed soil maps of Kandiyohi County do not match those on the maps of adjacent counties published at an earlier date.

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

Soil Descriptions

27B—Dickinson fine sandy loam, 1 to 6 percent slopes. This undulating, well drained soil is on ridges and knolls on outwash plains and outwash-mantled till plains. Individual areas are irregular in shape and range from 3 to about 12 acres in size.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsurface layer is very dark gray fine sandy loam about 6 inches thick. The subsoil is dark brown fine sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown fine sand. In some places the underlying material has bands of silt loam or is calcareous. In other places it is gravelly coarse sand.

Included with this soil in mapping are small areas of the moderately well drained Lowlein and Normania soils. These soils are in landscape positions similar to those of

the Dickinson soil. Lowlein soils have loamy underlying material at a depth of 24 to 40 inches. Normania soils formed entirely in loamy glacial till.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the underlying material. The available water capacity is moderate. The organic matter content also is moderate. The surface soil is medium acid to neutral. Surface runoff is medium.

Most areas are cultivated. This soil is well suited to all of the crops commonly grown in the county but is best suited to shallow-rooted, early maturing crops because of the hazard of drought. The main management concerns are controlling water erosion and soil blowing and overcoming the hazard of drought. Applying a system of conservation tillage that leaves crop residue on the surface and returning crop residue to the soil conserve moisture and help to prevent excessive soil loss.

This soil is fairly well suited to pasture and hay. Drought and erosion are hazards. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. Overgrazing increases the erosion hazard. Hay production can be increased by irrigation.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to building site development. Topsoil should be stockpiled during construction for later use in landscaping. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because the underlying material has a poor filtering capacity, this soil is poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water.

This soil is fairly well suited to local roads and streets. Frost action can damage the road surface. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

35—Blue Earth mucky silt loam. This nearly level, very poorly drained soil is in lake basins on glacial moraines and till plains. It is commonly ponded for brief periods in spring. Individual areas are typically circular or oblong and range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark gray, calcareous mucky silt loam about 10 inches thick. Below this to a depth of about 60 inches is black and dark gray, calcareous mucky silt loam. In some places the upper 10 to 36 inches is muck. In other places the depth to loamy glacial till is 20 to 30 inches.

Included with this soil in mapping are small areas of the excessively drained Hawick and poorly drained Regal soils. These soils are along the outer edges of the mapped areas.

Permeability is moderate in the Blue Earth soil. The available water capacity is high or very high. The organic matter content is very high. The surface layer is mildly alkaline or moderately alkaline. The seasonal high water table is 2 feet above the surface to 1 foot below.

Most of the acreage is idle land. Undrained or partly drained areas support marsh vegetation and provide excellent habitat for wildlife. If drained, this soil is fairly well suited to the crops commonly grown in the county. The main management concern is the wetness. Deep ditches and properly installed tile can improve drainage. The high content of lime in this soil can cause chlorosis, especially if soybeans are grown. Corn and soybeans cannot reach full maturity in some years because the soil is subject to early frost. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and leaving the surface rough and cloddy can help to prevent excessive soil blowing late in fall and early in spring, when the surface is bare.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can limit grazing. Hummocks tend to form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand the excessive wetness. Seedling mortality is severe because of the wetness. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the underlying organic material should be replaced with coarse textured, compacted fill. A drainage system can lower the water table and thus can help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

39—Wadena loam. This nearly level, well drained soil is in swales and depressions on glacial outwash plains. Individual areas are elongated and range from about 3 to 10 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 12 inches thick. The subsoil is about 14 inches thick. It is dark brown. It is loam in the upper

part and loamy coarse sand in the lower part. The underlying material to a depth of about 60 inches is grayish brown, calcareous coarse sand. In some places the dark surface soil is more than 24 inches thick. In other places the upper part of the soil has less clay.

Included with this soil in mapping are small areas of the poorly drained Biscay soils. These soils are in the lower lying depressions.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the underlying material. The available water capacity is moderate. The organic matter content is high. The surface layer is slightly acid or neutral. Surface runoff is medium.

Most areas are cultivated or are used as pasture and hayland. This soil is well suited to all of the crops commonly grown in the county but is best suited to shallow-rooted, early maturing crops because of the hazard of drought. It is well suited to irrigation. Crop response to irrigation is excellent. Applying a system of conservation tillage that leaves crop residue on the surface and returning crop residue to the soil conserve moisture.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, weeds can become established. Hay production can be increased by irrigation.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to building site development and to local roads and streets. Topsoil should be stockpiled during construction for later use in landscaping. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because the underlying material has a poor filtering capacity, this soil is poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water. This hazard can be reduced by backfilling trenches around septic lines with material that can better filter the effluent.

The land capability classification is IIs.

41A—Estherville coarse sandy loam, 0 to 3 percent slopes. This nearly level, well drained soil is on broad flats or slight rises on glacial outwash plains and stream benches. Individual areas are irregular in shape and range from about 5 to more than 200 acres in size.

Typically, the surface layer is black coarse sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 11 inches thick. It is dark brown. It is sandy loam in the upper part and gravelly loamy coarse sand in the lower part. The underlying material to a depth of about 60 inches is brown, calcareous coarse sand and gravelly coarse sand. In places the subsoil has more clay than the surface layer. In areas where it has been mixed with the subsoil by plowing, the surface layer is lighter colored. In some areas the surface layer and subsoil contain more sand or gravel.

Permeability is moderately rapid in the upper part of the soil and very rapid in the underlying material. The available water capacity is low. The organic matter content is moderate. The surface layer is medium acid to neutral. Surface runoff is slow.

Most areas are cultivated or are used as pasture and hayland. Because of the hazard of drought, this soil is only fairly well suited to crops. The main management concerns are the limited amount of available moisture and the hazard of soil blowing. The soil is well suited to irrigation. Crop response to irrigation is good. Areas that are not irrigated are better suited to shallow-rooted, early maturing crops than to other crops. A system of conservation tillage that leaves crop residue on the surface and field windbreaks conserve moisture and help to control soil blowing in winter and spring.

Because of the hazard of drought, this soil is only fairly well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, weeds can become established. Hay production can be increased by irrigation.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the low available water capacity. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to building site development and to local roads and streets. Topsoil should be stockpiled during construction for later use in landscaping. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because the underlying material has a poor filtering capacity, this soil is poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water. This hazard can be reduced by backfilling trenches around septic lines with material that can better filter the effluent.

The land capability classification is IIIs.

84—Brownton silty clay loam. This nearly level, poorly drained, calcareous soil is on flats or the convex rims of depressions on till plains and ground moraines mantled with lacustrine sediments. Individual areas are irregular in shape and range from 3 to about 60 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is black, calcareous clay about 8 inches thick. The subsoil is olive gray, mottled, calcareous silty clay about 16 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam. In

some places the dark surface soil is more than 24 inches thick. In other places it has an accumulation of lime or gypsum.

Included with this soil in mapping are areas of the somewhat poorly drained and moderately well drained Nicollet soils and the very poorly drained Okoboji soils. Nicollet soils are on slight rises. Okoboji soils are in closed depressions and are subject to ponding.

Permeability is slow in the Brownton soil. The available water capacity and organic matter content are high. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1.0 to 2.5 feet.

Most areas are farmed. If properly managed, this soil is well suited to intensive cropping. The main management concerns are overcoming the excessive wetness and maintaining good tilth. Ditches and subsurface drainage lines can improve drainage. The soil is subject to severe compaction when wet. Returning crop residue to the soil and deferring fieldwork when the soil is too wet help to prevent excessive compaction and improve tilth.

This soil is well suited to pasture and hay. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction. A drainage system and applications of fertilizer can increase hay production.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness and a high shrink-swell potential, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table. Properly designed footings and basement walls can withstand the shrink-swell action of the soil.

Because of the high water table and the restricted permeability, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by drainage lines. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength, frost action, and the shrink-swell potential, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

94—Terril loam. This nearly level, moderately well drained soil is on toe slopes and in swales on foot slopes. Individual areas are generally elongated and range from 3 to about 10 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is loam about 28 inches thick. It is black in the upper part and very dark brown and very dark grayish brown in the lower part. The subsoil is dark yellowish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. In some places the surface soil is less than 24 inches thick or is calcareous. In other places the subsoil has more clay than the surface layer. In a few areas the soil is somewhat poorly drained. In some areas the underlying material is stratified sandy and silty material.

Permeability is moderate. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Runoff is medium.

Most areas are used as cropland. This soil is well suited to intensive cultivation. Maintaining fertility and tilth is the main management concern. Applying a system of minimum tillage and returning crop residue to the soil help to maintain good tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, undesirable weeds can become established.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is well suited to building site development and septic tank absorption fields. It is poorly suited to local roads and streets because of low strength. Well compacted base material that has more strength should be used in the roadbed.

The land capability classification is I.

106B—Lester loam, 2 to 8 percent slopes. This undulating, well drained soil is on ridges, knolls, and convex side slopes on glacial till plains. Individual areas are irregular in shape and range from 3 to about 70 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsoil is dark brown and dark yellowish brown clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some places the dark surface layer is more than 10 inches thick. In other places the subsoil contains more clay and less sand. In some areas the soil has seams and pockets of sand or gravel. In a few areas it is moderately well drained.

Included with this soil in mapping are small areas of the well drained Swanlake and poorly drained Webster

soils. Swanlake soils are on the more sloping peaks and ridges. They are calcareous. Webster soils are in swales and on toe slopes.

Permeability is moderate in the Lester soil. The available water capacity is high. The organic matter content is moderate. The surface layer is medium acid or slightly acid. Surface runoff is medium.

Most areas are forested and are used as pasture or woodland. In areas that have been cleared, this soil is well suited to cultivation. Water erosion is the main management concern. It can be controlled by a cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface. Applications of lime are needed in some areas. Returning crop residue to the soil and minimizing tillage can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

This soil is well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The shrink-swell potential of the subsoil is the main limitation. Properly designed footings and basement walls can withstand the shrink-swell action of the soil. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

Because of the restricted permeability, this soil is only fairly well suited to septic tank absorption fields. Enlarging the absorption field helps to overcome this limitation.

Because of low strength, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed.

The land capability classification is IIe.

110—Marna silty clay. This nearly level, poorly drained soil is on flats and in swales and drainageways on till plains and ground moraines mantled with lacustrine sediments. Individual areas are irregular in shape and range from 3 to about 80 acres in size.

Typically, the surface layer is black silty clay about 9 inches thick. The subsurface layer is about 11 inches thick. It is black silty clay in the upper part and very dark gray, mottled clay in the lower part. The subsoil is olive gray, mottled clay about 8 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled silty clay loam and clay loam. In some places the surface layer is mildly alkaline. In other places the dark surface soil is more than 24 inches thick. In some areas the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the very poorly drained Okoboji soils. These soils are in closed depressions and are subject to ponding.

Permeability is slow in the Marna soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas are farmed. If properly managed, this soil is well suited to intensive cropping. The main management concerns are overcoming the excessive wetness and maintaining good tilth. Ditches and subsurface drainage lines can improve drainage. The soil is subject to severe compaction when wet. Returning crop residue to the soil and deferring fieldwork when the soil is too wet can help to prevent excessive compaction and improve tilth.

This soil is well suited to pasture and hay. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction. A drainage system and applications of fertilizer can increase hay production.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is poorly suited to building site development. Wetness and a high shrink-swell potential are the main limitations. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table. Properly designed footings and basement walls can withstand the shrink-swell action of the soil.

Because of the high water table and the restricted permeability, this soil is poorly suited to septic tank absorption fields. A mound system helps to overcome these limitations. The water table can be lowered by artificial drains. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength, frost action, and the shrink-swell potential, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

112—Harps clay loam. This nearly level, poorly drained, calcareous soil is on the slightly convex rims of depressions on till plains. Individual areas are irregular in shape and range from 3 to about 25 acres in size.

Typically, the surface layer is black, calcareous clay loam about 9 inches thick. The subsurface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 16 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, mottled, calcareous loam. In some places the surface soil and subsoil are silt loam or contain less lime. In other places an accumulation of gypsum is at or near the surface. In some areas the soil has seams and pockets of sand and gravel. In other areas it has more sand and less clay.

Included with this soil in mapping are areas of the very poorly drained Glencoe and Okoboji soils and the moderately well drained Seaforth soils. Glencoe and Okoboji soils are in closed depressions and are subject to ponding. Seaforth soils are on slight rises.

Permeability is moderate in the Harps soil. The available water capacity and organic matter content are high. The surface layer is moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are farmed. This soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and maintain fertility and tilth. The wetness can be reduced by subsurface drainage lines and by ditches. The soil has enough lime to cause a fertility imbalance. Yields of soybeans can be reduced by chlorosis. Applying a system of conservation tillage that leaves crop residue on the surface and returning crop residue to the soil help to maintain tilth and reduce the hazard of soil blowing.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

113—Webster silty clay loam. This nearly level, poorly drained soil is in swales and on flats on glacial till plains. Individual areas are irregular in shape and range from 3 to about 80 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The next layer is black silty clay loam about 6 inches thick. Below this is very dark gray silty clay loam about 4 inches thick. The subsoil is grayish brown, mottled clay loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous clay loam. In some places the surface layer and subsoil contain more clay or are mildly alkaline. In other places the soil has seams and pockets of sand or gravel. In a few areas it is somewhat poorly drained. In some areas it has more sand and less clay.

Included with this soil in mapping are areas of the very poorly drained Glencoe and Okoboji soils. These soils are in depressions and are subject to ponding.

Permeability is moderate in the Webster soil. The available water capacity and organic matter content are high. Reaction is neutral in the surface layer. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas are used as cropland. If properly managed, this soil is well suited to intensive cropping. The main management needs are measures that improve drainage and maintain tilth and fertility. Ditches and subsurface drainage lines can reduce the wetness. Returning crop residue to the soil and deferring fieldwork when the soil is too wet improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in depressions on ground moraines. It is frequently ponded for brief or long periods. Individual areas typically are oval or elongated and range from 3 to about 15 acres in size.

Typically, the surface layer is black clay loam about 21 inches thick. The next layer also is black clay loam. It is about 18 inches thick. The subsoil is olive gray, mottled loam about 5 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places the surface soil is less than 24 inches thick or contains lime. In other places the subsoil has more clay than the surface soil. In some areas the underlying material contains more sand and less clay. In other areas layers of silty or sandy material are in the lower part of the profile.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Harps soils and the very poorly drained Palms soils. Canisteo and Harps soils are on the higher lying rises within depressions or on the fringe of the mapped areas. Palms soils are in the center of some depressions. They are muck to a depth of more than 16 inches.

Permeability is moderately slow in the Glencoe soil. The available water capacity is high. The organic matter content is high or very high. The surface layer is neutral or mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Undrained or partly drained areas support marsh vegetation and provide excellent habitat for wildlife. If drained, this soil is fairly well suited to all of the crops commonly grown in the county. The main management needs are measures that improve drainage and maintain fertility and tilth. A system of subsurface drainage lines connected to a suitable outlet can lower the water table. A surface inlet can provide rapid drainage of ponded surface water. Returning crop residue to the soil can help to maintain tilth.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks tend to form if the pasture is grazed when too wet. Deferment of grazing when the soil is wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the ponding, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the unstable surface soil should be removed. Constructing the roads on raised, well compacted, coarse textured fill material, establishing adequate side ditches, and installing culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

130A—Nicollet silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained and moderately well drained soil is in plane areas and on rises on water-modified glacial till plains. Individual areas are irregular in shape and range from 3 to about 80 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 9 inches thick. The subsoil is dark grayish brown, mottled clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some areas the soil is poorly drained. In other areas it is calcareous throughout. In places layers and pockets of sandy or gravelly material are in the lower part of the profile.

Permeability is moderate. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are farmed. This soil is well suited to intensive cultivation. Maintaining tilth and fertility is the main management concern. Returning crop residue to the soil improves tilth.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The wetness is the main limitation. Seepage into basements can be a problem. It can be controlled by installing the footings above the water table. If drainage lines are installed along the footings, surface water can be intercepted before it enters the basement. Stronger base material should be used under the footings and basement floor.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines can be

increased by installing the lines in a mound of suitable fill material. Also, a drainage system helps to lower the water table.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is I.

130B—Nicollet clay loam, 2 to 5 percent slopes. This undulating, somewhat poorly drained and moderately well drained soil is on convex side slopes and knolls on till plains. Individual areas are irregular in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsoil is olive brown clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the soil is poorly drained. In other places the depth to lime is less than 20 inches. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with this soil in mapping are small areas of the well drained Swanlake and Ves soils. These soils are on knobs and ridges.

Permeability is moderate in the Nicollet soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are farmed. This soil is well suited to all of the crops commonly grown in the county. The main management needs are measures that control erosion and maintain fertility and tilth. A cropping sequence that includes grasses and legumes, a system of conservation tillage that leaves crop residue on the surface, and grassed waterways help to control erosion. Returning crop residue to the soil and minimizing tillage help to maintain tilth.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The wetness is the main limitation. Seepage into basements can be a problem. It can be controlled by installing the footings above the water table. If drainage lines are installed along the footings, surface water can be intercepted before it enters the basement. Stronger base material should be used under the footings and basement floor.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines can be increased by installing the lines in a mound of suitable fill material. Also, a drainage system helps to lower the water table.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted, coarse textured base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

134—Okoboji silty clay loam. This nearly level, very poorly drained soil is in depressions on till plains. It is frequently ponded for brief or long periods. Individual areas are typically oval or elongated and range from 3 to about 25 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The next layer is black silty clay about 15 inches thick. Below this is very dark gray silty clay loam about 7 inches thick. The subsoil is olive gray, mottled silty clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silt loam. In some places the surface soil is less than 24 inches thick. In other places the subsoil has less clay and more silt. In some areas loamy glacial till is at a depth of 30 to 60 inches.

Included with this soil in mapping are small areas of the very poorly drained Palms soils. These soils are typically near the center of the depressions. They are muck to a depth of more than 16 inches.

Permeability is moderately slow in the Okoboji soil. The available water capacity is high. The organic matter content is very high. The surface layer is neutral or mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are drained and are used as cropland. Undrained or partly drained areas support marsh vegetation and provide habitat for wildlife. If drained, this soil is fairly well suited to all of the crops commonly grown in the county. The main management needs are measures that improve drainage and maintain fertility and tilth. A system of subsurface drainage lines connected to a suitable outlet can lower the water table. A surface inlet can rapidly drain ponded surface water. Returning crop residue to the soil helps to maintain tilth.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads and streets are built across areas of this soil, stronger fill material is needed in the roadbed. The surface soil should be removed before the base is laid. A

drainage system that includes culverts helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

140—Spicer silty clay loam. This nearly level, poorly drained, calcareous soil is in swales and on flats in the uplands. Individual areas are irregular in shape and range from 3 to about 60 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The next layer is very dark gray, calcareous silty clay loam about 6 inches thick. Below this is very dark gray, mottled, calcareous silt loam about 6 inches thick. The subsoil is grayish brown, mottled, calcareous silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous silt loam. In some places an accumulation of lime is in the upper part of the subsoil. In other places the soil contains less clay and more sand throughout. In some areas layers of sandy material are in the lower part of the profile.

Included with this soil in mapping are small areas of the very poorly drained Okoboji soils. These soils are in closed depressions and are subject to ponding.

Permeability is moderate in the Spicer soil. The available water capacity is high or very high. The organic matter content is high. The surface layer is mildly alkaline or moderately alkaline. Runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. If properly managed, this soil is well suited to intensive cropping. The main management needs are measures that improve drainage and maintain fertility and tilth. Ditches and subsurface drainage lines can reduce the wetness. Tilling in the fall, which helps to prevent compaction, and returning crop residue to the soil can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

230A—Guckeen clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is in plane areas and on rises on ground moraines and till plains mantled with lacustrine sediments. Individual areas are irregular in shape and range from 3 to about 30 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is very dark grayish brown clay about 6 inches thick. The subsoil is dark grayish brown, mottled, firm clay about 16 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam. In some places the surface soil and subsoil are calcareous or are loam. In other places the underlying material contains more clay and less sand. In some areas the soil is poorly drained.

Included with this soil in mapping are areas of the very poorly drained Okoboji soils. These soils are in depressions and are subject to ponding.

Permeability is slow or moderately slow in the Guckeen soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is medium. The seasonal high water table is at a depth of 2.0 to 3.5 feet.

Most areas are farmed. This soil is well suited to cultivation. The main management needs are measures that maintain tilth and fertility. The soil is highly susceptible to compaction. Deferring fieldwork when the soil is too wet and returning crop residue to the soil can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Seedling mortality is severe because the high content of clay causes moisture stress. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness and the shrink-swell potential, this soil is poorly suited to building site development. Installing drainage lines around the footings reduces the wetness. The footings should be installed above the

water table. Properly designed footings and basement walls can withstand the shrink-swell action of the soil.

Because of the high water table and the restricted permeability, this soil is poorly suited to septic tank absorption fields. Installing the distribution lines in a mound of suitable fill material and lowering the water table with artificial drains help to overcome these limitations. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

230B—Guckeen clay loam, 2 to 6 percent slopes. This undulating, somewhat poorly drained soil is on convex side slopes and knolls on ground moraines and till plains mantled with lacustrine sediments. Individual areas are irregular in shape and range from 3 to about 80 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay about 4 inches thick. The subsoil is dark grayish brown, mottled, firm clay about 14 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous clay loam. In some places, the subsoil is thinner and the depth to lime is less than 18 inches. In other places the underlying material contains more clay and less sand. In some areas layers of sandy or gravelly material are in the subsoil and the underlying material. In a few areas the soil is poorly drained.

Included with this soil in mapping are areas of the very poorly drained Okoboji soils. These soils are in closed depressions and are subject to ponding.

Permeability is slow or moderately slow in the Guckeen soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is medium. The seasonal high water table is at a depth of 2.0 to 3.5 feet.

Most areas are farmed. This soil is well suited to cultivation. The main management needs are measures that control erosion and maintain tilth and fertility. A cropping sequence that includes grasses and legumes, a system of conservation tillage that leaves crop residue on the surface, grassed waterways, and stripcropping help to control erosion. Deferring fieldwork when the soil is too wet and returning crop residue to the soil improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Seedling mortality is severe because the high content of clay causes moisture stress. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness and the shrink-swell potential, this soil is poorly suited to building site development. Installing drainage lines along the footings reduces the wetness. The footings should be installed above the water table. Properly designed footings and basement walls can withstand the shrink-swell action of the soil.

Because of the high water table and the restricted permeability, this soil is poorly suited to septic tank absorption fields. Installing the distribution lines in a mound of suitable fill material and lowering the water table with artificial drains help to overcome these limitations. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

238B—Kilkenny clay loam, 2 to 6 percent slopes. This undulating, well drained and moderately well drained soil is on ridges, knolls, and convex side slopes on moraines. Individual areas are irregular in shape and range from 3 to about 60 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark brown clay loam, and the lower part is olive brown, mottled clay and clay loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the dark surface soil is more than 10 inches thick. In other places the underlying material has less clay and more sand. In some areas the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the poorly drained Marna and well drained Sunburg soils. Marna soils are in swales. Sunburg soils are on the more sloping peaks and ridges. They are calcareous.

Permeability is moderately slow in the Kilkenny soil. The available water capacity is high. The organic matter content is moderate. The surface layer is medium acid or slightly acid. Surface runoff is medium.

Most areas are used as cropland. Some are used as woodland or pasture. This soil is well suited to cultivation. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. In some areas additions of lime are needed.

Returning crop residue to the soil and minimizing tillage can improve tilth.

The soil is well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

This soil is well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The shrink-swell potential is the main limitation. Properly designed footings and basement walls can withstand the shrink-swell action of the soil. Drainage lines around the footings help to keep basements dry during unusually wet periods, when seepage can be a problem.

Because of the restricted permeability, this soil is poorly suited to septic tank absorption fields. Enlarging the absorption field helps to overcome this limitation.

Because of low strength, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed.

The land capability classification is IIe.

238C—Kilkenny clay loam, 6 to 12 percent slopes. This rolling, well drained and moderately well drained soil is on ridges, knolls, and convex side slopes on moraines. Individual areas are irregular in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsoil is clay loam about 16 inches thick. The upper part is dark yellowish brown, and the lower part is olive brown and mottled. The underlying material to a depth of about 60 inches is light olive brown and olive brown, mottled, calcareous loam. In some places the dark surface soil is more than 10 inches thick. In other places the underlying material has less clay and more sand. In a few areas the soil is somewhat poorly drained.

Included with this soil in mapping are small areas of the poorly drained Marna and well drained Sunburg soils. Marna soils are in swales and on toe slopes. Sunburg soils are on peaks and ridges.

Permeability is moderately slow in the Kilkenny soil. The available water capacity is high. The organic matter content is moderate. The surface layer is medium acid or slightly acid. Surface runoff is medium.

Most areas are used as cropland. Some are used as woodland or pasture. This soil is fairly well suited to cultivation. The hazard of erosion is severe. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Some areas that have uniform slopes are suitable for terracing. In some areas applications of lime are needed. Returning crop residue to the soil and minimizing tillage can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

This soil is well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The shrink-swell potential and the slope are the main limitations. Properly designed footings and basement walls can withstand the shrink-swell action of the soil. Drainage lines around the footings help to keep basements dry during unusually wet periods, when seepage can be a problem. Unless the exposed surface is protected, erosion is a hazard during construction. It can be controlled by a cover crop.

Because of the restricted permeability, this soil is poorly suited to septic tank absorption fields. Enlarging the absorption field helps to overcome this limitation.

Because of low strength, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed.

The land capability classification is IIIe.

336—Delft loam. This nearly level, poorly drained soil is in swales and drainageways and on toe slopes on ground moraines and till plains. Individual areas are typically elongated and range from 3 to about 25 acres in size.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The next layer is black loam about 11 inches thick. Below this is very dark gray, calcareous clay loam about 9 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous sandy loam. In some places the surface soil is less than 24 inches thick and is calcareous. In other places the subsoil has more clay than the surface layer. In some areas layers of sandy or gravelly material are in the subsoil and the underlying material. In a few areas the soil is moderately well drained.

Included with this soil in mapping are small areas of the very poorly drained Glencoe soils. These soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderately slow in the Delft soil. The available water capacity and organic matter content are high. The surface layer is slightly acid to mildly alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. If properly managed, this soil is well suited to intensive cropping. The main management needs are measures that improve drainage and maintain fertility and tilth. Ditches and subsurface drainage lines can reduce the wetness. Tilling in the fall, which helps to prevent compaction, and returning crop residue to the soil can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table and the restricted permeability, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a drainage system. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

392—Biscay loam. This nearly level, poorly drained soil is in swales and on toe slopes on glacial outwash plains. Individual areas are irregular in shape and range from 3 to about 20 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 9 inches thick. The subsoil is olive gray, mottled sandy clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous coarse sand. In some places the surface soil and subsoil are mildly alkaline. In other places the loamy mantle is less than 20 inches thick.

Included with this soil in mapping are small areas of the very poorly drained, depressional Biscay soils and the moderately well drained Osakis soils. The depressional Biscay soils are subject to ponding. Osakis soils are on slight rises.

Permeability is moderate in the upper part of the Biscay soil and rapid in the underlying material. The available water capacity is moderate. The organic matter content is high. The surface layer is slightly acid to mildly alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are cultivated or pastured. This soil is well suited to cultivated crops. The main management concerns are improving drainage and maintaining fertility and tilth. Subsurface drainage lines and ditches can reduce the wetness. Draining the soil may be difficult, however, because suitable outlets are not available in some areas. Also, ditchbanks tend to cave in and tile lines may fill with sediment if they are unprotected. If the soil is drained, drought is a slight hazard. Returning crop residue to the soil and deferring tillage when the soil is very wet helps to maintain tilth.

This soil is well suited to pasture and hay. Deferment of grazing when the soil is too wet and proper stocking rates help to keep the pasture in good condition. A drainage system and applications of fertilizer can increase hay production.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because of the high water table and a poor filtering capacity in the underlying material, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas a mound system can be used. If the site is mounded, the effluent is adequately filtered before it reaches the water table and underlying material.

Because of low strength and frost action, this soil is poorly suited to local road and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

399—Biscay loam, depressional. This nearly level, very poorly drained soil is in depressions and drainageways on glacial outwash plains. It is commonly ponded for brief periods. Individual areas are irregular in shape and range from 3 to about 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is about 11 inches thick. It is black loam in the upper part and very dark gray sandy clay loam in the lower part. The subsoil is olive gray loam about 9 inches thick. The underlying material to a depth of about 60 inches is dark gray and olive gray, calcareous loamy sand and gravelly coarse sand. In some places the surface layer is muck. In other places the loamy mantle is less than 20 inches thick. In some areas the dark surface soil is more than 24 inches thick. In a few areas the soil is calcareous throughout.

Included with this soil in mapping are small areas of the very poorly drained Palms soils that have a sandy substratum. These soils are typically on the lowest part of the landscape. They are muck to a depth of more than 16 inches.

Permeability is moderate in the upper part of the Biscay soil and rapid in the underlying material. The available water capacity is moderate. The organic matter content is high. The surface layer is slightly acid to mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are used as pasture or wildlife habitat. This soil is only fairly well suited to cultivated crops because of the excessive wetness. The main management concerns are improving drainage and maintaining fertility and tilth. Subsurface drainage lines and ditches can reduce the wetness. Draining the soil may be difficult, however, because suitable outlets are not available in some areas. Also, ditchbanks tend to cave in and tile lines may fill with sediment if they are unprotected. Returning crop residue to the soil and deferring tillage when the soil is too wet help to maintain tilth. Corn and soybeans cannot reach maturity in some years because of delayed spring planting or early frost.

This soil is fairly well suited to pasture and hay. It is generally too wet for alfalfa hay. Deferment of grazing when the soil is too wet and proper stocking rates help to keep the pasture in good condition. Hay production can be increased by improving drainage and by planting species that can withstand the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. Roads that cross areas of this soil should be built on raised, well compacted, coarse textured fill material. Adequate side ditches and culverts help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

413—Osakis sandy loam. This nearly level, moderately well drained soil is on broad flats and slight rises on glacial outwash plains. Individual areas are irregular in shape and range from 3 to more than 100 acres in size.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 10 inches thick. It is dark brown. The upper part is sandy loam, and the lower part is loamy coarse sand. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous gravelly coarse sand and coarse sand. In some places the loamy mantle is more than 20 or less than 10 inches thick. In other places the soil is well drained. In some areas the underlying material is banded silty or loamy material.

Included with this soil in mapping are areas of the very poorly drained Biscay soils in low lying depressions. These soils are subject to ponding.

Permeability is moderately rapid in the upper part of the Osakis soil and rapid in the underlying material. The available water capacity is low. The organic matter content is moderate. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are cultivated or are used as pasture and hayland. Because of the hazard of drought, this soil is only fairly well suited to crops. The main management concerns are the hazards of drought and soil blowing and the level of fertility. The soil is well suited to irrigation. Crop response to irrigation is generally good. Areas that are not irrigated are better suited to shallow-rooted, early maturing crops than to other crops. A system of conservation tillage that leaves crop residue on the surface and field windbreaks conserve moisture and help to control soil blowing in winter and spring.

Because of the hazard of drought, this soil is only fairly well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, weeds can become established. Hay production can be increased by irrigation.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The seasonal high water table is the main limitation. The footings should be installed above the

water table. Fill can be used to backfill around shallow footings, or the footings can be installed in suitable fill material. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because of the high water table and a poor filtering capacity in the underlying material, this soil is poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water. A mound system can increase the distance between the water table and the distribution lines and can improve the filtering capacity.

This soil is fairly well suited to local roads and streets. The main problem is frost action. Coarse textured base material that is more resistant to frost action is needed in the roadbed. Properly designed road ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIs.

423—Seaforth loam. This nearly level, moderately well drained, calcareous soil is on knolls, side slopes, and ridges on glacial till plains. Individual areas are irregular in shape and range from 3 to about 20 acres in size.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsoil is light olive brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places reaction is neutral in the surface layer and subsoil. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas it is well drained.

Included with this soil in mapping are small areas of the poorly drained Canisteo and well drained Ves soils. Canisteo soils are on toe slopes or in the lower lying areas. Ves soils are on strongly sloping knobs and ridges.

Permeability is moderate in the Seaforth soil. The available water capacity and organic matter content are high. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are farmed. This soil is well suited to all of the crops commonly grown in the county. In some areas, however, yields of the crops that are adversely affected by a high content of lime are reduced. The main management concern is maintaining fertility and tilth. Returning crop residue to the soil improves tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The seasonal high water table is a limitation. Seepage into basements can be a problem. It can be minimized by installing drainage lines along basement walls.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines can be increased by installing the lines in a mound of suitable fill material. Also, a drainage system helps to lower the water table.

Because of frost action, this soil is poorly suited to local roads and streets. Base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIs.

444—Canisteo silty clay loam. This nearly level, poorly drained, calcareous soil is in plane or concave areas or on slight rises on glacial till plains. Individual areas are irregular in shape and range from 3 to about 200 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 10 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In places the surface soil and subsoil are neutral or are loam or clay. In some areas an accumulation of lime is in the upper 16 inches. In other areas the lower part of the soil has layers of sandy material.

Included with this soil in mapping are areas of the very poorly drained Okoboji and moderately well drained Seaforth soils. Okoboji soils are in low lying, closed depressions and are subject to ponding. Seaforth soils are on knolls and ridges.

Permeability is moderate in the Canisteo soil. The available water capacity and organic matter content are high. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. If properly managed, this soil is well suited to intensive cropping. The main management needs are measures that improve drainage and maintain fertility and tilth. Ditches and subsurface drainage lines can reduce the wetness. Minimizing tillage and returning crop residue to the soil can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

446A—Normania loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is in plane areas and on rises on till plains. Individual areas are irregular in shape and range from 5 to about 200 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, calcareous loam about 21 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the surface soil and subsoil are silty clay loam or silt loam or are calcareous. In areas where it is mixed with the subsoil by plowing, the surface layer is lighter in color. In some areas the soil has seams and pockets of sand or gravelly material. In a few areas it is well drained.

Included with this soil in mapping are areas of the very poorly drained Glencoe and poorly drained Marna and Webster soils. Glencoe soils are in low lying, closed depressions and are subject to ponding. Marna and Webster soils also are in low lying depressions but are not subject to ponding.

Permeability is moderate in the Normania soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are farmed. This soil is well suited to intensive cultivation. Maintaining fertility and tilth is the main management concern. Applying a system of minimum tillage and returning crop residue to the soil improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The seasonal high water table is a limitation. Seepage into basements can be a problem. It can be minimized by installing drainage lines along the footings.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines can be increased by installing the lines in a mound of suitable fill material. Also, a drainage system helps to lower the water table.

Because of frost action, this soil is poorly suited to local roads and streets. Well compacted base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is I.

446B—Normania loam, 2 to 5 percent slopes. This undulating, moderately well drained soil is on convex side slopes and knolls on till plains. Individual areas are irregular in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is loam about 23 inches thick. The upper part is olive brown, and the lower part is light olive brown, mottled, and calcareous. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In areas where it has been mixed with the subsoil by plowing, the surface layer is lighter colored. In places the surface layer and subsoil contain more clay and less sand or are calcareous. In a few areas the soil is well drained. In some areas it has pockets of sandy or gravelly material.

Included with this soil in mapping are areas of the very poorly drained Okoboji, well drained Swanlake, and poorly drained Webster soils. Okoboji soils are in low lying depressions and are subject to ponding. Swanlake soils are on the more sloping knobs and ridges. Webster soils are in low lying swales and on toe slopes.

Permeability is moderate in the Normania soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is medium. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas are farmed. This soil is well suited to all of the crops commonly grown in the county. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The wetness is a limitation. Seepage into basements can be a problem. It can be controlled by installing drainage lines along the footings.

Because of the high water table, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines can be increased by installing the lines in a mound of suitable fill material. Also, a drainage system helps to lower the water table.

Because of frost action, this soil is poorly suited to local roads and streets. Well compacted base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

447—Harpster silty clay loam. This nearly level, poorly drained, calcareous soil is on the convex rims of depressions or on broad flats on till plains. Individual areas are irregular in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 8 inches thick. The subsoil is grayish brown, mottled, calcareous silty clay loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous silt loam. In some places the dark surface soil is more than 24 inches thick. In other places the surface soil and subsoil contain less clay and more sand or contain less lime. In some areas an accumulation of gypsum is at or near the surface. In other areas the underlying material has seams or pockets of sandy material.

Included with this soil in mapping are areas of the very poorly drained Okoboji soils. These soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderate in the Harpster soil. The available water capacity is high or very high. The organic matter content is high. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 2 feet.

Most areas are farmed. If properly managed, this soil is well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and maintain fertility and tilth. The wetness can be reduced by subsurface drainage lines and by ditches. The excessive amount of lime in the soil can cause a fertility imbalance. Yields of crops, especially soybeans, can be reduced by chlorosis. Returning crop residue to the soil and minimizing tillage help to maintain tilth and reduce the hazard of soil blowing.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

This soil is poorly suited to septic tank absorption fields because of the wetness. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, this soil is poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

462E—Sunburg fine sandy loam, 18 to 25 percent slopes. This steep, well drained soil is on ridges, knolls, and convex side slopes on ground moraines. Individual areas are elongated and range from 3 to about 20 acres in size.

Typically, the surface layer is very dark grayish brown, calcareous fine sandy loam about 7 inches thick. The upper part of the underlying material is brown, calcareous loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In

some areas the underlying material has seams and pockets of sandy or gravelly material.

Included with this soil in mapping are areas of the excessively drained Hawick and moderately well drained Terril soils. Hawick soils are sandy. Terril soils are on low lying toe slopes.

Permeability is moderately rapid in the Sunburg soil. The available water capacity is moderate or high. The organic matter content is moderately low or moderate. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is rapid.

Most areas are used as pasture or wildlife habitat. This soil is generally unsuitable as cropland because of the slope and a severe hazard of erosion. A permanent cover of vegetation helps to prevent excessive erosion.

This soil is poorly suited to pasture. Applications of fertilizer and weed control increase forage production. Overgrazing reduces the extent of the protective plant cover and thus increases the erosion hazard.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand a high content of lime, which ties up minerals and limits their availability. The normal effectiveness of the windbreaks is reduced because of the slope. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, this soil is generally unsuited to building site development and sanitary facilities. The erosion hazard is severe in disturbed areas. Soils that are better suited to these uses are generally nearby.

Because of the slope, this soil is poorly suited to local roads and streets. Erosion-control measures, such as seeding, mulching, and diversions, are needed during and after construction.

The land capability classification is VIe.

523—Houghton muck. This nearly level, very poorly drained, organic soil is in large basins on glacial outwash plains and ground moraines. It is frequently ponded. Individual areas are irregular in shape and range from 10 to about 100 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The underlying material to a depth of about 60 inches also is black muck. In some places the soil is calcareous throughout. In other places the organic material is less decomposed mucky peat. In some areas the underlying material is coprogenous earth. In other areas the muck is less than 50 inches thick.

Included with this soil in mapping are small areas of the excessively drained Hawick and poorly drained Regal soils. These soils are on ridges along the outer edge of the mapped areas.

Permeability is moderately slow to moderately rapid in the Houghton soil. The available water capacity and organic matter content are very high. The surface layer is slightly acid or neutral. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained or partly drained and support marsh vegetation. They provide habitat for wildlife. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and fertility and control soil blowing. Open ditches that have an adequate grade can lower the water table enough to allow cultivation. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and leaving the surface rough and cloddy help to control soil blowing in the fall and spring, when the soil is subject to strong, drying winds. Small grain crops tend to lodge. Corn may not reach full maturity because of delayed spring planting or early frost.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks commonly form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the organic material should be replaced with suitable, well compacted fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

525—Muskego muck. This nearly level, very poorly drained, organic soil is in basins on ground moraines and outwash plains. It is frequently ponded. Individual areas are irregular in shape and range from 10 to about 100 acres in size.

Typically, the surface layer is black muck about 19 inches thick. The underlying material to a depth of about 60 inches is coprogenous earth. It is black and very dark gray mucky silt loam. In places the surface layer is calcareous or is less decomposed. In some areas mineral soil material is within a depth of 60 inches.

Included with this soil in mapping are areas of the excessively drained Hawick and poorly drained Regal soils. These soils are on beach ridges along the fringes of the mapped areas.

Permeability is moderately rapid in the upper part of the Muskego soil and slow in the underlying material. The available water capacity and organic matter content are very high. The surface layer is medium acid to neutral. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained or partly drained and support marsh vegetation. They provide excellent habitat for wildlife. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and fertility and control soil blowing. Open ditches that have an adequate grade can lower the water table enough to allow cultivation. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and leaving the surface rough and cloddy help to control soil blowing in fall and spring, when the soil is subject to strong, drying winds. Small grain crops tend to lodge. Corn may not reach full maturity because of delayed spring planting or early frost.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks commonly form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the organic material should be replaced with suitable, well compacted fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

539—Palms muck. This nearly level, very poorly drained, organic soil is in depressions and basins on ground moraines and till plains. It is frequently ponded. Individual areas are irregular in shape and range from 5 to about 60 acres in size.

Typically, the surface layer is black muck about 27 inches thick. The next 15 inches is black and very dark gray silty clay loam and loam. The underlying material to a depth of about 60 inches is olive gray, calcareous silt loam and loam. In some places the surface layer is less decomposed mucky peat. In other places it is less than 16 inches thick. In some areas the organic material is more than 50 inches thick.

Included with this soil in mapping are areas of the excessively drained Hawick and poorly drained Regal soils. These soils are on ridges along the fringes of the mapped areas.

Permeability is moderately slow to moderately rapid in the organic part of the Palms soil and moderate in the underlying material. The available water capacity and organic matter content are very high. The surface layer is medium acid to mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained or partly drained and support marsh vegetation. They provide excellent habitat for wildlife. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and fertility and control soil blowing. Open ditches and subsurface drainage lines that have an adequate grade can lower the water table enough to allow cultivation. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and leaving the surface rough and cloddy help to control soil blowing in fall and spring, when the soil is subject to strong, drying winds. Small grain crops tend to lodge. Corn may not reach full maturity because of delayed spring planting or early frost.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks commonly form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the organic material should be replaced with suitable, well compacted fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

548—Palms muck, sandy substratum. This nearly level, very poorly drained, organic soil is in depressions and basins on glacial outwash plains. It is frequently ponded. Individual areas are irregular in shape and range from 5 to about 60 acres in size.

Typically, the organic material is black muck about 27 inches thick. The next layer is black mucky loam about 8 inches thick. The subsoil is olive gray, mottled sandy clay loam about 4 inches thick. The underlying material to a depth of about 60 inches is olive gray, calcareous gravelly loamy coarse sand. In some places the surface layer is sedimentary peat. In other places it is less than 16 inches thick.

Included with this soil in mapping are areas of the very poorly drained, depressional Biscay soils and the very poorly drained Houghton soils. The Biscay soils are around the fringes of the depressions. They do not have an organic surface layer. Houghton soils are typically in the center of the depressions. They have more than 50 inches of organic material.

Permeability is moderately rapid to moderately slow in the organic part of the Palms soil and rapid in the underlying material. The available water capacity and organic matter content are very high. The surface layer is medium acid to mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained or partly drained and support marsh vegetation. A few partly drained areas are farmed. This soil is only fairly well suited to cultivated crops because of the excessive wetness. Draining the soil is difficult because outlets for drainage systems are generally not available. Subsurface drains may fill with sandy and silty material if they are unprotected. Ditches tend to cave in because of unstable sides. Small grain crops tend to lodge. Corn may not reach full maturity because of delayed spring planting or early frost.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks commonly form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the organic material should be replaced with suitable, well compacted fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

559—Lena muck. This nearly level, very poorly drained, calcareous, organic soil is in basins and drainageways on ground moraines. It is frequently ponded. Individual areas are irregular in shape and range from 10 to about 150 acres in size.

Typically, the surface layer is black, calcareous muck about 10 inches thick. The underlying material to a depth of about 60 inches is very dark gray and black, calcareous muck. In some places the organic material is less calcareous or is less decomposed. In other places the underlying material is coprogenous earth. In some areas mineral soil material is within a depth of 50 inches.

Included with this soil in mapping are areas of the excessively drained Hawick and poorly drained Regal soils. These soils are on ridges on the fringes of the mapped areas.

Permeability is moderately slow to moderately rapid in the Lena soil. The available water capacity and organic matter content are very high. The surface layer is mildly alkaline or moderately alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained or partly drained and support marsh vegetation. They provide excellent habitat for wildlife. If drained, this soil is fairly well suited to most of the crops commonly grown in the county. The main management needs are measures that improve drainage and fertility and control soil blowing. Open ditches that have an adequate grade can lower the water table enough to allow cultivation. Returning crop residue to the soil, applying a system of conservation tillage that leaves crop residue on the surface, and leaving the surface rough and cloddy help to control soil blowing in the fall and spring, when the soil is subject to strong, drying winds. Small grain crops tend to lodge. Corn may not reach full maturity because of delayed spring planting or early frost.

Unless drained, this soil is poorly suited to pasture and hay. The excessive wetness can prohibit grazing. Hummocks commonly form in pastured areas. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness. Because of the wetness, seedling mortality is severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and low strength, this soil is generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, this soil is poorly suited to local roads and streets. If roads are built across areas of this soil, the organic material should be replaced with suitable, well compacted fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

566—Regal loam. This nearly level, poorly drained, calcareous soil is on broad flats and in swales on outwash plains. Individual areas are irregular in shape and range from 3 to about 100 acres in size.

Typically, the surface layer is black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous loam about 4 inches thick. The subsoil is grayish brown, mottled, calcareous sandy clay loam about 4 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous gravelly loamy sand and gravelly coarse sand. In some places the loamy mantle is more than 20 inches thick. In other places an accumulation of lime is in the upper 16 inches. In some areas the upper part of the underlying material is stratified loamy and silty material.

Included with this soil in mapping are small areas of the very poorly drained, depressional Biscay soils and the moderately well drained Osakis soils. The Biscay soils are in low lying, closed depressions and are subject to ponding. Osakis soils are on the higher lying rises.

Permeability is moderate in the upper part of the Regal soil and rapid in the underlying material. The available water capacity is low. The organic matter content is high. The surface layer is neutral to moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are cultivated or pastured. This soil is fairly well suited to cultivated crops. The main management concerns are improving drainage and maintaining fertility and tilth. Subsurface drainage lines and ditches can reduce the wetness. Draining the soil may be difficult, however, because suitable outlets are not available in some areas. Also, ditchbanks tend to cave in, and tile lines may fill with sediment if they are unprotected. If the soil is drained, drought is a slight hazard. Returning crop residue to the soil and deferring tillage when the soil is too wet help to maintain tilth.

This soil is fairly well suited to pasture and hay. Deferment of grazing when the soil is too wet and proper stocking rates help to keep the pasture in good condition. The species selected for planting on hayland should be those that can withstand the wetness. A drainage system can significantly reduce the wetness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, this soil is poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed on coarse textured fill material above the seasonal high water table. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because of the high water table and a poor filtering capacity in the underlying material, this soil is poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas a mound system can be used. If the site is mounded, the effluent is adequately filtered before it reaches the water table and underlying material.

Because of wetness and frost action, this soil is only fairly well suited to local roads and streets. Well compacted base material that has more strength should be used to raise the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIw.

611D—Hawick gravelly loamy coarse sand, 12 to 20 percent slopes. This hilly, excessively drained soil is on ridges, knobs, and side slopes on glacial outwash plains. Individual areas are irregular in shape and range from 3 to about 40 acres in size.

Typically, the surface layer is black gravelly loamy coarse sand about 7 inches thick. The subsurface layer is very dark brown gravelly loamy coarse sand about 4 inches thick. The subsoil is dark brown, calcareous gravelly loamy coarse sand about 5 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and brown, calcareous gravelly coarse sand and coarse sand. In places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In some areas the soil has thin bands of loamy or silty material. In other areas the subsoil has more clay than the surface layer.

Included with this soil in mapping are areas of the well drained Sunburg and Wadena soils. Sunburg soils formed in loamy glacial till and are not so gravelly as the Hawick soil. Wadena soils are on low lying toe slopes.

Permeability is very rapid in the Hawick soil. The available water capacity is very low or low. The organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is rapid.

Most areas are used as hayland or pasture. Because of the slope and a severe hazard of drought, this soil is generally unsuitable as cropland. A permanent cover of vegetation helps to control erosion. The soil is generally too steep for irrigation.

This soil is poorly suited to pasture and hay because of the slope and the hazard of drought. Overgrazing reduces the extent of the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand droughty conditions. The normal effectiveness of the windbreaks is reduced because of the slope.

Seedling mortality is moderate because of the moisture stress caused by the low available water capacity. Some protective vegetation should be left on the surface during the early years of establishment because soil blowing is a hazard. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, this soil is poorly suited to building site development. The slope increases the cost of leveling and land shaping and the extent of erosion during and after construction. The buildings should be designed so that they conform to the natural slope of the land. Reestablishing a vegetative cover is difficult because of the droughtiness. Topsoil should be stockpiled or hauled in for later use in landscaping. As soon as construction is completed, the site should be either seeded and mulched or sodded. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because of the slope and the very rapid permeability, this soil is poorly suited to septic tank absorption fields. Hillside seepage and pollution of the local ground water are hazards. If possible, an alternative site should be selected.

Because of the slope, this soil is poorly suited to local roads and streets. The slope increases the cost of grading and land shaping and the extent of erosion. Erosion-control measures, such as seeding, mulching, and sodding, are needed during and after construction. Topsoil should be stockpiled for later use in landscaping. Establishing a plant cover is difficult because of the droughty nature of the soil.

The land capability classification is VIs.

611F—Hawick gravelly loamy coarse sand, 20 to 35 percent slopes. This steep and very steep, excessively drained soil is on ridges and knolls on glacial outwash plains. Individual areas are elongated and range from 3 to about 20 acres in size.

Typically, the surface layer is black gravelly loamy coarse sand about 6 inches thick. The subsoil is dark yellowish brown gravelly loamy coarse sand about 5 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In some areas the soil has bands of loamy or silty material.

Included with this soil in mapping are areas of the well drained Sunburg and Wadena soils. Sunburg soils are formed in loamy glacial till and are not so gravelly as the Hawick soil. Wadena soils are on low lying toe slopes.

Permeability is very rapid in the Hawick soil. The available water capacity is very low or low. The organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is rapid.

Most areas are pastured or are used as wildlife habitat. This soil is generally unsuitable as cropland and is poorly suited to pasture because of the slope and a severe hazard of drought. A permanent cover of vegetation is needed. Overgrazing can deplete the protective plant cover and increase the runoff rate and the erosion hazard. Also, weeds can become established in overgrazed areas.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand droughty conditions. The normal effectiveness of the windbreaks is reduced because of the slope. Seedling mortality is moderate because of the moisture stress caused by the low available water capacity. Some protective vegetation should be left on the surface during the early years of establishment because soil blowing is a hazard. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, this soil is generally unsuited to building site development and sanitary facilities. The hazard of erosion is severe in disturbed areas. Revegetating these areas is difficult because of the droughtiness. Soils that are better suited to these uses are generally nearby.

Because of the slope, this soil is poorly suited to local roads and streets. Erosion-control measures, such as seeding, mulching, and diversions, are needed during and after construction. Topsoil should be stockpiled for later use in landscaping. Revegetation is difficult in disturbed areas because of the droughty nature of the soil.

The land capability classification is VIIs.

613—Grovecity loam. This nearly level, somewhat poorly drained and moderately well drained soil is on flats and rises on ground moraines. Individual areas are irregular in shape and range from 3 to about 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is about 11 inches of olive brown and light olive brown sandy loam and fine sandy loam. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous fine sandy loam. In some places the brownish subsoil is exposed because of plowing. In other places the surface soil and subsoil are calcareous. In some areas the surface layer and subsoil are sandy clay loam or clay loam. In other areas the underlying material has seams and pockets of sandy or gravelly material. In places the soil is well drained.

Included with this soil in mapping are areas of the well drained Sunburg and poorly drained Webster soils. Sunburg soils are on the higher lying peaks and knobs. Webster soils are in swales.

Permeability is moderately rapid in the Grovecity soil. The available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. Surface runoff is slow. The seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are cropped. This soil is well suited to intensive cultivation. Maintaining fertility and tilth is the main management concern. Applying a system of minimum tillage and returning crop residue to the soil improve tilth.

This soil is well suited to pasture and hay. Applications of fertilizer and weed control increase forage production.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this soil. Cultivation or applications of herbicide help to remove competing vegetation.

This soil is fairly well suited to building site development. The high water table is a limitation. Seepage into basements can be a problem. It can be controlled by installing drainage lines along the footings.

Because of the wetness, this soil is poorly suited to septic tank absorption fields. The distance between the water table and the distribution lines should be increased. A mound type of absorption field is suitable in some areas.

Because of frost action, this soil is poorly suited to local roads and streets. Base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is I.

804B—Koronis-Hawick complex, 2 to 6 percent slopes. These undulating soils are on ground moraines and outwash plains. The well drained Koronis soil is on knolls, ridges, and convex side slopes. The excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are irregular in shape and range from 3 to about 40 acres in size. They are 50 to 85 percent Koronis soil and 15 to 50 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of very dark brown sandy loam about 5 inches thick. The subsurface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is dark yellowish brown sandy clay loam about 21 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places the dark surface soil is more than 10 inches thick.

Typically, the Hawick soil has a surface layer of very dark brown loamy sand about 10 inches thick. The subsoil is dark brown gravelly loamy sand about 14 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous gravelly coarse sand. In places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In some areas the underlying material contains more clay and less sand. In other areas the subsoil has more clay than the surface layer.

Included with these soils in mapping are areas of the poorly drained Delft and moderately well drained Terril soils. These included soils are in swales and on toe slopes.

In the Koronis soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is moderate. The surface layer is medium acid to neutral. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is medium on both soils.

Most areas are used as woodland or pasture. These soils are only fairly well suited to crops because drought is a severe hazard on the Hawick soil. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil, applying a system of conservation tillage, and leaving the surface rough can improve tilth and conserve moisture. Crop growth varies within short distances because of the droughty nature of Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

These soils are well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying. The seedling survival rate can be low on the Hawick soil because of droughtiness.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. The ones grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

The Koronis soil is well suited to septic tank absorption fields. The Hawick soil readily absorbs but

does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water.

The Hawick soil is well suited to local roads and streets, but the Koronis soil is only fairly well suited because of frost action. Well compacted base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIe.

804C—Koronis-Hawick complex, 6 to 12 percent slopes. These rolling soils are on ground moraines and outwash plains. The well drained Koronis soil is on convex side slopes and on knolls and ridges. The excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are irregular in shape and range from 3 to about 60 acres in size. They are 50 to 85 percent Koronis soil and 15 to 50 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of very dark brown sandy loam about 7 inches thick. The subsoil is dark brown and dark yellowish brown sandy clay loam about 22 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous fine sandy loam. In places the dark surface soil is more than 10 inches thick.

Typically, the Hawick soil has a surface layer of very dark grayish brown gravelly loamy coarse sand about 10 inches thick. The subsoil is dark brown gravelly loamy coarse sand about 12 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous gravelly coarse sand. In some places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In other places the underlying material has more clay and less sand. In some areas the subsoil has more clay than the surface layer. In other areas the underlying material is banded fine sand or silty material.

Included with these soils in mapping are small areas of the poorly drained Delft, moderately well drained Terril, and well drained Sunburg soils. Delft and Terril soils are on the lower lying toe slopes and in swales and drainageways. Sunburg soils are on the higher lying peaks and ridges.

In the Koronis soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is moderate. The surface layer is medium acid to neutral. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is medium on both soils.

Most areas are used as woodland or pasture. These soils are poorly suited to crops. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth. Crop growth varies within short distances because of the droughty nature of Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

These soils are well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying. The seedling survival rate can be low on the Hawick soil because of droughtiness.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. The ones grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be landscaped and should be either seeded and mulched or sodded. The buildings should be designed so that they conform to the natural slope of the land. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

The Koronis soil is fairly well suited to septic tank absorption fields. The slope is the main limitation. The absorption fields should be designed so that they conform to the natural slope of the land. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water.

These soils are only fairly well suited to local roads and streets. The main limitation is the slope. Also, the Koronis soil is subject to frost action. Coarse textured base material that is more resistant to frost action is needed in the roadbed. Erosion-control measures, such as seeding, mulching, land shaping, or sodding, are needed during and after construction.

The land capability classification is IVe.

804D—Koronis-Hawick complex, 12 to 20 percent slopes. These hilly soils are on ground moraines and outwash plains. The well drained Koronis soil is on convex side slopes and on ridges and knolls. The

excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are typically elongated and range from 3 to about 80 acres in size. They are 50 to 85 percent Koronis soil and 15 to 50 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of black sandy loam about 5 inches thick. The subsurface layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is dark yellowish brown sandy clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous fine sandy loam. In some places the dark surface soil is more than 10 inches thick. In other places the subsoil is not strongly expressed.

Typically, the Hawick soil has a surface layer of dark brown gravelly loamy coarse sand about 7 inches thick. The subsurface layer is very dark grayish brown gravelly loamy coarse sand about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the content of pebbles and cobbles in the underlying material is more than 35 percent. In other places the underlying material contains more clay and less sand. In some areas the subsoil has more clay than the surface layer.

Included with these soils in mapping are small areas of the well drained Sunburg and moderately well drained Terril soils. Sunburg soils are on the more sloping peaks and ridges. Terril soils are on the lower lying toe slopes and in swales.

In the Koronis soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is moderate. The surface layer is medium acid to neutral. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is rapid on both soils.

Most areas are used as pasture or woodland. Some are cropped. These soils are generally unsuitable as cropland because of the slope and the hazard of drought. A permanent vegetative cover helps control erosion.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are fairly well suited to woodland. The erosion hazard is moderate in cleared or replanted areas. Plant competition can be controlled by cultivating or spraying around the seedlings. Seedling mortality is a problem on the Hawick soil because of the droughtiness.

A wide variety of trees and shrubs can be grown as environmental plantings on these soils. The ones planted on the Hawick soil should be those that can withstand droughty conditions. Water erosion can be severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are poorly suited to building site development. The slope increases the cost of leveling and land shaping and the extent of erosion during and after construction. The buildings should be designed so that they conform to the natural slope of the land. Diversions and cover crops help to control erosion during construction. As soon as construction is completed, the site should be either seeded and mulched or sodded.

Because of the slope, these soils are generally unsuited to sanitary facilities. Hillside seepage is a serious hazard. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water.

Because of the slope, these soils are poorly suited to local roads and streets. The slope increases the cost of grading and land shaping and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction.

The land capability classification is VIe.

804E—Koronis-Hawick complex, 20 to 30 percent slopes. These steep and very steep soils are on ground moraines and outwash plains. The well drained Koronis soil is on convex side slopes and on ridges and knolls. The excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are typically elongated and range from 3 to about 20 acres in size. They are 50 to 85 percent Koronis soil and 15 to 50 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of dark brown sandy loam about 7 inches thick. The subsoil is dark yellowish brown sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places the dark surface soil is more than 10 inches thick. In some areas the subsoil is not so strongly expressed.

Typically, the Hawick soil has a surface layer of very dark grayish brown gravelly loamy coarse sand about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the content of pebbles and cobbles in the underlying material is more than 35 percent. In other places the underlying material contains more clay and less sand. In some areas the subsoil has more clay than the surface layer.

Included with these soils in mapping are small areas of the well drained Sunburg and moderately well drained

Terril soils. Sunburg soils are on the more sloping peaks and ridges. Terril soils are on toe slopes and in swales.

In the Koronis soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is moderate. The surface layer is medium acid to neutral. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is rapid on both soils.

Most areas are used as pasture or woodland. These soils generally are unsuitable as cropland because of the slope and the hazards of erosion and drought. A permanent plant cover is needed.

These soils are fairly well suited or poorly suited to pasture. Applications of fertilizer and weed control can increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are fairly well suited to woodland. The erosion hazard is moderate in cleared or replanted areas. Plant competition can be controlled by cultivating or spraying around the seedlings. Seedling mortality is a problem on the Hawick soil because of the droughtiness.

A wide variety of trees and shrubs can be grown as environmental plantings on these soils. The ones planted on the Hawick soil should be those that can withstand droughty conditions. The normal effectiveness of the windbreaks is reduced because of the slope. Water erosion can be severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of the slope, these soils are poorly suited to local roads and streets. If roads cross areas of these soils, erosion-control measures, such as seeding, mulching, and diversions, are needed during construction.

The land capability classification is VIIe.

805B—Wadenill-Sunburg loams, 2 to 6 percent slopes. These undulating, well drained soils are on glacial moraines. Typically, the Wadenill soil is on convex side slopes and low rises. The calcareous Sunburg soil is on the more sloping knobs and ridges. Individual areas are irregular in shape and range from 3 to about 200 acres in size. They are 60 to 85 percent Wadenill soil and 15 to 40 percent Sunburg soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Wadenill soil has a surface layer of very dark brown loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is dark yellowish brown loam, and the lower part is olive brown fine sandy loam. The underlying material to a depth of about 60 inches is light olive brown, calcareous fine sandy loam. In places the dark surface soil is more than 16 inches thick. In some areas the soil has seams and pockets of sand and gravel. In a few areas it is moderately well drained.

Typically, the Sunburg soil has a surface layer of very dark grayish brown, calcareous loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. It has an accumulation of lime in the upper part. In places the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are small areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are on toe slopes or in swales and drainageways. Glencoe soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderately rapid in the Wadenill and Sunburg soils. The available water capacity is moderate or high. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. The Sunburg soil has a moderately low or moderate organic matter content and a mildly alkaline or moderately alkaline surface layer. Surface runoff is medium on both soils.

Most areas are farmed. These soils are well suited to cultivation. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, a system of conservation tillage that leaves crop residue on the surface, and contour stripcropping help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development and septic tank absorption fields. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

Because of frost action, these soils are only fairly well suited to local roads and streets. Coarse textured base material that is more resistant to frost action is needed ir the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

805C—Sunburg-Wadenill complex, 6 to 12 percent slopes. These rolling, well drained soils are on ground moraines. The calcareous Sunburg soil is on the more sloping peaks and ridges. The Wadenill soil is on convex side slopes. Individual areas are irregular in shape and range from 3 to about 60 acres in size. They are 50 to 75 percent Sunburg soil and 25 to 50 percent Wadenill soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sunburg soil has a surface layer of dark brown, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is brown and yellowish brown, calcareous fine sandy loam. It has an accumulation of lime in the upper part. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Wadenill soil has a surface layer of very dark gray fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 3 inches thick. The subsoil is dark yellowish brown and yellowish brown fine sandy loam about 21 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places, the surface layer and subsoil are thinner and the depth to lime is less than 18 inches. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas the dark surface soil is more than 16 inches thick.

Included with these soils in mapping are areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are on the lower lying toe slopes and in swales and drainageways. Glencoe soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderately rapid in the Sunburg and Wadenill soils. The available water capacity is moderate or high. The Sunburg soil has a moderately low or moderate organic matter content and a mildly alkaline or moderately alkaline surface layer. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. Surface runoff is medium on both soils.

Most areas are farmed. These soils are fairly well suited to cultivated crops. The erosion hazard is severe. The main management needs are measures that control erosion and improve fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and terraces help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be either seeded and mulched or sodded. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

Because of the slope, these soils are only fairly well suited to septic tank absorption fields. Hillside seepage is a hazard. The absorption fields should be designed so that they conform to the natural slope of the land.

Because of the slope and frost action, these soils are only fairly well suited to local roads and streets. Coarse textured base material that is more resistant to frost action is needed in the roadbed. Erosion-control measures, such as seeding, mulching, shaping, and sodding, are needed during and after construction.

The land capability classification is IIIe.

805D—Sunburg-Wadenill complex, 12 to 18 percent slopes. These hilly, well drained soils are on ground moraines. The calcareous Sunburg soil is on the more sloping ridges and peaks. The Wadenill soil is on the less sloping, convex side slopes. Individual areas are typically elongated and range from 3 to about 30 acres in size. They are 60 to 85 percent Sunburg soil and 15 to 40 percent Wadenill soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sunburg soil has a surface layer of dark brown, calcareous loam about 8 inches thick. The upper part of the underlying material is brown, calcareous loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Wadenill soil has a surface layer of very dark brown fine sandy loam about 7 inches thick. The subsoil is dark yellowish brown fine sandy loam about 11 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places, the surface soil and subsoil are thinner and the depth to lime is less than 18 inches. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas the dark surface soil is more than 16 inches thick.

Included with these soils in mapping are the poorly drained Delft soils. These included soils are in low lying swales and drainageways.

Permeability is moderately rapid in the Sunburg and Wadenill soils. The available water capacity is moderate or high. The Sunburg soil has a moderately low or moderate organic matter content and a mildly alkaline or

moderately alkaline surface layer. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. Surface runoff is rapid on both soils.

Most areas are used as pasture or cropland. These soils are poorly suited to cultivated crops. The hazard of erosion is severe. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

The trees and shrubs selected for windbreaks and environmental plantings should be those that can withstand a high content of lime, which ties up minerals and limits their availability. The normal effectiveness of the windbreaks is reduced because of the slope. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are poorly suited to building site development. The slope increases the cost of leveling and land shaping and the extent of erosion during and after construction. Diversions and cover crops help to control erosion during construction. As soon as construction is completed, the site should be either seeded and mulched or sodded. Drainage lines along the footings intercept surface water during unusually wet periods.

Because of the slope, these soils are poorly suited to septic tank absorption fields. Hillside seepage is a serious hazard. Carefully designing the absorption field on the contour reduces this hazard. If possible, an alternative site should be selected.

Because of the slope, these soils are poorly suited to local roads and streets. The slope increases the cost of land grading and shaping and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction.

The land capability classification is IVe.

806C—Guckeen-Arkton complex, 4 to 12 percent slopes. These undulating to rolling, moderately well drained soils are on ground moraines and till plains mantled with lacustrine sediments. The Guckeen soil is on the less sloping, convex side slopes and hilltops. The Arkton soil is on the more sloping ridges, convex side slopes, and peaks. Individual areas are irregular in shape and range from 3 to about 20 acres in size. They are 50 to 75 percent Guckeen soil and 25 to 50 percent Arkton soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Guckeen soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is very dark gray silty clay about 3 inches thick. The subsoil is dark grayish brown, mottled clay about 14 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the surface soil and subsoil contain more sand and clay. In other places, the surface layer and subsoil are thinner and the depth to lime is less than 18 inches. In some areas the underlying material contains more clay and less sand.

Typically, the Arkton soil has a surface layer of very dark gray, calcareous clay about 9 inches thick. The subsoil is dark grayish brown, mottled, calcareous clay about 18 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the underlying material contains more clay and less sand. In other places the surface layer is lighter colored.

Included with these soils in mapping are small areas of the poorly drained Marna and well drained Swanlake soils. Marna soils are in the lower lying swales and drainageways. Swanlake soils are on ridges.

In the Guckeen soil, permeability is slow or moderately slow and the available water capacity and organic matter content are high. The surface layer is slightly acid or neutral. In the Arkton soil, permeability is moderately slow, the available water capacity is high, and the organic matter content is moderate. The surface layer is neutral to moderately alkaline. Surface runoff is medium on both soils. The Guckeen soil has a seasonal high water table at a depth of 3.5 to 5.0 feet. The Arkton soil has one at a depth of 3.0 to 6.0 feet.

Most areas are farmed. These soils are fairly well suited to cultivated crops. Erosion is a severe hazard. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, a system of conservation tillage that leaves crop residue on the surface, and contour stripcropping help to control erosion. Returning crop residue to the soil, tilling in the fall, minimizing tillage, and deferring fieldwork when the soil is too wet improve tilth. Improving tilth is important because the soils are highly susceptible to compaction.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Grazing when the soil is too wet can cause severe compaction and can increase the runoff rate.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Guckeen soil. The ones grown on Arkton soil should be those that can withstand a high content of lime, which ties up

minerals and limits their availability. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation. Moisture stress can occur during extended dry periods because the clay in the soils ties up soil moisture and makes it unavailable to the plant.

These soils are fairly well suited to building site development. The wetness, the slope, and the shrink-swell potential are the main limitations. Installing drainage lines along the footings reduces the wetness. Extra reinforcement in footings and walls helps to prevent the structural damage caused by shrinking and swelling. Erosion is a hazard during and after construction. It can be controlled by establishing diversions and by either seeding and mulching or sodding as soon as possible after construction is complete. These soils are very dense. As a result, excavating may be difficult.

Because of the high water table and the restricted permeability, these soils are poorly suited to septic tank absorption fields. A mound system helps to overcome these limitations. The water table can be lowered by artificial drains. Enlarging the absorption field helps to compensate for the restricted permeability.

Because of low strength and frost action, these soils are poorly suited to local roads and streets. Well compacted base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIe.

806D—Guckeen-Arkton complex, 12 to 18 percent slopes. These hilly, moderately well drained soils are on ground moraines and till plains mantled by lacustrine sediments. The Guckeen soil is on convex side slopes. The Arkton soil is on the more sloping ridges and knolls. Individual areas are irregular in shape and range from 3 to about 15 acres in size. They are 50 to 80 percent Guckeen soil and 20 to 50 percent Arkton soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Guckeen soil has a surface layer of black clay about 9 inches thick. The subsoil is dark grayish brown, mottled clay about 12 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous clay loam. In some places, the surface layer and subsoil are thinner and the depth to lime is less than 18 inches. In other places the underlying material contains more clay and less sand.

Typically, the Arkton soil has a surface layer of very dark grayish brown, calcareous clay loam about 9 inches thick. The subsoil is olive brown, mottled, calcareous clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some places the surface layer is lighter colored. In other places the underlying material contains more clay and less sand.

Included with these soils in mapping are small areas of the poorly drained Marna and well drained Swanlake soils. Marna soils are on the lower lying toe slopes and in swales. Swanlake soils are on ridges.

Permeability is slow or moderately slow in the Guckeen soil and moderately slow in the Arkton soil. The available water capacity is high in both soils. The Guckeen soil has a high organic matter content and a slightly acid or neutral surface layer. The Arkton soil has a moderate organic matter content and a neutral to moderately alkaline surface layer. Surface runoff is rapid on both soils. The Guckeen soil has a seasonal high water table at a depth of 3.5 to 5.0 feet. The Arkton soil has one at a depth of 3.0 to 6.0 feet.

Most areas are pastured or are used as cropland. These soils are poorly suited to cultivated crops. The erosion hazard is severe. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil, tilling in the fall, minimizing tillage, and deferring fieldwork when the soil is too wet improve tilth. Improving tilth is important because the soils are highly susceptible to compaction.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Grazing when the soil is too wet can cause severe compaction and can increase the runoff rate.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Guckeen soil. The ones grown on the Arkton soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation. Moisture stress can occur during extended dry periods because the clay in the soils ties up soil moisture and makes it unavailable to the plant.

Because of the slope, these soils are poorly suited to building site development. The slope increases the cost of leveling and shaping the site and the extent of erosion during and after construction. Diversions and cover crops help to control erosion. As soon as possible after construction is complete, the site should be either seeded and mulched or sodded.

Because of the wetness, the restricted permeability, and the slope, these soils are poorly suited to septic tank absorption fields. Extensive site modification and

special design are needed to overcome these limitations. An alternative site should be selected.

Because of low strength, slope, and frost action, these soils are poorly suited to local roads and streets. Coarse textured base material that has more strength and is more resistant to frost action is needed in the roadbed. The slope increases the cost of land grading and shaping and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction.

The land capability classification is IVe.

807B—Koronis-Sunburg complex, 2 to 6 percent slopes. These undulating, well drained soils are on ground moraines. The Koronis soil is on the less sloping side slopes and the lower rises, and the calcareous Sunburg soil is on knolls and the steeper ridges and peaks (fig. 6). Individual areas are irregular in shape and range from 3 to about 40 acres in size. They are 60 to 85 percent Koronis soil and 15 to 40 percent Sunburg soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of very dark brown sandy loam about 9 inches thick. The subsoil is dark brown and dark yellowish brown sandy clay loam about 22 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous fine sandy loam. In some places the surface layer is more than 10 inches thick. In other places, the subsoil is thinner and the depth to lime is less than 20 inches. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas it is moderately well drained.

Typically, the Sunburg soil has a surface layer of dark grayish brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are small areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are in the lower lying swales and drainageways. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderately rapid in the Koronis and Sunburg soils. The available water capacity is moderate or high. The Koronis soil has a moderate organic matter content and a medium acid to neutral surface layer. The Sunburg soil has a moderate or moderately high organic matter content and a moderately alkaline or mildly alkaline surface layer. Surface runoff is medium on both soils.

Most areas are used as pasture or woodland. A few are used as cropland. These soils are well suited to cultivated crops. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. In some areas applications of lime are needed. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. On the Sunburg soil, the ones selected for planting should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development and septic tank absorption fields. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

Because of frost action, this soil is only fairly well suited to local roads and streets. Well compacted, coarse textured base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

807C—Koronis-Sunburg complex, 6 to 12 percent slopes. These rolling, well drained soils are on ground moraines. The Koronis soil is on side slopes and the lower rises. The calcareous Sunburg soil is on the more sloping ridges and knobs. Individual areas are irregular in shape and range from 3 to about 100 acres in size. They are 50 to 75 percent Koronis soil and 25 to 50 percent Sunburg soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of very dark gray sandy loam about 9 inches thick. The subsoil is about 18 inches thick. It is dark brown sandy loam in the upper part and dark yellowish brown sandy clay loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some places the surface layer is more than 10 inches thick. In other places, the subsoil is thinner and the depth to lime is less than 20 inches. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Sunburg soil has a surface layer of dark grayish brown, calcareous fine sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy

Figure 6.—An area of the Koronis-Sunburg complex, 2 to 6 percent slopes. The light colored Sunburg soil is on knolls surrounded by the darker Koronis soil.

loam. In places the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are on the lower lying toe slopes and in swales and drainageways. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderately rapid in the Koronis and Glencoe soils. The available water capacity is moderate or high. The Koronis soil has a moderate organic matter content and a medium acid to neutral surface layer. The Sunburg soil has a moderate or moderately low organic matter content and a mildly alkaline or moderately alkaline surface layer. Surface runoff is medium on both soils.

Most areas of these soils are used as pasture or woodland. A few are used as cropland. These soils are fairly well suited to cultivated crops. The main

management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. In some areas applications of lime are needed. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by cultivating or spraying.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on these soils. On the Sunburg soil, the ones selected for planting should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. The buildings should be designed so that they conform to the natural slope of the land. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be landscaped and should be either seeded and mulched or sodded. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

These soils are fairly well suited to septic tank absorption fields. The slope is a limitation. Hillside seepage is a hazard. The absorption fields should be designed so that they conform to the natural slope of the land.

Because of slope and frost action, these soils are only fairly well suited to local roads and streets. Well compacted, coarse textured base material that is more resistant to frost action is needed in the roadbed. Erosion-control measures, such as seeding, mulching, land shaping, and sodding, are needed during and after construction.

The land capability classification is IIIe.

807D—Koronis-Sunburg complex, 12 to 20 percent slopes. These hilly, well drained soils are on ground moraines. The Koronis soil is on side slopes and the lower rises. The calcareous Sunburg soil is on the more sloping ridges and peaks. Individual areas are typically elongated and range from 3 to about 100 acres in size. They are 50 to 70 percent Koronis soil and 30 to 45 percent Sunburg soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Koronis soil has a surface layer of black fine sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 4 inches thick. The subsoil is dark yellowish brown fine sandy loam about 18 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous loam. In some places, the subsoil is thinner and the depth to lime is less than 20 inches. In other places the soil has seams and pockets of sandy and gravelly material.

Typically, the Sunburg soil has a surface layer of black loam about 4 inches thick. The subsurface layer is very dark gray, calcareous fine sandy loam about 3 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places the soil has seams and pockets of sandy and gravelly material.

Included with these soils in mapping are small areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are in the lower lying swales and drainageways. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderately rapid in the Koronis and Sunburg soils. The available water capacity is moderate or high. The Koronis soil has a moderate organic matter content and a medium acid to neutral surface layer. The Sunburg soil has a moderate or moderately low organic matter content and a mildly alkaline or moderately alkaline surface layer. Surface runoff is rapid on both soils.

Most areas are used as pasture or woodland. A few are used as cropland. These soils are poorly suited to cultivated crops. The hazard of erosion is severe. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. In some areas applications of lime are needed. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are fairly well suited to woodland. Plant competition is severe in replanted areas. It can be controlled by spraying or cultivating. Because of the slope, operating equipment is hazardous. The erosion hazard is moderate in clearcut areas.

A wide variety of trees and shrubs can be grown as environmental plantings on these soils. On the Sunburg soil, the ones selected for planting should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or

applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are poorly suited to building site development. The slope increases the cost of leveling and land shaping and the extent of erosion during and after construction. The buildings should be designed so that they conform to the natural slope of the land. Diversions and cover crops help to control erosion during construction. As soon as construction is completed, the site should be either seeded and mulched or sodded.

Because of the slope, these soils are poorly suited to septic tank absorption fields. Hillside seepage is a serious hazard. Carefully designing the absorption field on the contour reduces this hazard. If possible, an alternative site should be selected.

Because of the slope, these soils are poorly suited to local roads and streets. The slope increases the cost of land grading and shaping and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction.

The land capability classification is IVe.

807E—Koronis-Sunburg complex, 20 to 30 percent slopes. These steep, well drained soils are on ground moraines. The Koronis soil is on side slopes and the lower rises. The calcareous Sunburg soil is on ridges and peaks. Individual areas are typically elongated and range from 3 to about 40 acres in size. They are 30 to 60 percent Koronis soil and 30 to 60 percent Sunburg soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, Koronis soil has a surface layer of black sandy loam about 4 inches thick. The subsurface layer is dark grayish brown sandy loam about 3 inches thick. The subsoil is dark yellowish brown sandy clay loam about 16 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous fine sandy loam. In places, the subsoil is thinner and the depth to lime is less than 20 inches. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, Sunburg soil has a surface layer of black, calcareous fine sandy loam about 4 inches thick. The subsurface layer is very dark grayish brown, calcareous fine sandy loam about 3 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are small areas of the very poorly drained Glencoe and excessively drained Hawick soils. Glencoe soils are in low lying, closed depressions and are subject to ponding. Hawick soils are sandy. They are in scattered areas throughout the unit.

Permeability is moderately rapid in the Koronis and Sunburg soils. The available water capacity is moderate or high. The Koronis soil has a moderate organic matter content and a medium acid to neutral surface layer. The Sunburg soil has a moderate or moderately low organic matter content and a mildly alkaline or moderately alkaline surface layer. Surface runoff is rapid on both soils.

Most areas are used as pasture, woodland, or wildlife habitat. These soils are generally unsuitable as cropland because of the slope and a severe hazard of erosion. A permanent cover of vegetation helps to control erosion.

These soils are fairly well suited or poorly suited to pasture. Applications of fertilizer and weed control can increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

These soils are fairly well suited to woodland. Plant competition is severe in replanted areas. Because of the slope, operating equipment is hazardous. The hazard of erosion is severe in disturbed areas.

A wide variety of trees and shrubs can be grown as environmental plantings on these soils. On Sunburg soil, the ones selected for planting should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are generally unsuited to building site development and sanitary facilities. The hazard of erosion is severe in disturbed areas. Soils that are better suited to these uses are generally nearby.

Because of the slope, these soils are poorly suited to local roads and streets. Erosion-control measures, such as seeding, mulching, and diversions, are needed during and after construction.

The land capability classification is VIe.

809—Lowlein-Estherville sandy loams. These nearly level soils are on ground moraines and outwash plains. The moderately well drained Lowlein soil is in slight depressions, and the well drained Estherville soil is on slight rises. Individual areas are irregular in shape and range from 3 to about 20 acres in size. They are 70 to 85 percent Lowlein soil and 15 to 30 percent Estherville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Lowlein soil has a surface layer of black sandy loam about 10 inches thick. The subsurface layer is very dark gray sandy loam about 4 inches thick. The subsoil is about 17 inches thick. The upper part is dark brown sandy loam, and the lower part is olive brown, mottled loamy sand. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places the surface layer contains more

sand and gravel. In other places the subsoil contains more clay and less sand.

Typically, the Estherville soil has a surface layer of black sandy loam about 10 inches thick. The subsoil is about 15 inches thick. The upper part is dark yellowish brown sandy loam, and the lower part is dark brown loamy coarse sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In areas where it has been mixed with the subsoil by plowing, the surface layer is lighter colored.

Included with these soils in mapping are areas of the poorly drained Coriff and moderately well drained Seaforth soils. Coriff soils are in the lower lying swales and drainageways. Seaforth soils are in landscape positions similar to those of the Lowlein and Estherville soils. They do not have sandy layers and are calcareous.

Permeability is moderately rapid in the upper part of the Lowlein soil and moderate in the lower part. It is moderately rapid in the upper part of the Estherville soil and very rapid in the underlying material. The Lowlein soil has a moderate or high available water capacity, a high organic matter content, and a slightly acid or neutral surface layer. The Estherville soil has a low available water capacity, a moderate organic matter content, and a medium acid to neutral surface layer. Surface runoff is slow on both soils. The seasonal high water table is at a depth of 2.5 to 5.0 feet in the Lowlein soil.

Most areas are farmed. These soils are only fairly well suited to crops because of droughtiness, especially during long dry periods in summer. The main management concerns are conserving moisture, maintaining fertility, and preventing excessive soil blowing. Applying a system of conservation tillage that leaves crop residue on the surface, establishing field windbreaks, and returning crop residue to the soil conserve moisture and reduce the susceptibility to soil blowing.

These soils are fairly well suited to pasture and hay. Drought is a moderate hazard. Applications of fertilizer and weed control increase forage production. If the pasture is overgrazed, weeds can become established.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand droughty conditions. Leaving some vegetation on the surface during the early years of establishment helps to control soil blowing. The seedling mortality rate can be moderate because of the moisture stress during extended dry periods. Cultivation or applications of herbicide help to remove competing vegetation.

The Estherville soil is well suited to building site development, but the Lowlein soil is limited as a site for buildings because of the wetness. Seepage into basements can be a problem. It can be minimized by installing drainage lines along the footings or by installing the footings above the water table. The sides of shallow excavations can cave in unless they are properly shaped and supported.

These soils are poorly suited to septic tank absorption fields. The wetness of both soils is a limitation. Also, a poor filtering capacity in the Lowlein soil can result in the pollution of local ground water. The distance between the water table and the distribution lines can be increased by installing the absorption field in a mound of suitable fill material. Also, a drainage system can lower the water table.

The Estherville soil is well suited to local roads and streets, but the Lowlein soil is only fairly well suited because of frost action. Coarse textured base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIs.

810—Coriff-Fieldon complex. These nearly level, poorly drained soils are on lake plains and ground moraines. The Coriff soil is in slightly concave or convex areas, and the Fieldon soil is in plane or slightly convex areas. Individual areas are irregular in shape and range from 5 to about 200 acres in size. They are 25 to 75 percent Coriff soil and 25 to 75 percent Fieldon soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Coriff soil has a surface layer of black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous sandy loam about 8 inches thick. The subsoil is about 15 inches thick. It is calcareous and mottled. The upper part is grayish brown sandy loam, and the lower part is olive gray loamy fine sand. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some places the upper part of the soil has an accumulation of lime. In other places a gravelly layer is directly above the underlying material. In a few areas the soil is somewhat poorly drained.

Typically, the Fieldon soil has a surface layer of black, calcareous fine sandy loam about 10 inches thick. The subsurface layer is very dark gray, calcareous fine sandy loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous fine sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous fine sand. In places an accumulation of lime is at or near the surface. In a few areas the soil is somewhat poorly drained.

Included with these soils in mapping are small areas of the very poorly drained, depressional Biscay soils and the moderately well drained Lowlein soils. The Biscay soils are in low lying depressions and are subject to ponding. Lowlein soils are on slight rises.

Permeability is moderately rapid in the upper part of the Coriff soil and moderate in the lower part. It is moderately rapid in the upper part of the Fieldon soil and rapid in the lower part. The available water capacity is

high in the Coriff soil and moderate in the Fieldon soil. The organic matter content is high in both soils. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are farmed. If properly managed, these soils are well suited to all of the crops commonly grown in the county. The main management concerns are improving drainage and maintaining fertility and tilth. Drainage can be improved by subsurface drainage lines and by ditches. Because the Fieldon soil is sandy in the underlying material, ditchbanks tend to cave in. Tile lines may become plugged with fine sand unless they are protected. Iron chlorosis can affect soybeans in some years because of the high content of lime in these soils. Returning crop residue to the soil and applying a system of conservation tillage help to maintain tilth and reduce the susceptibility to soil blowing.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness and a high content of lime, which ties up minerals and limits their availability. Seedling mortality is moderate because of the wetness. Cultivation or applications of herbicide help to control competing vegetation.

Because of the wetness, these soils are poorly suited to building site development and septic tank absorption fields. In places a mound type of absorption field is suitable. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because of frost action, these soils are poorly suited to local roads and streets. Coarse textured base material that is more resistant to frost action should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

817—Canisteo-Seaforth complex. These nearly level, calcareous soils are on till plains. The poorly drained Canisteo soil is in swales and on toe slopes. The moderately well drained Seaforth soil is on rises and ridges. Individual areas are irregular in shape and range from 10 to more than 200 acres in size. They are 50 to 75 percent Canisteo soil and 25 to 50 percent Seaforth soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Canisteo soil has a surface layer of black, calcareous silty clay loam about 10 inches thick. The next 12 inches is black and very dark gray, calcareous silty clay loam and loam. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In places the surface soil has an accumulation of lime. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Seaforth soil has a surface layer of black, calcareous loam about 10 inches thick. The subsoil is light olive brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the surface soil and subsoil are not calcareous. In other places the soil has seams and pockets of sandy or gravelly material. In some areas it is well drained.

Included with these soils in mapping are areas of the poorly drained Marna and very poorly drained Okoboji soils. Marna soils are in swales. Okoboji soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderate in the Canisteo and Seaforth soils. The available water capacity and organic matter content are high. The surface layer is mildly alkaline or moderately alkaline. Surface runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet in the Canisteo soil and 3 to 6 feet in the Seaforth soil.

Most areas are farmed. If properly managed, these soils are well suited to all of the crops commonly grown in the county. The main management concerns are improving the drainage of the Canisteo soil and maintaining fertility and tilth in both soils. Subsurface tile drainage is the most effective method of reducing the wetness of the Canisteo soil. Minimizing tillage and returning crop residue to the soil help to maintain tilth. If soybeans are grown, iron chlorosis may be a problem in some years because of the high content of lime in these soils.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness of the Canisteo soil and the high content of lime in both soils. The lime ties up minerals and limits their availability. Seedling mortality is moderate on the Canisteo soil because of the wetness. Cultivation or applications of herbicide help to control competing vegetation.

Because of the wetness, these soils are poorly suited to building site development. Installing the footings above the water table helps to keep basements dry.

Because of the wetness, these soils are poorly suited to septic tank absorption fields. In areas of the Seaforth soil, a mound system can help to overcome this limitation.

Because of frost action and low strength, these soils are poorly suited to local roads and streets. Coarse

textured base material that has more strength is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

819B—Regal-Hawick complex, 0 to 4 percent slopes. These nearly level and gently sloping soils are on the margins of present and former lakes and ponds. The poorly drained Regal soil is on toe slopes and in plane areas. The excessively drained Hawick soil is on the more sloping knolls and ridges. Individual areas are typically long and narrow and range from 3 to about 60 acres in size. They are 30 to 70 percent Regal soil and 30 to 70 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Regal soil has a surface layer of black sandy loam about 9 inches thick. The subsurface layer is black, calcareous loamy sand about 8 inches thick. The underlying material to a depth of about 60 inches is olive gray, calcareous gravelly coarse sand. In some places the dark surface soil is more than 20 inches thick. In other places the underlying material contains more clay and less sand.

Typically, the Hawick soil has a surface layer of very dark brown gravelly loamy coarse sand about 10 inches thick. The upper part of the underlying material is brown, calcareous gravelly sand. The lower part to a depth of about 60 inches is brown, calcareous sand. In some places the dark surface layer is thinner. In other places the underlying material contains more clay and less sand.

Included with these soils in mapping are areas of the very poorly drained, depressional Biscay soils, the very poorly drained Palms soils, the well drained Estherville soils, and the moderately well drained Osakis soils. The Biscay and Palms soils are in closed depressions and are subject to ponding. Estherville soils are on convex side slopes. Osakis soils are on slight rises.

Permeability is moderate in the upper part of the Regal soil and rapid in the underlying material. It is very rapid in the Hawick soil. The Regal soil has a low available water capacity, a high organic matter content, and a neutral to moderately alkaline surface layer. The Hawick soil has a low or very low available water capacity, a moderately low organic matter content, and a slightly acid to mildly alkaline surface layer. Surface runoff is slow on both soils. The seasonal high water table is at a depth of 1 to 3 feet in the Regal soil.

Most areas are used as pasture, hayland, or wildlife habitat. Areas around developed lakes are graded and landscaped and are used for yards and beaches. These soils are poorly suited to cultivated crops. A drainage system is needed in the Regal soil, and the Hawick soil is droughty.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture or hayland in good condition. Weeds can become established in overgrazed areas.

The trees and shrubs grown as windbreaks and environmental plantings on the Regal soil should be those that can withstand wetness. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Seedling mortality is moderate because of the moisture stress caused by the droughtiness. Cultivation or applications of herbicide help to remove competing vegetation.

The Hawick soil is well suited to building site development, but the Regal soil is poorly suited because of the wetness. Draining this soil is difficult because the water table is generally at or near the level of the surrounding landscape. The soil is better suited to buildings without basements than to buildings with basements. Fill material can be used to increase the depth to the water table. Topsoil should be stockpiled for later use in landscaping. The sides of shallow excavations can cave in unless they are properly shaped and supported.

These soils are poorly suited to septic tank absorption fields. The wetness of the Regal soil and a poor filtering capacity in both soils are limitations. The poor filtering capacity can result in the pollution of local ground water. In places a mound type of absorption field is suitable.

The Hawick soil is well suited to local roads and streets, but the Regal soil is only fairly well suited because of wetness and frost action. Well compacted, raised roadbeds and properly designed side ditches and culverts help to prevent the damage caused by wetness and frost action.

The land capability classification is IVw.

833B—Wadenill-Sunburg-Hawick complex, 2 to 6 percent slopes. These undulating soils are on ground moraines and outwash plains. The well drained Wadenill soil is on convex side slopes and on knolls. The well drained, calcareous Sunburg soil is on the more sloping peaks and ridges. The excessively drained Hawick soil occurs in a random pattern throughout the unit. In some areas it has gravel on the surface. Individual areas are irregular in shape and range from 3 to about 40 acres in size. They are 40 to 60 percent Wadenill soil, 25 to 40 percent Sunburg soil, and 15 to 30 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Wadenill soil has a surface layer of black loam about 10 inches thick. The subsoil is about 15 inches thick. The upper part is dark brown loam, and the lower part is dark yellowish brown fine sandy loam. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some

places the surface soil is more than 24 inches thick. In other places the soil is moderately well drained.

Typically, the Sunburg soil has a surface layer of very dark gray, calcareous loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. It has an accumulation of lime in the upper part. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Hawick soil has a surface layer of black loamy coarse sand about 10 inches thick. The subsoil is dark yellowish brown loamy coarse sand about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous coarse sand. In some places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In other places the underlying material contains more clay.

Included with these soils in mapping are small areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are in low lying swales and on toe slopes. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderately rapid in the Wadenill and Sunburg soils and very rapid in the Hawick soil. The available water capacity is moderate or high in the Wadenill and Sunburg soils and very low or low in the Hawick soil. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. The Sunburg soil has a moderate or moderately low organic matter content and a mildly alkaline surface layer. The Hawick soil has a moderately low or moderate organic matter content and a slightly acid to mildly alkaline surface layer. Surface runoff is medium on all three soils.

Most areas are farmed. These soils are only fairly well suited to cultivated crops because of the hazard of erosion and the droughty nature of the Hawick soil. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage improve tilth and conserve moisture. Crop growth varies within short distances because of the droughty nature of Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Wadenill soil. The trees and shrubs grown on the Sunburg soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

The Wadenill and Sunburg soils are well suited to septic tank absorption fields. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water.

The Hawick soil is well suited to local roads and streets, but the Wadenill and Sunburg soils are only fairly well suited because of frost action. Base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIe.

833C—Sunburg-Wadenill-Hawick complex, 6 to 12 percent slopes. These rolling soils are on ground moraines and outwash plains. The well drained, calcareous Sunburg soil is on the more sloping peaks and ridges. The well drained Wadenill soil is on convex side slopes and on knolls. The excessively drained Hawick soil occurs in a random pattern throughout the unit. It commonly has gravel on the surface. Individual areas are irregular in shape and range from 3 to about 60 acres in size. They are 40 to 60 percent Sunburg soil, 20 to 40 percent Wadenill soil, and 15 to 30 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sunburg soil has a surface layer of very dark grayish brown, calcareous loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. It has an accumulation of lime in the upper part. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Wadenill soil has a surface layer of black loam about 10 inches thick. The subsoil is dark yellowish brown loam about 14 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some places the surface soil is more than 24 inches thick. In other places the soil has layers of sandy or gravelly material.

Typically, the Hawick soil has a surface layer of very dark gravelly loamy coarse sand about 10 inches thick. The subsoil is dark yellowish brown gravelly loamy coarse sand about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the content of pebbles and cobbles in the subsoil and

underlying material is more than 35 percent. In other places the underlying material contains more clay.

Included with these soils in mapping are areas of the poorly drained Delft and very poorly drained Glencoe soils. Delft soils are in the lower lying swales and drainageways. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderately rapid in the Sunburg and Wadenill soils and very rapid in the Hawick soil. The available water capacity is moderate or high in the Sunburg and Wadenill soils and very low or low in the Hawick soil. The Sunburg soil has a moderate or moderately low organic matter content and a mildly alkaline or moderately alkaline surface layer. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. The Hawick soil has a moderately low organic matter content and a slightly acid to mildly alkaline surface layer. Surface runoff is medium on all three soils.

Most areas are used as cropland or pasture. These soils are poorly suited to cultivated crops. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth. Crop growth varies within short distances because of the droughty nature of the Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

The trees and shrubs grown as windbreaks and environmental plantings on the Sunburg soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. A wide variety of trees and shrubs can be grown on the Wadenill soil. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. The buildings should be designed so that they conform to the natural slope of the land. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be either seeded and mulched or sodded. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

The Sunburg and Wadenill soils are fairly well suited to septic tank absorption fields. The slope is the main limitation. The absorption fields should be designed so that they conform to the natural slope of the land. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of ground water.

Because of frost action and slope, these soils are only fairly well suited to local roads and streets. Coarse textured base material that is resistant to frost action is needed in the roadbed. Erosion-control measures, such as seeding, mulching, land shaping, and sodding, are needed during and after construction.

The land capability classification is IVe.

833D—Sunburg-Wadenill-Hawick complex, 12 to 18 percent slopes. These hilly soils are on ground moraines. The calcareous, well drained Sunburg soil is on the more sloping peaks and ridges. The well drained Wadenill soil is on convex side slopes and on knolls. The excessively drained Hawick soil occurs in a random pattern throughout the unit. In places it has gravel on the surface. Individual areas are typically irregular in shape and range from 3 to about 20 acres in size. They are 50 to 70 percent Sunburg soil, 15 to 25 percent Wadenill soil, and 15 to 25 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sunburg soil has a surface layer of very dark grayish brown, calcareous fine sandy loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. It has an accumulation of lime in the upper part. In some areas the soil has layers of sandy or gravelly material.

Typically, the Wadenill soil has a surface layer of very dark brown loam about 8 inches thick. The subsoil is dark yellowish brown fine sandy loam about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In some places the surface soil is more than 24 inches thick. In other places the underlying material has sandy or gravelly layers.

Typically, the Hawick soil has a surface layer of very dark grayish brown, calcareous loamy sand about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous sand. In some places the content of pebbles and cobbles in the underlying material is more than 35 percent. In other places the underlying material contains more clay.

Included with these soils in mapping are small areas of the poorly drained Delft, very poorly drained Glencoe, and moderately well drained Terril soils. Delft soils are on the lower lying toe slopes. Glencoe soils are in closed depressions and are subject to ponding. Terril soils are in swales and drainageways and on toe slopes.

Permeability is moderately rapid in the Sunburg and Wadenill soils and very rapid in the Hawick soil. The available water capacity is moderate or high in the Sunburg and Wadenill soils and very low or low in the Hawick soil. The Sunburg soil has a moderate or

moderately low organic matter content and a mildly alkaline or moderately alkaline surface layer. The Wadenill soil has a high organic matter content and a slightly acid or neutral surface layer. The Hawick soil has a moderately low organic matter content and a slightly acid to mildly alkaline surface layer. Surface runoff is rapid on all three soils.

Most areas are used as pasture. Some are cropped. These soils are generally unsuitable as cropland because of the slope and the hazard of drought. A permanent plant cover helps to control erosion.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

The trees and shrubs grown as windbreaks and environmental plantings on the Sunburg soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. A wide variety of trees and shrubs can be grown on the Wadenill soil. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are poorly suited to building site development. The slope is the main limitation. It increases the cost of leveling and land shaping and the extent of erosion during and after construction. The buildings should be designed so that they conform to the natural slope of the land. Diversions and cover crops help to control erosion during construction. As soon as construction is completed, the site should be either seeded and mulched or sodded.

These soils are poorly suited to septic tank absorption fields, mainly because of the slope. Hillside seepage is a hazard. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water. Carefully designing the field along the contour of the slope can reduce the hazard of seepage. If possible, a better suited alternative site should be selected.

Because of the slope, these soils are poorly suited to local roads and streets. The slope increases the cost of grading and land shaping and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction.

The land capability classification is VIe.

833E—Sunburg-Wadenill-Hawick complex, 18 to 35 percent slopes. These steep and very steep soils are on ground moraines. The well drained, calcareous Sunburg soil is on the more sloping peaks and ridges. The well drained Wadenill soil is on the less sloping, convex side slopes. The excessively drained Hawick soils occur in a random pattern throughout the unit. In places it has gravel on the surface. Individual areas are elongated and range from 3 to about 40 acres in size. They are 45 to 70 percent Sunburg soil, 15 to 30 percent Wadenill soil, and 15 to 25 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Sunburg soil has a surface layer of very dark grayish brown, calcareous fine sandy loam about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places the soil has layers of sandy or gravelly material.

Typically, the Wadenill soil has a surface layer of dark brown loam about 7 inches thick. The subsoil is dark yellowish brown loam about 11 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous fine sandy loam. In places the soil has seams and pockets of sandy or gravelly material.

Typically, the Hawick soil has a surface layer of dark brown gravelly loamy coarse sand about 5 inches thick. The subsurface layer is very dark brown gravelly loamy coarse sand about 4 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the content of pebbles or cobbles in the underlying material is more than 35 percent. In other places the underlying material contains more clay.

Included with these soils in mapping are areas of the moderately well drained Terril soils. These included soils are on toe slopes and in swales.

In the Sunburg soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is moderate or moderately low. The surface layer is mildly alkaline or moderately alkaline. In the Wadenill soil, permeability is moderately rapid, the available water capacity is moderate or high, and the organic matter content is high. The surface layer is slightly acid or neutral. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is rapid on all three soils.

Most areas are pastured or are used as wildlife habitat. These soils are generally unsuitable as cropland because of the slope and the hazards of erosion and drought.

These soils are fairly well suited or poorly suited to pasture. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard. Also, weeds can become established in overgrazed areas.

The trees and shrubs grown as windbreaks and environmental plantings on the Sunburg soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. A wide variety of trees and shrubs can be grown on the Wadenill soil. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are generally unsuited to building site development and sanitary facilities and are poorly suited to local roads and streets. The erosion hazard is severe in disturbed areas. Erosion-control measures, such as seeding, mulching, and diversions, are needed during and after road construction.

The land capability classification is VIIe.

842—Urban land-Udorthents complex. This map unit consists of nearly level to rolling areas that have been used for urban development. It is mainly within the city limits of Willmar, but it is also around lake developments, in small villages, and in outlying subdivisions. The landscape has been extensively altered. As a result, classification of the original soil is not practical.

Urban land consists of areas where the original soil material has been covered by paved roads, parking lots, and buildings.

Udorthents are areas of cut and filled land where sites were leveled for development purposes. In most of these areas, a nearby rise was cut and used to fill a low lying area. In places fill material was trucked in from another source. Most of the fill is glacial till, but some consists of broken concrete pavement, asphalt, or refuse material. Most of the filled areas are poorly drained or very poorly drained.

Included with this unit in mapping are small areas where the surface has not been disturbed. The common soils in these areas are the well drained Estherville and Ves soils, the poorly drained Fieldon and Webster soils, the very poorly drained Glencoe soils, and the moderately well drained Normania soils. Estherville and Normania soils are in plane areas or on slight rises. Fieldon and Webster soils are in swales or plane areas. Glencoe soils are in closed depressions and are subject to ponding. Ves soils are on convex side slopes and on knolls.

This unit is unsuitable for cropland and pasture. Undisturbed areas are well suited to home garden plots. Onsite investigation is needed to determine the suitability for a particular use.

No land capability classification is assigned.

875B—Estherville-Hawick complex, 2 to 6 percent slopes. These undulating soils are on outwash plains. The well drained Estherville soil is in plane areas, on slight rises, and in swales. The excessively drained Hawick soil is on the more sloping knobs and ridges. Individual areas are irregular in shape and range from 5 to about 200 acres in size. They are 50 to 75 percent Estherville soil and 25 to 50 percent Hawick soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Estherville soil has a surface layer of black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 3 inches thick. The subsoil is about 12 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy coarse sand. The underlying material to a depth of about 60 inches is brown, calcareous coarse sand. In areas where it has been mixed with the subsoil by plowing, the surface layer is lighter colored. In places the subsoil has more clay than the surface soil.

Typically, the Hawick soil has a surface layer of black loamy coarse sand about 7 inches thick. The subsurface layer is very dark grayish brown gravelly coarse sand about 5 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the surface soil is less than 10 inches thick. In other places the content of gravel is more than 35 percent. In some areas the underlying material has layers of fine sand or silty material.

Included with these soils in mapping are small areas of the poorly drained Biscay and Regal soils and the well drained Wadena soils. Biscay and Regal soils are on the fringes of depressions or in swales. Wadena soils are in swales and on toe slopes.

In the Estherville soil, permeability is moderately rapid in the upper part of the profile and very rapid in the underlying material, the available water capacity is low, and the organic matter content is moderate. The surface layer is neutral to medium acid. In the Hawick soil, permeability is very rapid, the available water capacity is low or very low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. Surface runoff is medium on both soils.

These soils are cultivated or are used for pasture and hay. Unless irrigated, they are only fairly well suited to crops because of the hazard of drought. The main management concerns are reducing the hazards of drought and erosion and improving fertility. The soils are well suited to irrigation. Crop response to irrigation is good. Because of a lower available water capacity, yields are lower on the Hawick soil than on the Estherville soil. Areas that are not irrigated are better suited to shallow-rooted, early maturing crops than to other crops. A system of conservation tillage that leaves crop residue

on the surface and field windbreaks help to control soil blowing in winter and spring.

Because of the hazard of drought, these soils are only fairly well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, weeds can become established. Hay production can be increased by irrigation.

These soils are fairly well suited to the trees and shrubs grown as windbreaks and environmental plantings. The species selected for planting should be those that can withstand drought. Mulching or watering reduces the hazard of drought. Cultivating or spraying helps to control plant competition.

These soils are well suited to building site development and to local roads and streets. They are a good source of roadfill (fig. 7). Topsoil should be stockpiled during construction for later use in landscaping. The sides of shallow excavations can cave in unless they are properly shaped and supported.

Because the underlying material has a poor filtering capacity, these soils are poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water.

The land capability classification is IIIs.

875C—Hawick-Estherville complex, 6 to 12 percent slopes. These rolling soils are on outwash plains. The excessively drained Hawick soil is on the more sloping knobs and ridges. In places it has gravel on the surface. The well drained Estherville soil is on side slopes. Individual areas are irregular in shape and range from 3

Figure 7.—A gravel pit in an area of the Estherville-Hawick complex, 2 to 6 percent slopes.

to about 40 acres in size. They are 50 to 75 percent Hawick soil and 25 to 50 percent Estherville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Hawick soil has a surface layer of very dark brown gravelly loamy coarse sand about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some places the dark surface soil is less than 10 inches thick. In other places the surface soil is lighter colored. In some areas the content of gravel is more than 35 percent. In other areas the underlying material has bands of fine sand or silty material.

Typically, the Estherville soil has a surface layer of black sandy loam about 8 inches thick. The subsoil is about 9 inches thick. It is dark yellowish brown. The upper part is sandy loam, and the lower part is loamy coarse sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In areas where it has been mixed with the subsoil by plowing, the surface layer is lighter colored. In places the subsoil has more clay than the surface layer.

Included with these soils in mapping are small areas of the well drained Wadena soils. These included soils are on the lower lying toe slopes and in swales.

In the Hawick soil, permeability is very rapid, the available water capacity is very low or low, and the organic matter content is moderately low. The surface layer is slightly acid to mildly alkaline. In the Estherville soil, permeability is moderately rapid in the upper part of the profile and very rapid in the underlying material, the available water capacity is low, and the organic matter content is moderate. The surface layer is medium acid to neutral. Surface runoff is medium on both soils.

Most areas are cultivated or are used as pasture or hayland. Because of a severe hazard of drought, these soils are poorly suited to crops. They are only fairly well suited to irrigation because of the limited available water capacity and the slope. Crop response to irrigation is fair. The main management concerns are reducing the hazard of drought and improving fertility. The Hawick soil is less productive than the Estherville soil because of the lower available water capacity. Areas that are not irrigated are better suited to shallow-rooted, early maturing crops than to other crops. Conservation tillage and field windbreaks help to control soil blowing.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control help to keep the pasture and hayland in good condition. If the pasture is overgrazed, weeds can become established. Hay production can be increased by irrigation.

These soils are fairly well suited to the trees and shrubs grown as windbreaks and environmental plantings. The hazard of drought can result in a high seedling mortality rate. Spraying or cultivating helps to control plant competition. If possible, the site should be watered during dry periods.

These soils are fairly well suited to building site development. The slope is the main limitation. Grading and land shaping are generally needed. Erosion is a hazard during construction. The topsoil should be stockpiled for later use in landscaping. If additional topsoil that is less droughty than these soils is provided, sod or new seedlings can be more easily established.

Because the underlying material has a poor filtering capacity, these soils are poorly suited to septic tank absorption fields. The poor filtering capacity can result in the pollution of local ground water.

Because of the slope, these soils are only fairly well suited to local roads and streets. Slope modification is needed. Erosion is a hazard in cut and filled areas. Erosion-control measures, such as seeding, mulching, land shaping, and sodding, are needed during and after construction. Revegetation is difficult because of the droughty nature of the soils. The soils are a good source of sand and gravel for roadfill.

The land capability classification is IVs.

897B—Seaforth-Swanlake loams, 2 to 6 percent slopes. These undulating soils are on till plains. The moderately well drained Seaforth soil is on slight rises and convex side slopes. The well drained Swanlake soil is on the more sloping peaks and ridges. Individual areas are irregular in shape and range from 3 to about 15 acres in size. They are 50 to 75 percent Seaforth soil and 25 to 50 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Seaforth soil has a surface layer of black, calcareous loam about 9 inches thick. The subsurface layer is very dark grayish brown, calcareous loam about 6 inches thick. The subsoil is brown, calcareous loam about 6 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In places the surface soil and subsoil are neutral or slightly acid. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Swanlake soil has a surface layer of very dark grayish brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In places the surface layer is lighter colored. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas the surface soil and subsoil are neutral or slightly acid.

Permeability is moderate in the Seaforth and Swanlake soils. The available water capacity is high. The Seaforth soil has a high organic matter content and a mildly alkaline or moderately alkaline surface layer. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. Surface runoff is medium on both soils. The Seaforth soil has a seasonal high water table at a depth of 3 to 6 feet.

Most areas are cropped. These soils are well suited to cultivation. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. If soybeans are grown, the high content of lime in the soils can cause iron chlorosis. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to the trees and shrubs grown as windbreaks and environmental plantings. The species selected for planting should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Spraying or cultivating helps to control competing plants and allows the trees and shrubs to become established.

The Swanlake soil is well suited to building site development, but the Seaforth soil is only fairly well suited because of wetness. Drainage lines along the footings help to keep basements dry.

The Swanlake soil is well suited to septic tank absorption fields, but the Seaforth soil is poorly suited because of the wetness. Installing the distribution lines in a mound of suitable fill material helps to overcome the wetness. Also, the water table can be lowered by artificial drains.

Because of frost action, these soils are poorly suited to local roads and streets. Well compacted, coarse textured base material that is more resistant to frost action is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

899—Harps-Okoboji complex. These nearly level soils are on glacial till plains. The poorly drained Harps soil is on the rims of depressions. The very poorly drained Okoboji soil is in the depressions and is subject to ponding. Individual areas are irregular in shape and range from 10 to about 100 acres in size. They are 50 to 80 percent Harps soil and 20 to 50 percent Okoboji soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Harps soil has a surface layer of black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous loam about 7 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 18 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the surface soil and subsoil contain more clay or less lime. In other places an accumulation of gypsum is at or near the surface. In some areas the soil has seams or pockets of sandy or gravelly material. In other areas the underlying material has more sand and less clay.

Typically, the Okoboji soil has a surface layer of black, calcareous silty clay loam about 10 inches thick. The next layer is black silty clay loam about 9 inches thick. Below this is very dark gray silt loam about 12 inches thick. The subsoil is olive brown, mottled, calcareous silt loam about 5 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silt loam. In places the dark surface soil is less than 24 inches thick. In some areas the soil has layers of sandy material, especially in the lower part. In other areas the soil has more sand and less clay.

Included with these soils in mapping are small areas of the moderately well drained Seaforth soils. These included soils are on the higher lying rises.

Permeability is moderate in the Harps soil and moderately slow in the Okoboji soil. The available water capacity is high in both soils. The Harps soil has a high organic matter content and a moderately alkaline surface layer. The Okoboji soil has a very high organic matter content and a neutral or mildly alkaline surface layer. Surface runoff is slow to ponded on both soils. The seasonal high water table is at a depth of 1 to 3 feet in the Harps soil and is 1 foot above to 1 foot below the surface of the Okoboji soil.

Most areas are cropped. These soils are fairly well suited to cultivated crops. The main management needs are measures that improve drainage and maintain fertility and tilth. Subsurface drainage lines connected to a suitable outlet can lower the water table. Water can pond on the Okoboji soil unless a surface outlet is provided. The high content of lime in the Harps soil may cause a fertility imbalance.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness of both soils and the high content of lime in the Harps soil. The lime ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate on the Harps soil and severe on the Okoboji soil. Cultivation or applications of herbicide help to remove competing vegetation.

Because of wetness and ponding, these soils are generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, these soils are poorly suited to local roads and streets. Coarse textured, well compacted base material that has more strength should be used in the roadbed. A drainage system that includes properly designed side ditches and culverts can remove excess water and thus can help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

927—Harps-Seaforth-Okoboji complex. These nearly level and undulating soils are on glacial till plains. The poorly drained Harps soil is on the rims of

depressions. The moderately well drained Seaforth soil is on the more sloping knobs and ridges. The very poorly drained Okoboji soil is in the depressions and is subject to ponding. Individual areas are irregular in shape and range from 10 to more than 200 acres in size. They are 25 to 40 percent Harps soil, 15 to 30 percent Seaforth soil, and 15 to 30 percent Okoboji soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Harps soil has a surface layer of very dark gray, calcareous clay loam about 10 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 21 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In places an accumulation of gypsum is at or near the surface. In some areas the underlying material has gravelly or sandy layers.

Typically, the Seaforth soil has a surface layer of black, calcareous loam about 10 inches thick. The subsoil is olive brown, calcareous loam about 12 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In places the surface layer and subsoil contain more clay. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Okoboji soil has a surface layer of black silty clay loam about 10 inches thick. The next layer also is black silty clay loam about 10 inches thick. Below this is very dark gray silty clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silt loam. In places the soil is dark to a depth of less than 24 inches. In some areas the soil has less clay and more silt. In other areas it has layers of sandy material in the lower part.

Included with these soils in mapping are small areas of the well drained, strongly sloping Ves soils. These included soils are on peaks and ridges.

Permeability is moderate in the Harps and Seaforth soils and moderately slow in the Okoboji soil. The available water capacity is high in all three soils. The organic matter content is high in the Harps and Seaforth soils and very high in the Okoboji soil. The Harps soil has a moderately alkaline surface layer, the Seaforth soil a mildly alkaline or moderately alkaline surface layer, and the Okoboji soil a neutral to mildly alkaline surface layer. Surface runoff is slow to ponded on all three soils. The seasonal high water table is at a depth of 1 to 3 feet in the Harps soil and 3 to 6 feet in the Seaforth soil. It is 1 foot above to 1 foot below the surface on the Okoboji soil.

Most areas are cropped. These soils are well suited to cultivated crops. The main management concerns are improving drainage and maintaining fertility and tilth. Subsurface drainage lines connected to a suitable outlet can lower the water table, but maintaining the grade may be difficult because of the undulating landscape. Water can pond in the many small depressions unless a surface inlet is provided. If soybeans are grown, the high content of lime in the Harps and Seaforth soils can cause chlorosis. Returning crop residue to the soil, minimizing tillage, and deferring fieldwork when the soil is too wet can improve tilth.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness of the Harps and Okoboji soils and the high content of lime in the Harps and Seaforth soils. The lime ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding and wetness, the Harps and Okoboji soils are generally unsuited to building site development. The Seaforth soil, however, is fairly well suited. The wetness is the main limitation. The basement level of buildings on the Seaforth soil should be constructed above the seasonal high water table. Tile drains around foundations help to remove excess subsurface water. Proper landscaping helps to drain surface water away from the building.

These soils are generally unsuited to sanitary facilities because of ponding and wetness. Soils that are better suited to this use are generally nearby.

Because of low strength, ponding, and frost action, these soils are poorly suited to local roads and streets. Coarse textured, well compacted base material that has more strength should be used in the roadbed. A drainage system that includes properly designed side ditches and culverts can remove excess water and thus can help to prevent the damage caused by ponding and frost action.

The land capability classification is IIw.

954B—Ves-Swanlake loams, 2 to 6 percent slopes. These undulating, well drained soils are on till plains. The Ves soil is on the less sloping side slopes and the lower rises. The calcareous Swanlake soil is on the more sloping knolls and ridges. Individual areas are irregular in shape and range from 3 to about 20 acres in size. They are 60 to 80 percent Ves soil and 20 to 40 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Ves soil has a surface layer of black loam about 10 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown clay loam, and the lower part is light yellowish brown, calcareous loam. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In some places the brownish subsoil is exposed. In other places the dark surface layer is less than 10 inches thick or contains more clay. In some areas the soil is moderately well drained. In a few areas it has seams and pockets of sandy or gravelly material.

Typically, the Swanlake soil has a surface layer of very dark grayish brown, calcareous loam about 9 inches

thick. The underlying material to a depth of about 60 inches is brown and light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In places the surface layer is lighter colored. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are small areas of the very poorly drained Glencoe and poorly drained Webster soils. Glencoe soils are in low lying, closed depressions and are subject to ponding. Webster soils are in swales and on toe slopes.

Permeability is moderate in the Ves and Swanlake soils. The available water capacity is high. The Ves soil has a high organic matter content and a neutral or slightly acid surface layer. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. Surface runoff is medium on both soils.

Most areas are cropped. These soils are well suited to all of the crops commonly grown in the county. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, terraces, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Because of the high content of lime, the Swanlake soil is less productive than the Ves soil. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Ves soil. The ones grown on the Swanlake soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development and septic tank absorption fields. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

Because of low strength and frost action, these soils are only fairly well suited to local roads and streets. Well compacted, coarse textured base material that has more strength is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIe.

954C—Swanlake-Ves loams, 6 to 12 percent slopes. These rolling, well drained soils are on till plains. The calcareous Swanlake soil is on the more sloping peaks and ridges. The Ves soil is on the less sloping side slopes. Individual areas are irregular in shape and range from 3 to about 30 acres in size. They are 50 to 75 percent Swanlake soil and 25 to 50 percent Ves soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Swanlake soil has a surface layer of very dark grayish brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is brown and light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In places the surface layer is lighter colored. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Ves soil has a surface layer of black loam about 10 inches thick. The subsoil is loam about 19 inches thick. The upper part is dark yellowish brown, and the lower part is brown and calcareous. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In places the surface soil contains more clay. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are areas of the poorly drained Delft and excessively drained Hawick soils. Delft soils are in swales and drainageways and on toe slopes. Hawick soils are sandy. They are in landscape positions similar to those of the Swanlake and Ves soils.

Permeability is moderate in the Ves and Swanlake soils. The available water capacity is high. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. The Ves soil has a high organic matter content and a neutral or slightly acid surface layer. Surface runoff is medium on both soils.

Most areas are cropped. These soils are fairly well suited to cultivated crops. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. The Swanlake soil is less productive than the Ves soil because of the high content of lime at or near the surface. Returning crop residue to the soil and minimizing tillage can improve tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase productivity. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Ves soil. The ones grown on the Swanlake soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be either

seeded and mulched or sodded. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

Because of the slope, these soils are only fairly well suited to septic tank absorption fields. Hillside seepage is a hazard. The absorption fields should be designed so that they conform to the natural slope of the land.

Because of low strength, frost action, and slope, these soils are only fairly well suited to local roads and streets. Coarse textured base material that has more strength and is more resistant to frost action is needed in the roadbed. Erosion-control measures, such as sodding, seeding, mulching, and land shaping, are needed during and after construction.

The land capability classification is IIIe.

954D—Swanlake-Ves loams, 12 to 18 percent slopes. These hilly, well drained soils are on till plains. The calcareous Swanlake soil is on the more sloping peaks and ridges. The Ves soil is on the less sloping side slopes. Individual areas typically are elongated and range from 3 to about 15 acres in size. They are 60 to 80 percent Swanlake soil and 20 to 40 percent Ves soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Swanlake soil has a surface layer of very dark grayish brown, calcareous loam about 7 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In places the surface layer is lighter colored. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Ves soil has a surface layer of very dark brown loam about 10 inches thick. The subsoil is loam about 16 inches thick. The upper part is dark yellowish brown, and the lower part is pale brown and calcareous. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In places the surface soil is thinner or contains more clay. In some areas the soil has seams and pockets of sandy or gravelly material.

Included with these soils in mapping are small areas of the poorly drained Delft and excessively drained Hawick soils. Delft soils are in low lying swales and on foot slopes. Hawick soils are sandy. They are in landscape positions similar to those of the Swanlake and Ves soils.

Permeability is moderate in the Ves and Swanlake soils. The available water capacity is high. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. The Ves soil has a high organic matter content and a neutral or slightly acid surface layer. Surface runoff is rapid on both soils.

Most areas are cultivated or pastured. These soils are poorly suited to cultivated crops. The erosion hazard is severe. The main management concerns are controlling erosion and improving fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, contour stripcropping, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. The Swanlake soil is less productive than the Ves soil because of the high content of lime at or near the surface. Returning crop residue to the soil and minimizing tillage improve tilth.

These soils are fairly well suited to pasture and hay. Applications of fertilizer and weed control increase productivity. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Ves soil. The ones grown on the Swanlake soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. Water erosion is severe unless the site is protected by a plant cover and site preparation is limited to an area within 2 feet of where the plant is to be established. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the slope, these soils are poorly suited to building site development. The slope increases the cost of leveling and land shaping and the extent of erosion during and after construction. The buildings should be designed so that they conform to the natural slope of the land. Diversions and cover crops help to control erosion during construction. As soon as construction is completed, the site should be either seeded and mulched or sodded.

Because of the slope, these soils are poorly suited to septic tank absorption fields. Hillside seepage is a hazard. Carefully designing the absorption field on the contour reduces this hazard. If possible, an alternative site should be selected.

Mainly because of the slope, these soils are poorly suited to local roads and streets. The slope increases the cost of grading and shaping roads and the extent of erosion. Erosion-control measures, such as land shaping, seeding, mulching, and sodding, are needed during and after construction. Coarse textured base material that has more strength and is more resistant to frost action is needed in the roadbed.

The land capability classification is IVe.

981—Canisteo-Harps loams. These nearly level, poorly drained soils are on till plains. They are about 35 to 50 percent Canisteo soil and 35 to 50 percent Harps soil. The Canisteo soil is in plane and concave areas at the base of the steeper slopes. The Harps soil is in slightly convex areas on the rims of depressions. Individual areas are irregular in shape and range from 3 to about 100 acres in size. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Canisteo soil has a surface layer of black, calcareous loam about 10 inches thick. The subsurface layer is very dark gray, calcareous loam

about 11 inches thick. The subsoil is grayish brown, mottled, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some places the surface soil is neutral in reaction or is more than 24 inches thick. In other places the surface layer and subsoil contain more clay. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas the underlying material has more sand and less clay.

Typically, the Harps soil has a surface layer of black, calcareous loam about 9 inches thick. The subsurface layer is very dark gray, calcareous loam about 6 inches thick. The subsoil is grayish brown, calcareous loam about 18 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous loam. In some places the surface soil and subsoil contain more clay. In other places an accumulation of gypsum is at or near the surface. In some areas the soil has seams and pockets of sandy or gravelly material. In other areas the underlying material has more sand and less clay.

Included with these soils in mapping are areas of the very poorly drained Glencoe and Okoboji soils. These included soils are in low lying, closed depressions and are subject to ponding.

Permeability is moderate in the Canisteo and Harps soils. The available water capacity and organic matter content are high. The surface layer of the Canisteo soil is mildly alkaline or moderately alkaline, and that of the Harps soil is moderately alkaline. Surface runoff is slow on both soils. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are cropped. These soils are well suited to most of the crops commonly grown in the county. The main management concerns are improving drainage and maintaining fertility and tilth. Drainage can be improved by subsurface drainage lines and ditches. The Harps soil has enough lime to cause a fertility imbalance. Yields of soybeans can be reduced by chlorosis. Minimizing tillage and returning crop residue to the soil help to maintain tilth.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. A drainage system can increase hay production. Deferment of grazing when the soil is too wet helps to prevent excessive surface compaction.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness and a high content of lime, which ties up minerals and limits their availability. Because of the wetness, seedling mortality is moderate and spring planting may be delayed. Cultivation or applications of herbicide help to remove competing vegetation.

Because of the wetness, these soils are poorly suited to building site development. Seepage into underground basements can be a problem. It can be controlled by installing drainage lines along the sides of footings. The footings should be installed in coarse textured fill material above the seasonal high water table.

Because of the high water table, these soils are poorly suited to septic tank absorption fields. Pollution of ground water is likely unless the distribution lines are installed above the water table. In some areas, a mound system can be used and the water table can be lowered by a system of artificial drains.

Because of low strength and frost action, these soils are poorly suited to local roads and streets. Well compacted, coarse textured base material that has more strength should be used in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIw.

999B—Ves-Swanlake-Hawick complex, 2 to 6 percent slopes. These undulating soils are on till plains and outwash plains. The well drained Ves soil is on convex side slopes and on knolls. The well drained, calcareous Swanlake soil is on the more sloping peaks and ridges. The excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are irregular in shape and range from 3 to about 40 acres in size. They are 40 to 60 percent Ves soil, 25 to 40 percent Swanlake soil, and 15 to 30 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Ves soil has a surface layer of black loam about 10 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is loam about 16 inches thick. The upper part is dark brown, and the lower part is olive brown and calcareous. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In places the brownish subsoil is exposed because of plowing.

Typically, the Swanlake soil has a surface layer of very dark gray, calcareous loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In places the surface layer is lighter colored. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Hawick soil has a surface layer of very dark brown loamy coarse sand about 10 inches thick. The subsoil is dark yellowish brown loamy coarse sand about 11 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous gravelly coarse sand. In places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In some areas the underlying material contains more clay.

Included with these soils in mapping are small areas of the very poorly drained Glencoe, moderately well drained

Terril, and poorly drained Webster soils. Glencoe soils are in closed depressions and are subject to ponding. Terril and Webster soils are in low lying swales and on toe slopes.

Permeability is moderate in the Ves and Swanlake soils and very rapid in the Hawick soil. Available water capacity is high in the Ves and Swanlake soils and very low or low in the Hawick soil. The Ves soil has a high organic matter content and a neutral or slightly acid surface layer. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. The Hawick soil has a moderately low organic matter content and a slightly acid to mildly alkaline surface layer. Surface runoff is medium on all three soils.

Most areas are cropped. These soils are only fairly well suited to cultivated crops because of the hazard of erosion and the droughty nature of the Hawick soil. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence that includes grasses and legumes, grassed waterways, terraces, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage improve tilth and conserve moisture. Crop growth varies within short distances because of the droughty nature of the Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Ves soil. The ones grown on the Swanlake soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are well suited to building site development. Drainage lines along the sides of footings help to keep underground basements dry by intercepting surface water during unusually wet periods.

The Ves and Swanlake soils are well suited to septic tank absorption fields. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water.

The Hawick soil is well suited to local roads and streets, but the Ves and Swanlake soils are only fairly well suited because of frost action and low strength. Well compacted, coarse textured base material that has more strength is needed in the roadbed. Properly designed side ditches and culverts carry away excess water and thus help to prevent the damage caused by frost action.

The land capability classification is IIIe.

999C—Swanlake-Ves-Hawick complex, 6 to 12 percent slopes. These rolling soils are on till plains and outwash plains. The well drained, calcareous Swanlake soil is on the more sloping peaks and ridges. The well drained Ves soil is on convex side slopes and on knolls. The excessively drained Hawick soil occurs in a random pattern throughout the unit. Individual areas are irregular in shape and range from 3 to about 40 acres in size. They are 40 to 60 percent Swanlake soil, 20 to 40 percent Ves soil, and 15 to 30 percent Hawick soil. The three soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Swanlake soil has a surface layer of very dark grayish brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. It has an accumulation of lime in the upper part. In some places the surface layer is lighter colored. In other places the underlying material has seams and pockets of sandy or gravelly material.

Typically, the Ves soil has a surface layer of very dark brown loam about 10 inches thick. The subsoil is about 20 inches thick. It is olive brown clay loam in the upper part and light olive brown, calcareous loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam. In places the brownish subsoil is exposed because of plowing. In some areas the soil has seams and pockets of sandy or gravelly material.

Typically, the Hawick soil has a surface layer of dark brown loamy sand about 10 inches thick. The subsoil is dark yellowish brown loamy sand about 6 inches thick. The underlying material to a depth of about 60 inches is brown, calcareous sand. In places the content of pebbles and cobbles in the subsoil and underlying material is more than 35 percent. In some areas the underlying material contains more clay.

Included with these soils in mapping are areas of the poorly drained Delft, very poorly drained Glencoe, and moderately well drained Terril soils. Delft and Terril soils are in the lower lying swales and drainageways and on toe slopes. Glencoe soils are in closed depressions and are subject to ponding.

Permeability is moderate in the Swanlake and Ves soils and very rapid in the Hawick soil. Available water capacity is high in the Swanlake and Ves soils and very low or low in the Hawick soil. The Swanlake soil has a moderate organic matter content and a mildly alkaline surface layer. The Ves soil has a high organic matter content and a neutral or slightly acid surface layer. The Hawick soil has a moderately low organic matter content and a slightly acid to mildly alkaline surface layer. Surface runoff is medium on all three soils.

Most areas are cropped or pastured. These soils are poorly suited to cultivated crops. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. A cropping sequence

that includes grasses and legumes, grassed waterways, contour stripcropping, terraces, and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil and minimizing tillage can improve tilth. Crop growth varies within short distances because of the droughty nature of the Hawick soil.

These soils are well suited to pasture and hay. Applications of fertilizer and weed control increase forage production. Overgrazing depletes the protective plant cover and thus increases the erosion hazard.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Ves soil. The ones grown on the Swanlake soil should be those that can withstand a high content of lime, which ties up minerals and limits their availability. The trees and shrubs grown on the Hawick soil should be those that can withstand droughty conditions. Cultivation or applications of herbicide help to remove competing vegetation.

These soils are fairly well suited to building site development. The slope is the main limitation. Erosion is a moderate hazard during construction. It can be controlled by diversions and cover crops. As soon as construction is completed, the site should be either seeded and mulched or sodded. Drainage lines along the sides of footings intercept surface water during unusually wet periods.

Because of the slope, these soils are only fairly well suited to septic tank absorption fields. Hillside seepage is a hazard. The Hawick soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of local ground water. Properly designing the absorption field across the slope can reduce the hazard of hillside seepage.

Because of low strength, frost action, and slope, these soils are only fairly well suited to local roads and streets. Coarse textured base material that has more strength and is more resistant to frost action is needed in the roadbed. Erosion-control measures, such as seeding, mulching, land shaping, and sodding, are needed during and after construction.

The land capability classification is IVe.

1016—Udorthents, loamy. These nearly level and gently sloping soils are in areas where the landscape has been greatly altered. In places, slopes were cut down and the soil material was used as fill in low areas and as material for building sites. Some fill material was hauled in from off the site. Some areas have been used as a source of borrow material. In these areas the original topsoil has been restored and reseeded after excavation.

Many areas of these soils are in and around Willmar. As the city grew in size, the surrounding areas were filled and leveled when they were developed as sites for buildings, roads, parking lots, playgrounds, or parks. Some areas are along lakeshores, in outlying subdivisions, and in small towns.

Because of the altered landscape, classification of the original soil is not practical. The soil characteristics vary widely. Onsite investigation and soil borings are needed to determine the suitability for a specific use.

No land capability classification is assigned.

1029—Pits, gravel. This map unit consists of excavations from which gravel or sand has been removed. Many of the pits are mined, but some have been abandoned. The abandoned ones support grasses or trees. Areas of open water are in some of the deeper pits, especially in the spring.

Most of the pits are in areas of Estherville and Hawick soils. Onsite investigation is needed to determine the suitability for specific uses.

No land capability classification is assigned.

1055—Aquolls and Histosols, ponded. These nearly level, very poorly drained soils are in depressions and basins and on the margins of lakes. They are frequently ponded for long periods. The mineral Aquolls are on the fringes of the mapped areas, and the organic Histosols are generally near the center of the areas. Individual areas are irregular in shape and range from 3 to more than 200 acres in size. Some are entirely Aquolls or Histosols, and some are a mixture of both.

The surface texture, color, and thickness of these soils vary, but the Aquolls commonly are black loam in the upper 30 inches. In some areas the surface layer is mucky. The underlying material to a depth of about 60 inches generally is olive gray, calcareous loam. In places it is coarse sand and gravel.

Commonly, the upper 20 inches of the Histosols is black muck. The next layer is very dark gray coprogenous earth about 30 inches thick. The underlying material to a depth of about 60 inches is olive, calcareous loam. In some places the muck is more than 60 inches thick. In other places the coprogenous earth is at the surface. In some areas the underlying material is coarse sand and gravel.

Included with these soils in mapping are small areas of the excessively drained Hawick and poorly drained Regal soils. These included soils are on ridges along the fringes of the mapped areas.

Permeability is moderate or moderately slow in the Aquolls and moderately slow to rapid in the Histosols. The available water capacity and organic matter content are high in the Aquolls and high or very high in the Histosols. Water usually is on the surface of both soils throughout the year, but some areas dry up during extended dry periods. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas provide habitat for wetland wildlife. Because of the wetness, these soils are unsuitable for

pasture and cropland and for windbreaks and environmental plantings.

Because of ponding, low strength, and frost action, these soils are generally unsuitable for building site development, sanitary facilities, and local roads and streets. Other soils that are better suited to these uses are generally nearby.

The land capability classification is VIIIw.

1065B—Aquolls and Histosols, sloping. These gently sloping, poorly drained and very poorly drained soils are on side slopes and toe slopes on ground moraines and outwash plains. They receive additional water from underground springs or hillside seeps. Slopes range from 1 to 6 percent. Individual areas are irregular in shape and range from 5 to about 40 acres in size. Some are entirely Aquolls or Histosols, and some are a mixture of both.

The surface texture, color, and thickness of these soils vary, but the Aquolls commonly are black, calcareous clay loam in the upper 20 inches. The underlying material to a depth of about 60 inches is olive gray, calcareous loam.

Commonly, the Histosols are black, calcareous muck in the upper 30 inches. The underlying material to a depth of about 60 inches generally is olive gray, calcareous loam. In places it is coarse sand and gravel or clay loam.

Included with these soils in mapping are small areas of the poorly drained Canisteo, Delft, and Harps soils. These included soils are in slight depressions.

Permeability is moderate or moderately slow in the Aquolls and moderately slow to rapid in the Histosols. The available water capacity and organic matter content are high in the Aquolls and very high in the Histosols. Surface runoff is slow or medium on both soils. Springs keep the soils wet. They generally flow all year, but some may stop flowing during the summer and fall. The seasonal high water table is within a depth of 1 foot.

Most areas are used as pasture or wildlife habitat. Because of the wetness, these soils are poorly suited to pasture and are generally unsuitable as cropland. Onsite inspection is needed to determine the suitability for the trees and shrubs grown as windbreaks and environmental plantings. Unless a drainage system is installed, a high seedling mortality rate can be expected.

Because of the excessive wetness, these soils are generally unsuitable for building site development, sanitary facilities, and local roads and streets. Overcoming this limitation is difficult.

The land capability classification is VIw.

1900—Okoboji-Canisteo silty clay loams, depressional. These nearly level, very poorly drained soils are in depressions on till plains. They are subject to ponding. The Okoboji soil is typically in the center of the depressions. The calcareous Canisteo soil typically is on the outer parts of the depressions. Because of a gradual slope, water generally drains toward the center of the depressions. Individual areas are irregular in shape and range from 5 to about 100 acres in size. They are 50 to 75 percent Okoboji soil and 25 to 50 percent Canisteo soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Okoboji soil has a surface layer of black silty clay loam about 10 inches thick. The next 15 inches is black silty clay loam. Below this is very dark gray silty clay loam about 7 inches thick. The subsoil is olive gray, mottled silty clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous silt loam. In some places the soil has less clay and more silt. In other places the surface soil is loam, clay loam, or muck. In some areas the underlying material has sandy layers.

Typically, the Canisteo soil has a surface layer of black, calcareous silty clay loam about 10 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 7 inches thick. The subsoil is olive gray, mottled, calcareous silt loam about 13 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some places an accumulation of gypsum or lime is in the upper 16 inches. In other places the surface layer and subsoil contain more clay. In some areas the underlying material has sandy layers.

Included with these soils in mapping are small areas of the poorly drained Harps and Harpster soils and the very poorly drained Palms soils. Harps and Harpster soils are around the rims of the depressions and on slight rises within the depressions. Palms soils are near the center of the larger depressions. They are organic to a depth of more than 16 inches.

Permeability is moderately slow in the Okoboji soil and moderate in the Canisteo soil. The available water capacity is high in both soils. The organic matter content is very high in the Okoboji soil and high in the Canisteo soil. The surface layer of the Okoboji soil is slightly acid to mildly alkaline, and that of the Canisteo soil is mildly alkaline or moderately alkaline. The seasonal high water table is 1 foot above to 1 foot below the surface of both soils.

Most areas have been drained and are farmed. These soils are fairly well suited to all of the crops commonly grown in the county. Subsurface drainage lines connected to a suitable outlet help to lower the water table. In areas of the Okoboji soil, which commonly is on the lowest part of the landscape, the drainage system should result in rapid drainage of ponded surface water. Tilling in the fall and returning crop residue to the soil help to maintain tilth.

The trees and shrubs grown as windbreaks and environmental plantings should be those that can withstand the wetness of both soils and the high content of lime in the Canisteo soil. The lime ties up minerals

and limits their availability. Because of the wetness, seedling mortality is moderate or severe. Cultivation or applications of herbicide help to remove competing vegetation.

Because of ponding, these soils are generally unsuited to building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, these soils are poorly suited to local roads and streets. Coarse textured, well compacted base material that has more strength should be used in the roadbed. A drainage system that includes properly designed side ditches and culverts can remove excess water and thus can help to prevent the damage caused by ponding and frost action.

The land capability classification is IIIw.

1908—Biscay-Palms complex. These nearly level, very poorly drained soils are adjacent to streams and rivers. They are occasionally flooded and are frequently ponded. Individual areas are typically elongated and range from 10 to more than 200 acres in size. They are 30 to 70 percent Biscay soil and 30 to 70 percent Palms soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is not practical.

Typically, the Biscay soil has a surface layer of black loam about 12 inches thick. The subsurface layer is very dark gray loam about 8 inches thick. The subsoil is olive gray, mottled sandy clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous gravelly coarse sand. In some places the surface soil and subsoil are calcareous. In other places the underlying material contains more clay. In some areas layers of loamy sand, sand, silt loam, or muck are in the upper part of the profile.

Typically, the Palms soil has a surface soil of black muck about 21 inches thick. The next layer is black loam about 8 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous sand. In places the surface soil is stratified with silt loam, loam, loamy sand, or sand. In some areas the underlying material is fine sandy loam or loam.

Included with these soils in mapping are areas of the very poorly drained Houghton, moderately well drained Osakis, and poorly drained Regal soils. Houghton soils are in landscape positions similar to those of the Palms soil. They have more than 51 inches of decomposed organic material. Osakis soils are on scattered ridges. Regal soils are on the fringes of the mapped areas, adjacent to upland soils.

Permeability is moderate in the upper part of the Biscay soil and rapid in the underlying material. It is moderately rapid in the upper part of the Palms soil and rapid in the underlying material. The available water capacity is moderate in the Biscay soil and very high in the Palms soil. The organic matter content is high in the Biscay soil and very high in the Palms soil. The surface layer of both soils is slightly acid to mildly alkaline. The seasonal high water table is 1 foot above the surface to 1 foot below.

Most areas are undrained and are used as pasture, hayland, or wildlife habitat. Because of the high water table and the occasional flooding, these soils are generally unsuitable as cropland. Draining the soils is difficult because suitable outlets for drainage systems generally are not available.

These soils are poorly suited to pasture and hay because of the excessive wetness. The periodic flooding limits grazing. Hummocks tend to form if the Palms soil is grazed when wet.

Because of ponding, flooding, and low strength, these soils are generally unsuitable for building site development and sanitary facilities. Soils that are better suited to these uses are generally nearby.

Because of low strength, ponding, and frost action, these soils are poorly suited to local roads and streets. If roads are built across areas of these soils, the organic part of the Palms soil should be replaced with suitable, well compacted, coarse textured fill material. A drainage system helps to lower the water table and thus helps to prevent the damage caused by frost action. Measures that protect the road against ponding and flooding are needed.

The land capability classification is VIw.

Prime Farmland

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

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

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

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

About 290,000 acres in the survey area, or 52 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county. They are mainly in associations 4 through 8, which are described under the heading "General Soil Map Units." The main crops grown on this land are corn and soybeans.

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

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

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

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Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

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

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

In 1982, about 243,900 acres in Kandiyohi County was used for corn and soybeans; 74,000 acres for small grain, primarily wheat and oats; and 29,400 acres for hay, primarily alfalfa-grass mixtures. Many steeply sloping or excessively wet soils are used for pasture. Sunflowers, sugar beets, snap beans, and peas are grown on small acreages.

The soils in the county are marginally productive to highly productive. Good management can increase yields and conserve the soil. The paragraphs that follow describe the main concerns in managing the cropland in the county.

Most of the cropland is subject to water erosion or soil blowing. The erosion hazard ranges from slight to severe. The more sloping soils are more susceptible to water erosion than the less sloping soils. As topsoil is removed through erosion, nutrients and organic matter also are lost. The eroding sediment generally is deposited at the base of the slopes or in nearby depressions, but some of it enters rivers and lakes, lowering the quality of the water.

Numerous methods can be used to control erosion. One of the most cost effective methods is conservation tillage. A system of conservation tillage leaves part or all of the crop residue on the surface. Examples are full-width tillage, use of a chisel plow or disc or strip tillage, till planting on ridges, and no-till planting. The benefits of conservation tillage include erosion control, reduced fuel consumption, and a substantial saving of time.

Other erosion-control measures include grassed waterways, water- and sediment-control basins, diversions, and stripcropping. In areas where slopes are long and uniform, terraces, contour farming, and contour stripcropping can be effective in controlling erosion. Returning crop residue to the soil increases the rate of water infiltration and thus reduces the runoff rate and the susceptibility to erosion.

Soil blowing can be a problem throughout the county but is especially serious on Dickinson, Estherville, Hawick, Osakis, and other droughty soils. Most of the soil blowing occurs in fall or early in spring, when the surface is bare. Leaving crop residue on the surface helps to control soil blowing. Fall plowing, which leaves

the fields rough and cloddy, reduces the susceptibility to soil blowing until the rough and cloddy conditions are destroyed by freezing and thawing or by the wind. Properly located field windbreaks and wind stripcropping also are effective in controlling soil blowing.

Wetness is a limitation in many low lying and depressional areas. A drainage system is needed to control ponding and to lower the water table below the root zone. Open ditches drain much of the surface water and can be used as outlets for subsurface tile lines. Where outlets are not available, a pumping station may be needed. Pumps are commonly ineffective in wet, sandy soils, however, because of rapid permeability in the underlying material. The spacing of subsurface tile lines depends on the soil type and the depth at which the tile can be installed. The finer the soil texture, the closer the lines should be. In many small depressions, a surface inlet is needed to remove surface water rapidly.

Soil tilth is an important management concern. Good tilth increases the rate of water infiltration and facilitates preparation of a good seedbed. It also allows the soil to warm up more quickly in the spring and results in more efficient use of plant nutrients. Working the soil when it is very wet can cause compaction and can damage soil structure. On moderately fine textured and fine textured soils, fall tillage can increase the hazard of erosion. Ridge planting or chisel plowing reduces the hazard. Freezing and thawing loosen the surface and make seedbed preparation easier in spring. Returning crop residue to the soil and adding manure improve tilth. A cropping sequence that includes alfalfa-grass mixtures helps to loosen the soil and thus improves tilth.

On Dickinson, Estherville, Hawick, and other droughty soils, irrigation is effective in increasing productivity. Because the available water capacity of these soils is moderate or low, regular additions of water are needed during periods of moisture deficiency. Most of the irrigated soils in the county are in the Estherville-Hawick-Lena soil association, which is described under the heading "General Soil Map Units." These sandy soils are well suited to irrigation. If irrigated, they can be used for a wide variety of crops. Irrigation is especially beneficial in areas where specialty crops are grown. Crops growing on well drained soils that formed in glacial till also can benefit from irrigation, but the need to supplement rainfall is not so great during most years.

Crop response to applications of fertilizer is good on most of the soils in the county. The need for fertilizer depends on the soil type, past and present management, the degree of erosion, and the crop to be planted. A soil test can indicate the type and amount of fertilizer to be applied. The soil test should reflect the main soil types in a particular field. Crop response to fertilizer is limited in areas where cropping is affected by other limitations, such as droughtiness, excessive wetness, or an imbalance of plant nutrients caused by a high content of lime. A good fertility management program takes into account all aspects of plant growth.

Soil texture, organic matter content, and reaction affect herbicide application rates and carry-over. The texture, organic matter content, and reaction of each soil are described under the heading "Detailed Soil Map Units."

The acreage used for pasture in the county has been decreasing in recent years. The pastured areas tend to be too wet, too steep, or too droughty for crops. Existing pastures can be improved by applications of fertilizer, pasture rotation, deferment of grazing during wet periods, and weed control. In some areas they could be renovated by reseeding to more productive species. The species selected for planting should those that are suited to the soil type and the drainage conditions.

Deep, well drained to somewhat poorly drained soils, such as Guckeen, Koronis, Nicollet, Normania, Sunburg, Ves, and Wadenill soils, are suited to the widest range of pasture species. These species include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, timothy, orchardgrass, Kentucky bluegrass, and reed canarygrass. Also, warm-season grasses, including big bluestem, indiangrass, and switchgrass, grow well during July and August on these soils. The cool- and warm-season grasses grow well on the somewhat poorly drained and poorly drained Biscay, Canisteo, Delft, Harps, Marna, and Webster soils.

The only pasture species that grow well on the very poorly drained Blue Earth, Okoboji, Houghton, Lena, Muskego, and Palms soils are those that can withstand wet conditions. These species include reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils also are suitable for timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

Moderately well drained to excessively drained soils, including Dickinson, Estherville, Hawick and Osakis soils, usually produce forage when precipitation is adequate in spring, early in summer, and again in fall. During the droughty summer months, forage production is limited. Alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, orchardgrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well when the moisture supply is adequate.

The well drained and excessively drained soils are well suited to warm-season grasses, including big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama. If grazing is properly managed, these species provide good forage during the summer. Together with the cool-season grasses, they provide a full season of grazing. Current information about variety selection and species adaptation can be obtained from local offices of the Cooperative Extension Service and Soil Conservation Service.

Yields Per Acre

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

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

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

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

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

Land Capability Classification

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

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

Windbreaks and Environmental Plantings

Since the days of early settlement, windbreaks have been planted to protect farmsteads and livestock. In the 1930's, they were planted to control soil blowing. In recent years, field windbreaks have been planted to trap snow and thus increase the moisture supply. Maximum growth and survival rates can be obtained by controlling weeds around the newly planted trees and shrubs.

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

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

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field (fig. 8). 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

Kandiyohi County has many lakes and scenic areas of wooded hills that provide excellent opportunities for recreation. These areas are commonly used for camping, boating, fishing, hunting, cross-country skiing, and snowmobiling. The county owns and maintains seven county parks. Sibley State Park, in the northern part of the county, is the major recreational facility. Public access is available to most of the fishing lakes.

Because of its scenic diversity and limited agricultural value, the Koronis-Hawick-Sunburg association is better suited to recreational development than the other associations in the county. This association is characterized by many wooded slopes, ponds, and marshes that are well suited to recreational

Figure 8.—A field windbreak in an area of the Estherville-Hawick complex, 2 to 6 percent slopes.

development. It is described under the heading "General Soil Map Units."

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

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

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

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

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

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

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

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

Wildlife Habitat

The soils in Kandiyohi County can provide good habitat for a wide variety of wildlife. Such species as whitetail deer, rabbit, squirrel, pheasant, Hungarian partridge, ducks, geese, and ruffed grouse inhabit areas where suitable habitat is available. Fur-bearing animals, such as mink, muskrat, fox, and beaver, are also common. The numerous lakes commonly are inhabited by walleye, northern pike, perch, crappie, bass, sunfish, bullhead, carp, and suckers.

Changes in land use have altered the wildlife population. A slow decrease in the extent of wildlife habitat has resulted in a decrease in wildlife numbers. Drainage systems, clearing of forest areas, and urban expansion have reduced the extent of wildlife habitat.

Many areas of wildlife habitat can be improved by providing food, water, and cover. The areas best suited to the development of wildlife habitat generally are in the northern part of the county.

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, bluegrass, 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, yarrow, 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, ash, chokecherry, apple, hawthorn, dogwood, and blackberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, honeysuckle, 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, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, cattail, cordgrass, rushes, sedges, and reeds.

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

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

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include 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 ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, red fox, raccoon, and deer.

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

Engineering

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

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

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

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

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

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

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

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

Building Site Development

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

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, 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 the depth to the water table.

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

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock 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 salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

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

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

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock 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 due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, 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 determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

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

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

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

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

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

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

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

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

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

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

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

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree

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

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

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

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

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

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

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

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, 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. Availability of drainage outlets is not considered in the ratings.

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

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

Soil Properties

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

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

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

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

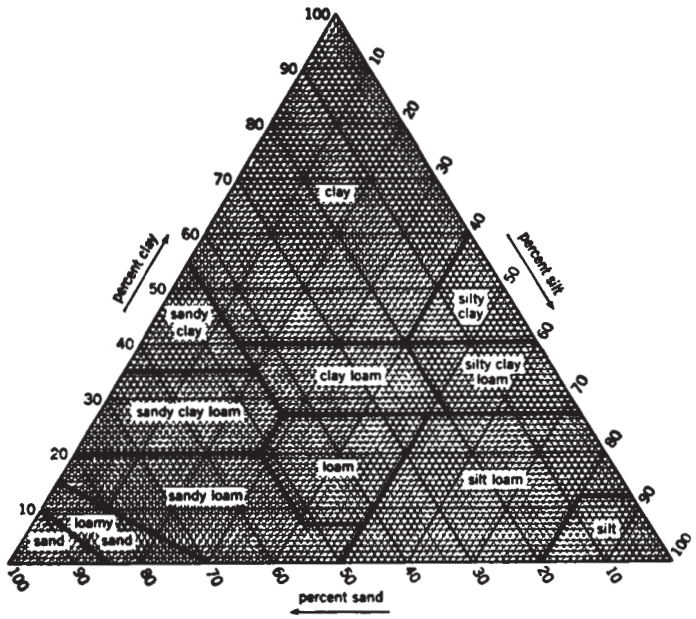

Figure 9.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 9). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

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

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

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

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

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

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

Physical and Chemical Properties

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

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

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

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

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

Soil and Water Features

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

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

The four hydrologic soil groups are:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, 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 Hapludolls (*Hapl*, meaning minimal horizonation, plus *udoll*, the suborder of the Mollisols that have a humid 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 *Aquic* identifies the subgroup that is wetter than the typical great group. An example is Aquic Hapludolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Aquic Hapludolls.

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*6*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*7*). 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."

Arkton Series

The Arkton series consists of deep, moderately well drained, moderately slowly permeable soils on ground moraines that have a mantle of lacustrine material. These soils formed in clayey and loamy lacustrine material and in the underlying firm, loamy glacial till. Slopes range from 4 to 18 percent.

Typical pedon of Arkton clay, in an area of Guckeen-Arkton complex, 4 to 12 percent slopes, 2,150 feet west and 150 feet south of the center of sec. 34, T. 120 N., R. 34 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; weak fine and medium

subangular blocky structure; friable; common fine roots; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Bk—9 to 27 inches; dark grayish brown (10YR 4/2) clay; few fine faint grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine roots; about 5 percent coarse fragments; few threads and masses of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C—27 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) and few fine faint light olive brown (2.5Y 5/6) mottles; massive; firm; few threads and masses of calcium carbonate; about 8 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 12 to 30 inches. The mollic epipedon is 7 to 12 inches thick. Free carbonates typically are throughout the profile. In some pedons, however, the upper 10 inches is leached. The content of coarse fragments ranges from 1 to 10 percent throughout the profile. The most common of these are shale fragments.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It is dominantly clay or clay loam, but the range includes silty clay and silty clay loam. This horizon is neutral to moderately alkaline. The Bk horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is clay, silty clay, or clay loam. It is mildly alkaline or moderately alkaline. Some pedons have a 2C horizon. The C and 2C horizons have colors similar to those of the Bk horizon. They are clay loam or loam. They are mildly alkaline or moderately alkaline.

Biscay Series

The Biscay series consists of deep, poorly drained and very poorly drained soils on glacial outwash plains. These soils formed in a loamy mantle 20 to 40 inches deep over sandy and gravelly outwash. They are moderately permeable in the upper part and rapidly permeable in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Biscay loam, depressional, 2,400 feet east and 2,500 feet north of the southwest corner of sec. 12, T. 120 N., R. 33 W.

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—10 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; gradual wavy boundary.

A2—16 to 21 inches; very dark gray (10YR 3/1) sandy clay loam; few fine distinct olive gray (5Y 5/2) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; gradual wavy boundary.

Bg—21 to 30 inches; olive gray (5Y 5/2) loam; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

2Cg1—30 to 46 inches; dark gray (5Y 4/1) loamy sand; single grain; loose; about 3 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg2—46 to 60 inches; olive gray (5Y 5/2) gravelly coarse sand; single grain; loose; about 15 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of solum and of the fine-loamy mantle ranges from 20 to 40 inches and is typically the same as the depth to free carbonates. In some pedons the Ap horizon is calcareous. The mollic epipedon is 16 to 24 inches thick. The content of coarse fragments is typically less than 5 percent in the fine-loamy mantle and ranges from 5 to 50 percent in the underlying material.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is dominantly loam, but the range includes clay loam and sandy clay loam. This horizon is mildly alkaline to slightly acid. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, sandy clay loam, or clay loam. It is mildly alkaline or neutral. The 2Cg horizon has colors similar to those of the Bg horizon. It is typically stratified loamy coarse sand, loamy sand, coarse sand, or the gravelly analogs of these textures. It is mildly alkaline or moderately alkaline.

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained, moderately permeable, calcareous soils in postglacial lake basins. These soils formed in sedimentary peat. Slopes range from 0 to 2 percent.

Typical pedon of Blue Earth mucky silt loam, 1,700 feet south and 185 feet east of the northwest corner of sec. 25, T. 119 N., R. 35 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) mucky silt loam, gray (5Y 5/1) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; about 1 percent shell fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

C—10 to 60 inches; mixed black (10YR 2/1) and dark gray (10YR 4/1 and 5Y 4/1) mucky silt loam; weak fine and medium subangular blocky structure; very

friable; about 3 percent shell fragments; strong effervescence; moderately alkaline.

The thickness of the sedimentary peat ranges from 30 to more than 60 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile. The content of coarse fragments is 1 to 12 percent in the coprogenous earth. These are mainly shell fragments.

The sedimentary peat has hue of 10YR to 5Y, value of 2 to 4, and chroma of 1 or 2. It is silt loam, silty clay loam, or the mucky analogs of these textures. Some pedons have a 2C horizon. This horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, silt loam, or clay loam.

Brownton Series

The Brownton series consists of deep, poorly drained, slowly permeable soils on till plains and ground moraines mantled with lacustrine material. These soils formed in silty and clayey lacustrine material overlying loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Brownton silty clay loam, 1,310 feet east and 2,550 feet north of the southwest corner of sec. 1, T. 117 N., R. 34 W.

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

A—10 to 18 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; firm; slight effervescence; mildly alkaline; clear wavy boundary.

Bg—18 to 34 inches; olive gray (5Y 5/2) silty clay; few fine distinct olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; firm; slight effervescence; mildly alkaline; clear wavy boundary.

2Cg—34 to 60 inches; olive gray (5Y 5/2) clay loam; common fine distinct olive brown (2.5Y 4/4) mottles; massive; firm; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 24 to 40 inches in thickness. The mollic epipedon is 12 to 24 inches thick. The lacustrine mantle ranges from 30 to 60 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout the profile. Typically, the content of coarse fragments is less than 2 percent in the lacustrine mantle and 2 to 8 percent in the underlying material.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is silty clay loam, silty clay, or 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 or clay. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6 and chroma of 2. It is clay loam or loam. Some pedons do not have a 2Cg horizon but have a Cg horizon, which is silty clay or silty clay loam.

Canisteo Series

The Canisteo series consists of deep, poorly drained and very poorly drained, moderately permeable, calcareous soils on glacial till plains. These soils formed in friable glacial till that has a lacustrine mantle in some areas. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo loam, in an area of Canisteo-Harps loams, 1,600 feet east and 100 feet south of the northwest corner of sec. 4, T. 117 N., R. 34 W.

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

A—10 to 21 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Bg—21 to 29 inches; grayish brown (2.5Y 5/2) loam; common medium distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; common threads and masses of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—29 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light olive brown (2.5Y 5/6) and many medium distinct light olive gray (5Y 6/2) mottles; massive; friable; about 8 percent coarse fragments; few threads and masses of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick. Reaction is mildly alkaline or moderately alkaline throughout the profile. The content of coarse fragments ranges from 0 to 5 percent in the solum and from 2 to 8 percent in the C horizon.

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

Coriff Series

The Coriff series consists of deep, calcareous, poorly drained soils on ground moraines and lake plains. These soils formed in loamy and sandy, water-stratified material overlying loamy glacial till. They are moderately rapidly permeable in the upper part and moderately permeable in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Coriff loam, in an area of Coriff-Fieldon complex, 2,100 feet west and 300 feet north of the southeast corner of sec. 17, T. 118 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 18 inches; very dark gray (10YR 3/1) sandy loam; dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; few roots; slight effervescence; mildly alkaline; clear wavy boundary.

Bg1—18 to 24 inches; grayish brown (2.5Y 5/2) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2—24 to 33 inches; light olive gray (5Y 6/2) loamy fine sand; common medium distinct yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; friable loose; slight effervescence; mildly alkaline; abrupt smooth boundary.

2Cg—33 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and of the water-stratified material ranges from 24 to 40 inches. The mollic epipedon is 12 to 22 inches thick. Reaction is mildly alkaline or moderately alkaline throughout the profile. The content of coarse fragments typically ranges from 2 to 8 percent throughout the profile. In some pedons, however, the upper part of the profile has no coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, sandy loam, or fine sandy loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is sandy loam or fine sandy loam in the upper part and grades to loamy fine sand, sand, or fine sand in the lower part. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is loam or clay loam.

Delft Series

The Delft series consists of deep, poorly drained, moderately slowly permeable soils on ground moraines and till plains. These soils formed in loamy alluvium and friable glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Delft loam, 300 feet north and 2,210 feet east of the southwest corner of sec. 21, T. 120 N., R. 35 W.

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

A1—10 to 21 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

A2—21 to 30 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Bg—30 to 36 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg—36 to 60 inches; olive gray (5Y 5/2) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 10 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 24 to 60 inches. Free carbonates are typically at a depth of about 20 to 40 inches but are at the surface in some pedons. The content of coarse fragments ranges from 1 to 5 percent in the solum and from 2 to 10 percent of the C horizon.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 and chroma of 0. It is loam, clay loam, or silty clay loam. It is slightly acid to mildly alkaline. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, silt loam, or clay loam. It is neutral or mildly alkaline. The Cg horizon has colors similar to those of the Bg horizon. It is loam, clay loam, or sandy loam. It is mildly alkaline or moderately alkaline.

Dickinson Series

The Dickinson series consists of deep, well drained soils on outwash plains and on till plains that have an outwash mantle. These soils formed in a loamy mantle overlying sandy outwash. They are moderately rapidly permeable in the upper part and rapidly permeable in the underlying material. Slopes range from 1 to 6 percent.

Typical pedon of Dickinson fine sandy loam, 1 to 6 percent slopes, 800 feet west and 1,100 feet south of the northeast corner of sec. 16, T. 120 N., R. 36 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A—10 to 16 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.
Bw—16 to 29 inches; dark brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) faces of peds; weak fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.
C1—29 to 38 inches; dark yellowish brown (10YR 4/4) fine sand; single grain; loose; slightly acid; clear wavy boundary.
C2—38 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; slightly acid.

The solum ranges from 24 to 40 inches in thickness. The loamy mantle ranges from 20 to 40 inches in thickness. The mollic epipedon is 10 to 20 inches thick. The soils generally have no coarse fragments.

The A horizon has chroma of 1 to 3. It is fine sandy loam, sandy loam, or loam. It is medium acid to neutral. The Bw and C horizons are medium acid or slightly acid. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is sandy loam or fine sandy loam. Some pedons have a BC horizon, which is loamy sand or loamy fine sand. The C horizon has value of 4 or 5 and chroma of 3 to 6. It is fine sand, sand, or loamy fine sand.

Estherville Series

The Estherville series consists of deep, well drained soils on outwash plains. These soils formed in a loamy mantle and in the underlying sandy and gravelly outwash material. They are moderately rapidly permeable in the upper part and very rapidly permeable in the underlying material. Slopes range from 0 to 12 percent.

Typical pedon of Estherville coarse sandy loam, 0 to 3 percent slopes, 930 feet north and 2,600 feet west of the southeast corner of sec. 26, T. 122 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) coarse sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine granular; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.
AB—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; clear wavy boundary.
Bw—13 to 18 inches; dark brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) faces of peds; weak fine and medium subangular blocky structure; friable; about 8 percent coarse fragments; slightly acid; clear wavy boundary.
2BC—18 to 24 inches; dark brown (7.5YR 3/2) gravelly loamy coarse sand; single grain; loose; about 25 percent coarse fragments; neutral; gradual wavy boundary.
2C1—24 to 33 inches; brown (10YR 5/3) coarse sand; single grain; loose; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.
2C2—33 to 60 inches; brown (10YR 5/3) gravelly coarse sand; single grain; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline.

The depth to free carbonates ranges from 15 to 24 inches. The depth to coarse textured material ranges from 10 to 20 inches. The mollic epipedon is 9 to 18 inches thick. Reaction is medium acid to neutral in the solum and mildly alkaline or moderately alkaline in the 2C horizon. The content of coarse fragments ranges from 0 to 5 percent in the loamy mantle and from 10 to 35 percent in the underlying material.

The A and AB horizons are loam, sandy loam, or coarse sandy loam. The Bw horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is sandy loam, loam, or coarse sandy loam. The 2BC horizon has colors similar to those of the Bw horizon but has chroma of 2 in some pedons. It is loamy coarse sand, loamy sand, or the gravelly analogs of these textures. The 2C horizon has value of 4 or 5 and chroma of 2 to 4. It is stratified sand, coarse sand, or gravelly coarse sand.

Fieldon Series

The Fieldon series consists of deep, poorly drained, calcareous soils that formed in loamy and sandy glacial outwash or deltaic sediments on glacial lake and outwash plains. These soils are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Fieldon fine sandy loam, in an area of Coriff-Fieldon complex, 2,400 feet east and 1,350 feet north of the southwest corner of sec. 17, T. 118 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.
A—10 to 17 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; strong

effervescence; moderately alkaline; clear wavy boundary.
Bg—17 to 27 inches; grayish brown (2.5Y 5/2) fine sandy loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.
Cg—27 to 60 inches; grayish brown (2.5Y 5/2) fine sand; common medium prominent yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. The mollic epipedon is 14 to 24 inches thick. Reaction is mildly alkaline or moderately alkaline throughout the profile. The soils typically have no coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is fine sandy loam, very fine sandy loam, or loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly fine sandy loam, very fine sandy loam, or loam, but some pedons have strata of silt loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3. It is dominantly fine sand or loamy fine sand but may have strata of finer textured material.

Glencoe Series

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

Typical pedon of Glencoe clay loam, 1,520 feet west and 175 feet north of the southeast corner of sec. 10, T. 121 N., R. 35 W.

A1—0 to 21 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.
A2—21 to 39 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; few fine distinct dark brown (7.5YR 3/2) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.
Bg—39 to 44 inches; olive gray (5Y 4/2) loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.
Cg—44 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The mollic epipedon is 24 to 46 inches thick. Reaction is neutral to mildly alkaline in the solum. The content of coarse fragments ranges from 0 to 5 percent in the solum and from 2 to 8 percent in the C horizon.

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

Grovecity Series

The Grovecity series consists of deep, somewhat poorly drained and moderately well drained, moderately rapidly permeable soils on ground moraines. These soils formed in friable glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Grovecity loam, 200 feet east and 240 feet north of the southwest corner of sec. 5, T. 120 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.
A—10 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.
Bw1—16 to 21 inches; olive brown (2.5Y 4/4) sandy loam; weak medium subangular blocky structure; friable; about 8 percent coarse fragments; neutral; clear wavy boundary.
Bw2—21 to 27 inches; light olive brown (2.5Y 5/4) fine sandy loam; common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; about 8 percent coarse fragments; neutral; clear wavy boundary.
C—27 to 60 inches; grayish brown (2.5Y 5/2) fine sandy loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 8 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of solum and the depth to free carbonates range from 18 to 36 inches. The mollic epipedon is 8 to 18 inches thick. Reaction is neutral or slightly acid in the solum and mildly alkaline or moderately alkaline in the C horizon. The content of coarse fragments ranges from 2 to 10 percent throughout the profile.

The A, Bw, and C horizons are loam, fine sandy loam, or sandy loam. The A horizon has chroma of 1 or 2. The Bw horizon has hue of 2.5Y or 10YR, value of 4 or 5,

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

Guckeen Series

The Guckeen series consists of deep, somewhat poorly drained and moderately well drained soils on ground moraines and till plains that have a lacustrine mantle. These soils formed in loamy and clayey lacustrine material overlying loamy glacial till. They are slowly permeable or moderately slowly permeable. Slopes range from 0 to 18 percent.

Typical pedon of Guckeen clay loam, 2 to 6 percent slopes, 2,325 feet north and 600 feet east of the southwest corner of sec. 34, T. 120 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium angular blocky structure; friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—10 to 14 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; common black (10YR 2/1) tongues; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—14 to 20 inches; dark grayish brown (2.5Y 4/2) clay; common very dark grayish brown (2.5Y 3/2) coatings on faces of peds; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—20 to 28 inches; dark grayish brown (2.5Y 4/2) clay; common very dark grayish brown (2.5Y 3/2) coatings on faces of peds; few medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

2Cg—28 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; firm; about 6 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of solum and the depth to free carbonates range from 18 to 36 inches. The lacustrine mantle ranges from 20 to 40 inches in thickness. The mollic epipedon is 12 to 20 inches thick. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the 2Cg horizon. The content of coarse fragments ranges from 0 to 5 percent in the solum and from 2 to 8 percent in the C horizon. The most common of these are shale fragments.

The A and AB horizons are clay loam, silty clay, silty clay loam, or clay. The Bw horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. It is clay, silty clay, or silty clay loam. The 2Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is loam or clay loam.

Harps Series

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

Typical pedon of Harps clay loam, 300 feet west and 900 feet north of the southeast corner of sec. 10, T. 119 N., R. 36 W.

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

Ak—9 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—16 to 21 inches; grayish brown (2.5Y 5/2) loam; weak medium subangular blocky structure; friable; common masses of calcium carbonate; about 5 percent coarse fragments; violent effervescence; moderately alkaline; clear wavy boundary.

Bg—21 to 32 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few masses or threads of calcium carbonate; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—32 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few masses and threads of calcium carbonate; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 50 inches. The mollic epipedon is 10 to 20 inches thick. Reaction is mildly alkaline or moderately alkaline throughout the profile. The content of coarse fragments ranges from 1 to 5 percent throughout the profile.

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

Harpster Series

The Harpster series consists of deep, poorly drained, moderately permeable, calcareous soils on glacial till

plains. These soils formed in silty sediments more than 60 inches thick. Slopes range from 0 to 2 percent.

Typical pedon of Harpster silty clay loam, 500 feet east and 100 feet north of the southwest corner of sec. 32, T. 119 N., R. 35 W.

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

Ak—9 to 17 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear wavy boundary.

Bg—17 to 26 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

Cg—26 to 60 inches; light olive gray (5Y 6/2) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of solum ranges from 25 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The soils are mildly alkaline or moderately alkaline throughout. They generally have no coarse fragments.

The A and Bg horizons are silty clay loam or silt loam. The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 or 3 and chroma of 0. The Bg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. The Cg horizon has colors and textures similar to those of the Bg horizon. Some pedons have a 2Cg horizon. This horizon is loam. It is at a depth of 40 inches or more.

Hawick Series

The Hawick series consists of deep, excessively drained, very rapidly permeable soils on outwash plains. These soils formed in sandy outwash that has a thin, discontinuous mantle of loamy material. Slopes range from 2 to 35 percent.

Typical pedon of Hawick gravelly loamy coarse sand, 12 to 20 percent slopes, 1,100 feet east and 2,100 feet north of the southwest corner of sec. 31, T. 121 N., R. 34 W.

A1—0 to 7 inches; black (10YR 2/1) gravelly loamy coarse sand, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 18 percent coarse fragments; neutral; clear smooth boundary.

A2—7 to 11 inches; very dark brown (10YR 2/2) gravelly loamy coarse sand, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; about 15 percent coarse fragments; neutral; clear wavy boundary.

Bw—11 to 16 inches; dark brown (10YR 3/3) gravelly loamy coarse sand; single grain; loose; about 35 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

C1—16 to 28 inches; yellowish brown (10YR 5/4) gravelly coarse sand; few medium distinct yellowish brown (10YR 5/6) relict mottles; single grain; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

C2—28 to 60 inches; brown (10YR 5/3) coarse sand; single grain; loose; about 12 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 14 to 24 inches in thickness. It is slightly acid to mildly alkaline. The depth to free carbonates ranges from 0 to 24 inches. The mollic epipedon is 10 to 16 inches thick. The content of coarse fragments is 5 to 35 percent throughout the profile. It is as much as 50 percent in some subhorizons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically loamy coarse sand or gravelly loamy coarse sand, but loamy sand, gravelly loamy sand, and sandy loam are within the range. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loamy sand, loamy coarse sand, coarse sand, or the gravelly analogs of these textures. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 6. It is sand, coarse sand, or the gravelly analogs of these textures. It is mildly alkaline or moderately alkaline.

Hawick gravelly loamy coarse sand, 20 to 35 percent slopes, and the Hawick soils in the Koronis-Hawick complex, 20 to 30 percent slopes, and the Sunburg-Wadenill-Hawick complex, 18 to 35 percent slopes, have a surface layer that is thinner or lighter colored than is definitive for the series. This difference, however, does not alter the behavior or usefulness of the soils.

Houghton Series

The Houghton series consists of deep, very poorly drained, organic soils in postglacial basins on ground moraines and outwash plains. These soils formed in sapric material. They are moderately slowly permeable to moderately rapidly permeable. Slopes range from 0 to 2 percent.

Typical pedon of Houghton muck, 400 feet west and 1,100 feet south of the northeast corner of sec. 33, T. 121 N., R. 33 W.

Oa1—0 to 10 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 25 percent fiber, 5 percent rubbed; weak medium granular structure; nonsticky; neutral; clear wavy boundary.

Oa2—10 to 24 inches; black (N 2/0), broken face and rubbed, sapric material; about 5 percent fiber, a trace rubbed; weak coarse subangular blocky structure; nonsticky; neutral; clear wavy boundary.
Oa3—24 to 60 inches; black (N 2/0), broken face and rubbed, sapric material; a trace of fiber; massive; nonsticky; neutral.

The O horizon has hue of 5YR to 10YR, value of 2 or 3, and chroma of 1 to 3, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is primarily sapric material, but some pedons have as much as 10 inches of hemic material. Reaction is slightly acid or neutral throughout the profile.

Kilkenny Series

The Kilkenny series consists of deep, well drained and moderately well drained, moderately slowly permeable soils on moraines. These soils formed in a mantle of loamy and clayey lacustrine sediments overlying loamy glacial till. Slopes range from 2 to 12 percent.

Typical pedon of Kilkenny clay loam, 2 to 6 percent slopes, 1,110 feet east and 830 feet north of the southwest corner of sec. 1, T. 120 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.
Bt1—9 to 14 inches; dark brown (10YR 4/3) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; nearly continuous thin very dark grayish brown (10YR 3/2) clay films on faces of peds and lining pores; about 6 percent coarse fragments; medium acid; gradual wavy boundary.
Bt2—14 to 24 inches; olive brown (2.5Y 4/4) clay; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; common thin very dark grayish brown (2.5Y 3/2) clay films on faces of peds; about 5 percent coarse fragments; medium acid; clear wavy boundary.
Bt3—24 to 36 inches; olive brown (2.5Y 4/4) clay loam; few fine distinct grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; firm; few thin dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 5 percent coarse fragments; slightly acid; gradual wavy boundary.
2C—36 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; about 6 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 20 to 48 inches in thickness. It is medium acid or slightly acid. The content of coarse fragments ranges from 2 to 6 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1. It is loam or clay loam. Pedons in some uncultivated areas have an E horizon. This horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. In some pedons it is mottled in the lower part. It is clay loam or clay. The C horizon has value of 4 or 5 and chroma of 2 to 4. It is loam or clay loam.

Koronis Series

The Koronis series consists of deep, well drained, moderately rapidly permeable soils on ground moraines. These soils formed in loamy glacial till. Slopes range from 2 to 30 percent.

Typical pedon of Koronis sandy loam, in an area of Koronis-Hawick complex, 6 to 12 percent slopes, 2,100 feet east and 800 feet north of the southwest corner of sec. 35, T. 122 N., R. 35 W.

A—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.
Bt1—7 to 21 inches; dark brown (10YR 4/3) sandy clay loam; moderate medium prismatic structure parting to weak medium subangular blocky; friable; about 5 percent coarse fragments; common thin dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual wavy boundary.
Bt2—21 to 29 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; about 5 percent coarse fragments; few dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual wavy boundary.
C—29 to 60 inches; light olive brown (2.5Y 5/4) fine sandy loam; common medium distinct yellowish brown (10YR 5/4) relict mottles; massive; friable; about 8 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 18 to 40 inches in thickness. It is medium acid to neutral. The depth to free carbonates ranges from 16 to 36 inches. The content of coarse fragments is 5 to 12 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, sandy loam, or fine sandy loam. Some pedons have an E horizon. This horizon has hue of 10YR, value of 3 or 4, and chroma of 2. It is fine sandy loam or sandy loam. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is sandy clay loam, loam, or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to

4. It is loam, sandy loam, or fine sandy loam. It is mildly alkaline or moderately alkaline.

Lena Series

The Lena series consists of deep, very poorly drained, calcareous, organic soils in postglacial basins on ground moraines. These soils formed in sapric material. They are moderately slowly permeable to moderately rapidly permeable. Slopes range from 0 to 2 percent.

Typical pedon of Lena muck, 50 feet south and 2,230 feet west of the northeast corner of sec. 10, T. 122 N., R. 35 W.

Oa1—0 to 10 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 2 percent fiber, a trace rubbed; weak fine and medium subangular blocky structure; very friable; slight effervescence; mildly alkaline; clear wavy boundary.

Oa2—10 to 18 inches; very dark gray (10YR 3/1), rubbed, sapric material, very dark brown (10YR 2/2), broken face; about 5 percent fiber, a trace rubbed; weak medium platy structure parting to weak medium subangular blocky; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

Oa3—18 to 60 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 30 percent fiber, 10 percent rubbed; weak medium platy structure; very friable; slight effervescence; mildly alkaline.

The organic material is mildly alkaline or moderately alkaline. The O horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 to 3, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is mostly sapric material, but some pedons have as much as 10 inches of hemic material.

Lester Series

The Lester series consists of deep, well drained, moderately permeable soils on till plains. These soils formed in friable, loamy glacial till. Slopes range from 2 to 8 percent.

Typical pedon of Lester loam, 2 to 8 percent slopes, 2,340 feet east and 1,575 feet north of the southwest corner of sec. 33, T. 119 N., R. 34 W.

A—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bt1—8 to 18 inches; dark brown (10YR 4/3) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; common thin dark brown (10YR 3/3) clay films on faces of peds; about 5 percent coarse fragments; slightly acid; clear wavy boundary

Bt2—18 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; few thin dark brown (10YR 4/3) clay films on faces of peds; about 5 percent coarse fragments; slightly acid; gradual wavy boundary.

C1—28 to 43 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 6 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C2—43 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 6 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 45 inches. Reaction is medium acid to slightly acid in the solum. The content of coarse fragments ranges from 2 to 8 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have an E horizon. This horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It is loam or sandy loam. The Bt horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or clay loam. The C horizon has value of 4 or 5 and chroma of 4 to 6. It is loam or clay loam.

Lowlein Series

The Lowlein series consists of deep, moderately well drained soils on ground moraines. These soils formed in loamy and sandy, stratified material overlying loamy glacial till. They are moderately rapidly permeable in the upper part and moderately permeable in the lower part. Slopes range from 0 to 3 percent.

Typical pedon of Lowlein sandy loam, in an area of Lowlein-Estherville sandy loams, 1,920 feet east and 760 feet south of the northwest corner of sec. 8, T. 118 N., R. 34 W.

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

A—10 to 14 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable about 1 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—14 to 24 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—24 to 31 inches; olive brown (2.5Y 4/4) loamy sand; common medium distinct grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure;

very friable; about 2 percent coarse fragments; neutral; abrupt wavy boundary.
2C—31 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and of the stratified mantle ranges from 24 to 40 inches and is commonly the same as the depth to free carbonates. The mollic epipedon is 10 to 18 inches thick. Reaction is neutral or slightly acid in the solum and mildly alkaline or moderately alkaline in the 2C horizon. The content of coarse fragments ranges from 1 to 10 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or sandy loam. Some pedons have an AB or BA horizon. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is typically sandy loam or fine sandy loam in the upper part and grades to loamy sand, sand, or fine sand in the lower part. The 2C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 2 to 4. It is loam or silt loam.

Marna Series

The Marna series consists of deep, poorly drained, slowly permeable soils on till plains and ground moraines that have a lacustrine mantle. These soils formed in clayey lacustrine material overlying loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Marna silty clay, 530 feet west and 1,200 feet north of the southeast corner of sec. 18, T. 119 N., R. 33 W.

Ap—0 to 9 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A—9 to 15 inches; black (5Y 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine and medium angular blocky structure; friable; slightly acid; clear wavy boundary.
AB—15 to 20 inches; very dark gray (5Y 3/1) clay, dark gray (10YR 4/1) dry; common fine distinct olive gray (5Y 4/2) mottles; weak fine and medium angular blocky structure; firm; slightly acid; gradual wavy boundary.
Bg—20 to 28 inches; olive gray (5Y 4/2) clay; few fine distinct olive brown (2.5Y 4/4) mottles; common dark olive gray (5Y 3/2) coatings on faces of peds; weak medium prismatic structure parting to moderate medium angular blocky; firm; slightly acid; gradual wavy boundary.
Cg1—28 to 36 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct dark brown (7.5YR 4/4) mottles; massive; firm; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.
2Cg2—36 to 60 inches; olive gray (5Y 5/2) clay loam; common medium distinct dark brown (7.5YR 4/4) mottles; massive; firm; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of solum and the depth to free carbonates range from 26 to 40 inches. The depth to loam or clay loam glacial till ranges from 24 to 40 inches. The mollic epipedon is 16 to 24 inches thick. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the Cg and 2Cg horizons. The content of coarse fragments ranges from 0 to 6 percent in the lacustrine mantle and from 2 to 8 percent in the 2Cg horizon.

The A and AB horizons have hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1, or they are neutral in hue and have value of 2 or 3 and chroma of 0. They are silty clay, silty clay loam, or clay. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay or clay. The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam, silty clay, or clay. The 2Cg horizon has colors similar to those of the Cg horizon. It is loam or clay loam.

Muskego Series

The Muskego series consists of deep, very poorly drained soils in postglacial lake basins on ground moraines and outwash plains. These soils formed in organic material overlying coprogenous earth. They are moderately rapidly permeable in the organic material and slowly permeable in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Muskego muck, 100 feet east and 275 feet north of the southwest corner of sec. 27, T. 120 N., R. 35 W.

Oa—0 to 19 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 20 percent fiber, 5 percent rubbed; weak fine and medium subangular blocky structure; nonsticky; neutral; clear smooth boundary.
C1—19 to 36 inches; black (5Y 2/1) mucky silt loam; massive; about 2 percent broken shell fragments; slightly sticky; strong effervescence; moderately alkaline; gradual wavy boundary.
C2—36 to 60 inches; very dark gray (5Y 3/1) mucky silt loam; massive; about 2 percent broken shell fragments; slightly sticky; slight effervescence; mildly alkaline.

The thickness of the sapric material ranges from 16 to 50 inches. The content of coarse fragments in the coprogenous earth is 0 to 3 percent. These are mainly shell fragments. The O horizon has hue of 10YR or 7.5YR or is neutral in hue. It has value of 2 or 3 and

chroma of 0 to 3. It is medium acid to neutral. The C horizon has hue of 2.5Y or 5Y, value of 2 to 4, and chroma of 1 to 3. It is mildly alkaline or moderately alkaline.

Nicollet Series

The Nicollet series consists of deep, somewhat poorly drained and moderately well drained, moderately permeable soils on glacial till plains. These soils formed in water-modified, loamy glacial till. Slopes range from 0 to 5 percent.

Typical pedon of Nicollet silty clay loam, 0 to 2 percent slopes, 1,575 feet east and 410 feet north of the southwest corner of sec. 5, T. 117 N., R. 34 W.

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

A1—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

A2—14 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

Bw—18 to 29 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

C—29 to 60 inches; grayish brown (2.5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon is 12 to 24 inches thick. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the C horizon. The content of coarse fragments typically ranges from 1 to 8 percent throughout the profile. In some pedons, however, the soils have no coarse fragments in the upper part.

Some pedons have an AB horizon. The A and AB horizons have value of 2 or 3 and chroma of 1 or 2. The A, AB, and Bw horizons are silty clay loam, clay loam, or loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is loam or clay loam.

Normania Series

The Normania series consists of deep, moderately well drained, moderately permeable soils on glacial till plains. These soils formed in friable, loamy glacial till. Slopes range from 0 to 5 percent.

Typical pedon of Normania loam, 0 to 2 percent slopes, 750 feet east and 1,285 feet south of the northwest corner of sec. 6, T. 118 N., R. 36 W.

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

A—9 to 15 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; gradual wavy boundary.

Bw1—15 to 20 inches; dark grayish brown (2.5Y 4/2) loam; common very dark grayish brown (2.5Y 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—20 to 25 inches; dark grayish brown (2.5Y 4/2) loam; few medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; about 5 percent coarse fragments; neutral; clear wavy boundary.

BCk—25 to 36 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; common threads and masses of calcium carbonate; about 6 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; few threads and masses of calcium carbonate; about 6 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 40 inches. The depth to free carbonates ranges from 18 to 36 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments ranges from 3 to 8 percent throughout the profile.

The A and Bw horizons are loam or clay loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is neutral or slightly acid. The Bw horizon has hue of 2.5Y or 10YR, value of 3 or 4, and chroma of 2 to 4. It is slightly acid to mildly alkaline. The BCk horizon has value of 4 or 5 and chroma of 2 to 4. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Okoboji Series

The Okoboji series consists of deep, very poorly drained, moderately slowly permeable soils on till plains. These soils formed in silty and clayey lacustrine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Okoboji silty clay loam, in an area of Okoboji-Canisteo silty clay loams, depressional, 2,500 feet east and 575 feet north of the southwest corner of sec. 5, T. 117 N., R. 34 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine and medium subangular blocky structure; friable; neutral; clear wavy boundary.

A1—10 to 25 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; neutral; clear wavy boundary.

A2—25 to 32 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

Bg—32 to 43 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

Cg—43 to 60 inches; olive gray (5Y 5/2) silt loam; common medium distinct dark yellowish brown (10YR 4/4) 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 20 to 50 inches. The mollic epipedon is 24 to 48 inches thick. The upper part of the profile typically has no coarse fragments. The content of these fragments in the underlying material is 0 to 8 percent.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly silt loam, silty clay, or silty clay loam. In some pedons, however, the upper 10 inches is the mucky analogs of these textures. Reaction is neutral or mildly alkaline in the A horizon. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam or silty clay. The C horizon has colors similar to those of the Bg horizon. It is stratified loam, silt loam, or silty clay loam. It is mildly alkaline or moderately alkaline.

Osakis Series

The Osakis series consists of deep, moderately well drained soils on outwash plains. These soils formed in a loamy mantle overlying sandy and gravelly outwash material. They are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Osakis sandy loam, 1,500 feet south and 400 feet west of the northeast corner of sec. 11, T. 122 N., R. 34 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—7 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear wavy boundary.

Bw—12 to 18 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

2BC—18 to 22 inches; dark brown (10YR 4/3) loamy coarse sand; single grain; loose; about 10 percent coarse fragments; common very dark grayish brown (10YR 3/2) organic stains on sand grains; neutral; clear wavy boundary.

2C1—22 to 40 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—40 to 60 inches; grayish brown (2.5Y 5/2) coarse sand; few medium distinct yellowish brown (10YR 5/6) mottles; single grain; about 10 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 25 inches. The depth to loamy sand or coarser textured material and the thickness of the mollic epipedon are 12 to 20 inches. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the 2C horizon. The content of coarse fragments ranges from 0 to 10 percent in the loamy mantle and from 5 to 50 percent in the underlying material.

The A, AB, and Bw horizons are loam or sandy loam. The A and AB horizons have 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 2BC horizon has colors similar to those of the Bw horizon. It is sand, loamy sand, loamy coarse sand, or coarse sand. The 2C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 or 3. It is coarse sand, sand, or gravelly coarse sand.

Palms Series

The Palms series consists of deep, very poorly drained, organic soils in depressions and lake basins on

glacial till plains and ground moraines. These soils formed in sapric material overlying loamy glacial till. They are moderately slowly permeable to moderately rapidly permeable in the organic material and moderately permeable in the underlying glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Palms muck, 210 feet east and 2,575 feet north of the southwest corner of sec. 19, T. 120 N., R. 36 W.

Oap—0 to 10 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 5 percent fiber, 1 percent rubbed; weak fine granular structure; nonsticky; slightly acid; abrupt smooth boundary.

Oa1—10 to 15 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 10 percent fiber, less than 5 percent rubbed; weak fine and medium platy structure; nonsticky; medium acid; clear wavy boundary.

Oa2—15 to 27 inches; black (N 2/0), broken face and rubbed, sapric material; less than 5 percent fiber, a trace rubbed; massive; slightly sticky; medium acid; abrupt smooth boundary.

A1—27 to 36 inches; black (5Y 2/1) silty clay loam; few fine distinct yellowish red (5YR 4/6) mottles; massive; firm; neutral; clear wavy boundary.

A2—36 to 42 inches; very dark gray (5Y 3/1) loam; massive; firm; about 2 percent snail shells; few yellowish red (5YR 4/6) coatings in old root channels; slight effervescence; mildly alkaline; clear wavy boundary.

Cg1—42 to 48 inches; olive gray (5Y 5/2) silt loam; few medium distinct olive (5Y 5/4) and light gray (5Y 7/2) mottles; massive; friable; slight effervescence; mildly alkaline; clear wavy boundary.

Cg2—48 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct dark brown (7.5YR 4/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The depth to the loamy A or C horizon is 16 to 50 inches. Reaction is medium acid to mildly alkaline in the organic material. Some organic layers contain free carbonates. The content of coarse fragments ranges from 0 to 10 percent in the underlying mineral horizons.

The O and A horizons have hue of 10YR to 5YR or are neutral in hue. They have value of 2 or 3 and chroma of 0 to 3. The O horizon is typically sapric material, but in some pedons it has thin strata of hemic material. The A horizon is loam, silty clay loam, or silt loam. It is mildly alkaline or neutral. The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. It is loam, clay loam, silt loam, or fine sandy loam. The sandy substratum phase has a 2Cg horizon. This horizon is gravelly loamy coarse sand, sand, coarse sand, or gravelly coarse sand.

Regal Series

The Regal series consists of deep, calcareous, poorly drained soils on glacial outwash plains. These soils formed in a thin mantle of loamy material over sandy and gravelly outwash. They are moderately permeable in the upper part and rapidly permeable in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Regal loam, 280 feet east and 1,500 feet north of the southwest corner of sec. 26, T. 121 N., R. 33 W.

Ap—0 to 10 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine granular; friable; many roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 14 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few roots; slight effervescence; mildly alkaline; clear wavy boundary.

Bg—14 to 18 inches; grayish brown (2.5Y 5/2) sandy clay loam; common medium distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

2Cg1—18 to 27 inches; olive gray (5Y 5/2) gravelly loamy sand; few fine distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg2—27 to 60 inches; olive gray (5Y 5/2) gravelly coarse sand that has thin strata of sand; single grain; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum, the thickness of the mollic epipedon, and the depth to loamy sand or coarser textured material range from 14 to 20 inches. The content of coarse fragments ranges from 0 to 10 percent in the loamy mantle and from 10 to 45 percent in the underlying material.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is neutral in hue and has value of 2 or 3 and chroma of 0. It is loam, clay loam, or sandy clay loam. It is moderately alkaline to neutral. The Bg and 2Cg horizons are mildly alkaline or moderately alkaline. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, sandy clay loam, or sandy loam. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1. It is stratified loamy sand, sand, loamy sand, coarse sand, or the gravelly analogs of these textures.

The Regal soil in the Regal-Hawick complex, 0 to 4 percent slopes, has less clay in the loamy mantle than is definitive for the series. This difference, however, does not affect the usefulness or behavior of the soil.

Seaforth Series

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

Typical pedon of Seaforth loam, in an area of Canisteo-Seaforth complex, 2,150 feet west and 710 feet south of the northeast corner of sec. 25, T. 117 N., R. 36 W.

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

Bk—10 to 19 inches; light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; friable; common threads and masses of calcium carbonate; about 3 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C—19 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; few threads and masses of calcium carbonate; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of solum ranges from 16 to 36 inches. The mollic epipedon is 8 to 16 inches thick. The soils are mildly alkaline or moderately alkaline throughout. The content of coarse fragments is 3 to 8 percent throughout the profile.

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

Spicer Series

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

Typical pedon of Spicer silty clay loam, 185 feet east and 400 feet north of the southwest corner of sec. 20, T. 117 N., R. 36 W.

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

A1—10 to 16 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

A2—16 to 22 inches; very dark gray (10YR 3/1) silt loam; few medium distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

Bg—22 to 32 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; strong effervescence; mildly alkaline; clear wavy boundary.

Cg—32 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of solum ranges from 22 to 40 inches. The mollic epipedon is 12 to 24 inches thick. The soils are mildly alkaline or moderately alkaline throughout. They typically have no coarse fragments.

The A, Bg, and Cg horizons are silt loam or silty clay loam. The A horizon has value of 2 or 3 and chroma of 1, or it is neutral in hue and has value of 2 or 3 and chroma of 0. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 1 or 2.

Sunburg Series

The Sunburg series consists of deep, well drained, moderately rapidly permeable, calcareous soils on ground moraines. These soils formed in friable, loamy glacial till. Slopes range from 2 to 35 percent.

Typical pedon of Sunburg loam, in an area of Sunburg-Wadenill complex, 6 to 12 percent slopes, 2,640 feet west and 140 feet north of the southeast corner of sec. 21, T. 120 N., R. 35 W.

Ap—0 to 8 inches; dark brown (10YR 3/3) loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; about 8 percent coarse fragments; violent effervescence; moderately alkaline; abrupt smooth boundary.

Bk—8 to 20 inches; brown (10YR 5/3) fine sandy loam; weak medium platy structure; very friable; common threads and masses of calcium carbonate; about 10 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C—20 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; common medium distinct strong brown (7.5YR 5/6) and light brownish gray (2.5Y 6/2) relict mottles; weak medium platy structure; very friable; few threads and masses of calcium carbonate; about 12 percent coarse fragments; slight effervescence; mildly alkaline.

Reaction is mildly alkaline or moderately alkaline throughout the profile. The content of coarse fragments is 5 to 15 percent throughout the profile.

The A horizon has value of 3 or 4 and chroma of 1 to 3. When dry, it has value of 6 or more. It is loam, fine sandy loam, or sandy loam. It is 6 to 10 inches thick. Some pedons in uncultivated areas have a thin AB horizon. The Bk and C horizons have hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4. They are loam, sandy loam, or fine sandy loam.

The Sunburg soils in the map unit Wadenill-Sunburg loams, 2 to 6 percent slopes, and in the Wadenill-Sunburg-Hawick complex, 2 to 6 percent slopes, have a dark surface layer that is thicker than is definitive for the series. The difference, however, does not affect the usefulness or behavior of the soils.

Swanlake Series

The Swanlake series consists of deep, calcareous, well drained, moderately permeable soils on glacial till plains. These soils formed in friable glacial till. Slopes range from 2 to 18 percent.

Typical pedon of Swanlake loam, in an area of Swanlake-Ves loams, 6 to 12 percent slopes, 500 feet west and 610 feet south of the northeast corner of sec. 6, T. 118 N., R. 35 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk—9 to 23 inches; brown (10YR 5/3) loam; massive; friable; common threads and masses of calcium carbonate; about 5 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C—23 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; few threads and masses of calcium carbonate; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the mollic epipedon ranges from 7 to 14 inches and is typically the same as the thickness of the solum. The content of coarse fragments ranges from 1 to 10 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is mildly alkaline, but it is neutral in some pedons. The Bk and C horizons have hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 6. They are loam or clay loam. They are mildly alkaline or moderately alkaline.

Terril Series

The Terril series consists of deep, moderately well drained, moderately permeable soils on foot slopes. These soils formed in local alluvium and in the underlying loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Terril loam, 650 feet south and 70 feet west of the northeast corner of sec. 16, T. 122 N., R. 36 W.

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

A1—9 to 24 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

A2—24 to 32 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

AB—32 to 37 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable neutral; clear wavy boundary.

Bw—37 to 45 inches; dark yellowish brown (10YR 4/4) loam; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4) loam; massive; friable; about 8 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness. It is slightly acid or neutral. The depth to free carbonates ranges from 40 to 60 inches. The mollic epipedon is 24 to 40 inches thick. The content of coarse fragments is 0 to 8 percent throughout the profile.

The A and AB horizons are loam, silt loam, or clay loam. The Bw and C horizons are loam or clay loam. The Bw horizon has value of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4.

Ves Series

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

Typical pedon of Ves loam, in an area of Ves-Swanlake loams, 2 to 6 percent slopes, 1,410 feet east and 350 feet south of the northwest corner of sec. 26, T. 118 N., R. 36 W.

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

Bw—10 to 20 inches; dark brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) faces of peds; mixed with about 5 percent light yellowish brown

(10YR 6/4) soil material in earthworm channels; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

BCk—20 to 33 inches; light yellowish brown (10YR 6/4) loam; weak fine and medium subangular blocky structure; friable; common threads and masses of calcium carbonate; about 3 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C—33 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; few threads and masses of calcium carbonate; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 18 to 40 inches. The depth to free carbonates ranges from 18 to 25 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments is 2 to 8 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is neutral or slightly acid. Some pedons have an AB horizon. This horizon may have chroma of 2. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is loam or clay loam. It is slightly acid or neutral. The BCk horizon has hue of 10YR or 2.5Y and value of 4 to 6. The C horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline.

Wadena Series

The Wadena series consists of deep, well drained soils on outwash plains. These soils formed in a loamy mantle and in the underlying sandy and gravelly outwash. They are moderately rapidly permeable in the upper part and very rapidly permeable in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Wadena loam, 1,600 feet east and 2,000 feet south of the northwest corner of sec. 12, T. 122 N., R. 34 W.

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

A1—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

A2—16 to 20 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

Bw—20 to 27 inches; dark brown (10YR 4/3) loam; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

2BC—27 to 34 inches; dark brown (10YR 4/3) loamy coarse sand; single grain; loose; about 12 percent coarse fragments; neutral; gradual wavy boundary.

2C—34 to 60 inches; grayish brown (10YR 5/2) coarse sand; single grain; loose; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and of the loamy mantle ranges from 24 to 40 inches. The mollic epipedon is 12 to 24 inches thick. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the 2C horizon. The content of coarse fragments ranges from 0 to 5 percent in the loamy mantle and from 5 to 50 percent in the underlying material.

The A horizon 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, sandy clay loam, or sandy loam. The 2BC horizon has colors similar to those of the Bw horizon. It is loamy coarse sand or loamy sand. The 2C horizon has value of 4 to 6 and chroma of 2 to 4. It is stratified coarse sand, sand, or the gravelly analogs of these textures.

Wadenill Series

The Wadenill series consists of deep, well drained, moderately rapidly permeable soils on glacial moraines. These soils formed in friable, loamy glacial till. Slopes range from 2 to 25 percent.

Typical pedon of Wadenill fine sandy loam, in an area of Sunburg-Wadenill complex, 6 to 12 percent slopes, 2,430 feet east and 850 feet north of the southwest corner of sec. 2, T. 121 N., R. 33 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; common roots; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—7 to 10 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; few roots; about 5 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—10 to 18 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak medium subangular blocky structure; friable; about 14 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—18 to 31 inches; yellowish brown (10YR 5/4) fine sandy loam; weak medium subangular blocky structure; friable; about 7 percent coarse fragments; neutral; clear wavy boundary.

C—31 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; few fine distinct grayish brown (10YR 5/2) and common medium distinct yellowish brown (10YR 5/6) relict mottles; massive; friable; about 8 percent coarse fragments; few threads and masses

of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 40 inches. The mollic epipedon is 7 to 16 inches thick. Reaction is slightly acid or neutral in the solum and mildly alkaline or moderately alkaline in the C horizon. The content of coarse fragments is 5 to 15 percent throughout the profile.

The A and AB horizons have value of 2 or 3 and chroma of 1 or 2. They have loam or fine sandy loam. The Bw and C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. They are loam, sandy loam, or fine sandy loam.

Webster Series

The Webster series consists of deep, poorly drained, moderately permeable soils on glacial till plains. These soils formed in friable glacial till. Slopes range from 0 to 2 percent

Typical pedon of Webster silty clay loam, 2,240 feet east and 1,150 feet north of the southwest corner of sec. 5, T. 117 N., R. 34 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—10 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

A2—16 to 20 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; neutral; gradual wavy boundary.

Bg—20 to 28 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear wavy boundary.

Cg—28 to 60 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 40 inches. The mollic epipedon is 12 to 24 inches thick. The solum is typically neutral but may be mildly alkaline in the lower part. The content of coarse fragments ranges from 0 to 3 percent in the solum and from 2 to 8 percent in the C horizon.

Some pedons have an AB horizon. The A, AB, and Bg horizons are silty clay loam, clay loam, or loam. The A and AB horizons have value of 2 or 3 and chroma of 1, or they are neutral in hue and have value of 2 and chroma of 0. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has colors similar to those of the B horizon. It is loam, clay loam, or sandy loam. It is mildly alkaline or moderately alkaline.

Formation of the Soils

Soil forms through the physical and chemical weathering of deposited or accumulated geological material. The characteristics of the soil at any given point are determined by the interaction of five factors. These factors are the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plants and animals living 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. The following paragraphs relate the factors of soil formation to the soils in the Kandiyohi County.

Parent Material

The soils in Kandiyohi County formed in glacial till, glacial till mantled with lacustrine sediments, and glacial outwash. As glacial ice sheets advanced over an area, they ground up the material in the area. The resulting glacial till is an unsorted mixture of sand, silt, clay, and rock fragments. As the climate became warmer, the ice sheets began to melt and retreat. The resulting meltwater deposited stratified outwash, deltaic sediments, and lacustrine material. Figure 10 shows the kinds of parent material as they occur in the major geomorphic areas in the county. These geomorphic areas are the Olivia Till Plain, the Alexandria Moraine Complex, the Belgrade-Glenwood Outwash Plain, and the Osakis Till Plain.

The Oliva Till Plain consists of areas 1, 2, and 3 on figure 10. The glacial till in these areas was formed by the Des Moines Lobe of the Late Wisconsin Glaciation (*9, 11*) and is called New Ulm Till (*3*). It is characterized by a friable consistence, an appreciable number of shale fragments, and gypsum in crystalline or powdery form. An analysis of 10 till samples shows that the average texture is loam with 40.2 percent sand, 35.7 percent silt, and 24.1 percent clay (fig. 11).

Area 1 consists mainly of soils that formed in New Ulm Till on uplands. Lacustrine sediments are in the depressions and basins.

Area 2 has been modified by the action of a shallow glacial lake that was in the area when the glacial ice melted. A lacustrine mantle typically overlies New Ulm Till. The lacustrine mantle is thickest in depressions and swales and thinnest on convex upland slopes. On very sharply convex knolls and ridges, the till is exposed.

Area 3 is a narrow delta formed by a stream of glacial meltwater. The deltaic sediments were deposited as the water slowed. They filled in the area, giving the landscape a smooth appearance. In some places they are 1 to 2 feet thick, and in other places they are more than 15 feet thick. The pattern of soils and parent material is very complex in this area.

The Alexandria Moraine Complex consists of areas 4 through 7 on figure 10. This complex has two distinct types of glacial till and several areas of glacial outwash. The core of the moraine was formed by the advance of the Wadena Lobe of the Wisconsin Glaciation and is called Wadena Till (*8*). The other till probably was thrust up from a buried position and is called Kandiyohi Till.

Area 4 has Kandiyohi Till, which is firm and very dense and has an abundance of shale fragments. An analysis of 10 till samples shows that the average texture is clay loam with 24.4 percent sand, 38.8 percent silt, and 36.8 percent clay. The material is believed to be old glacial till laid down prior to the Wisconsin Glaciation. It was thrust up to its present location by the weight of stagnant ice during the Wisconsin Glaciation. The density is so high and water movement so restricted that the water table is very near the surface.

Area 5 is a morainic area formed by the Wadena Lobe (*8*). The till is characterized by a friable consistence, a very low content of shale fragments, and an irregular pattern of relict mottles, which do not reflect present-day moisture regimes. An analysis of 10 till samples shows that the average texture is fine sandy loam with 58.5 percent sand, 28.3 percent silt, and 13.2 percent clay.

Area 6 has mixed glacial till and glacial outwash. The glacial till is similar to the Wadena Till in area 5. The outwash was buried within or was deposited on top of melting ice sheets and collapsed in a random pattern on top of the till when the ice finally melted.

Area 7 consists of outwash plains. The parent material throughout most of the area is loamy outwash 10 to 20 inches deep over sandy and gravelly outwash. Some of the underlying material is relatively free of shale, and some has an abundance of shale randomly diffused throughout or concentrated in bands.

The Belgrade-Glenwood Outwash Plain occurs as area 8 on figure 10. This extensive plain probably was formed by glacial meltwater flowing during the Wisconsin Glaciation. Slopes commonly are nearly level and gently undulating, but some are hilly. The soils typically formed

in loamy material 10 to 20 inches deep over stratified sand and gravel.

The Osakis Till Plain occurs as area 9 on figure 10. This small area is part of a large, nearly level and gently undulating till plain that extends into several adjacent counties. The plain probably was formed by the Des Moines Lobe of the Late Wisconsin Glaciation. The till is very similar to the New Ulm Till in area 1. It is friable, has some shale fragments, and typically is loam. In places, this till is thin and Wadena till is within 5 feet of the surface.

Climate

Kandiyohi County has a subhumid, continental climate characterized by cold winters and hot summers. The average daily maximum temperature in January is 18.8 degrees F, and the average daily maximum temperature in July is 83.1 degrees. The average annual rainfall is about 28 inches.

Climate affects soil formation in several ways. Alternate freezing and thawing help to develop soil structure. The length of the growing season affects the type and quantity of native plants on the soil. The amount and intensity of rainfall interact with the other soil-forming factors.

The climate in the county generally has favored the growth of native prairie grasses. As a result, most of the soils have a dark surface soil. In some areas the climate has favored the growth of forest vegetation. Because they contain less organic matter, the soils in these areas have a surface soil that is lighter colored than that of the soils that formed under grasses. Additional information about the climate is given under the heading "General Nature of the County."

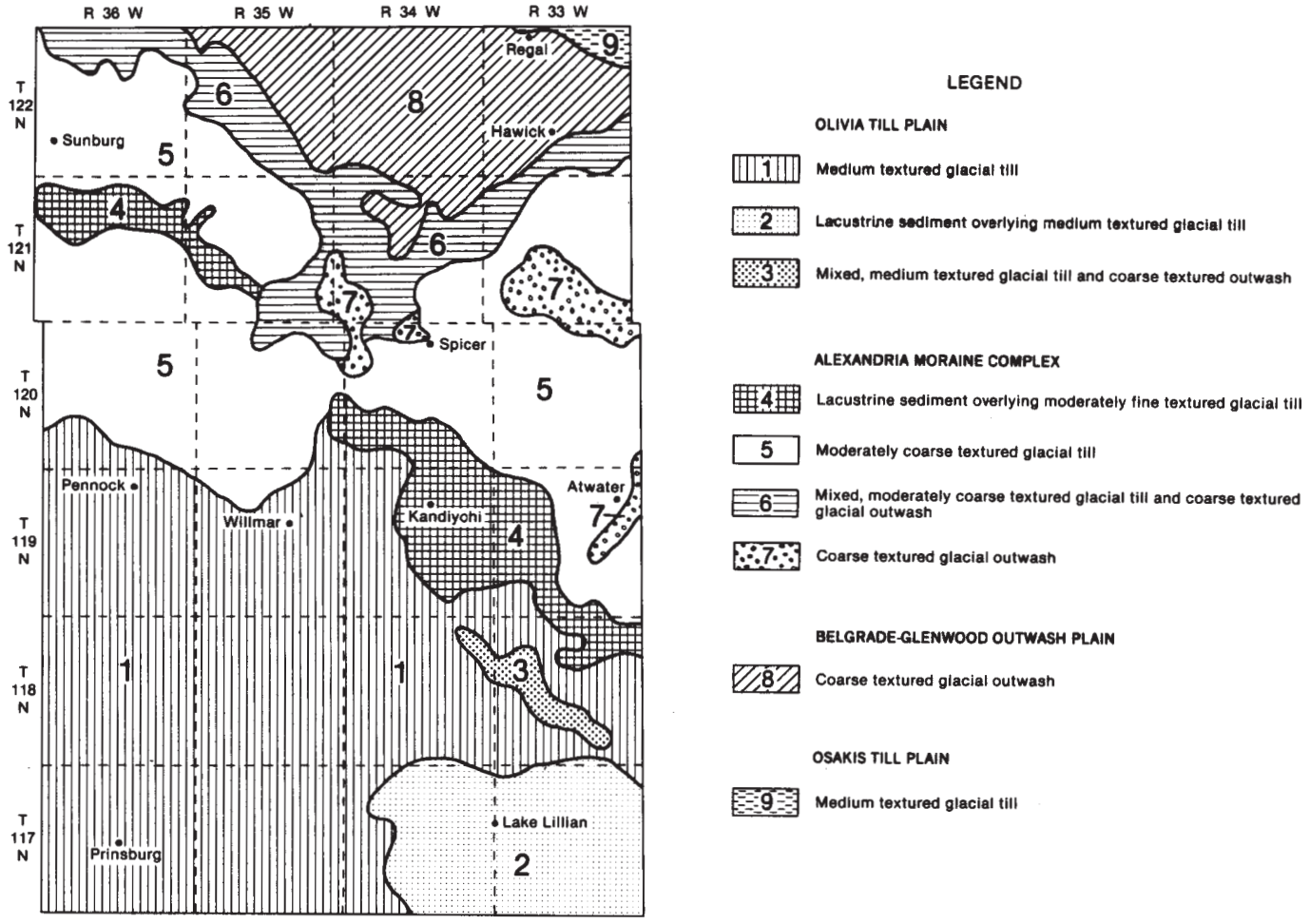

Figure 10.—Parent material in the major geomorphic areas of Kandiyohi County.

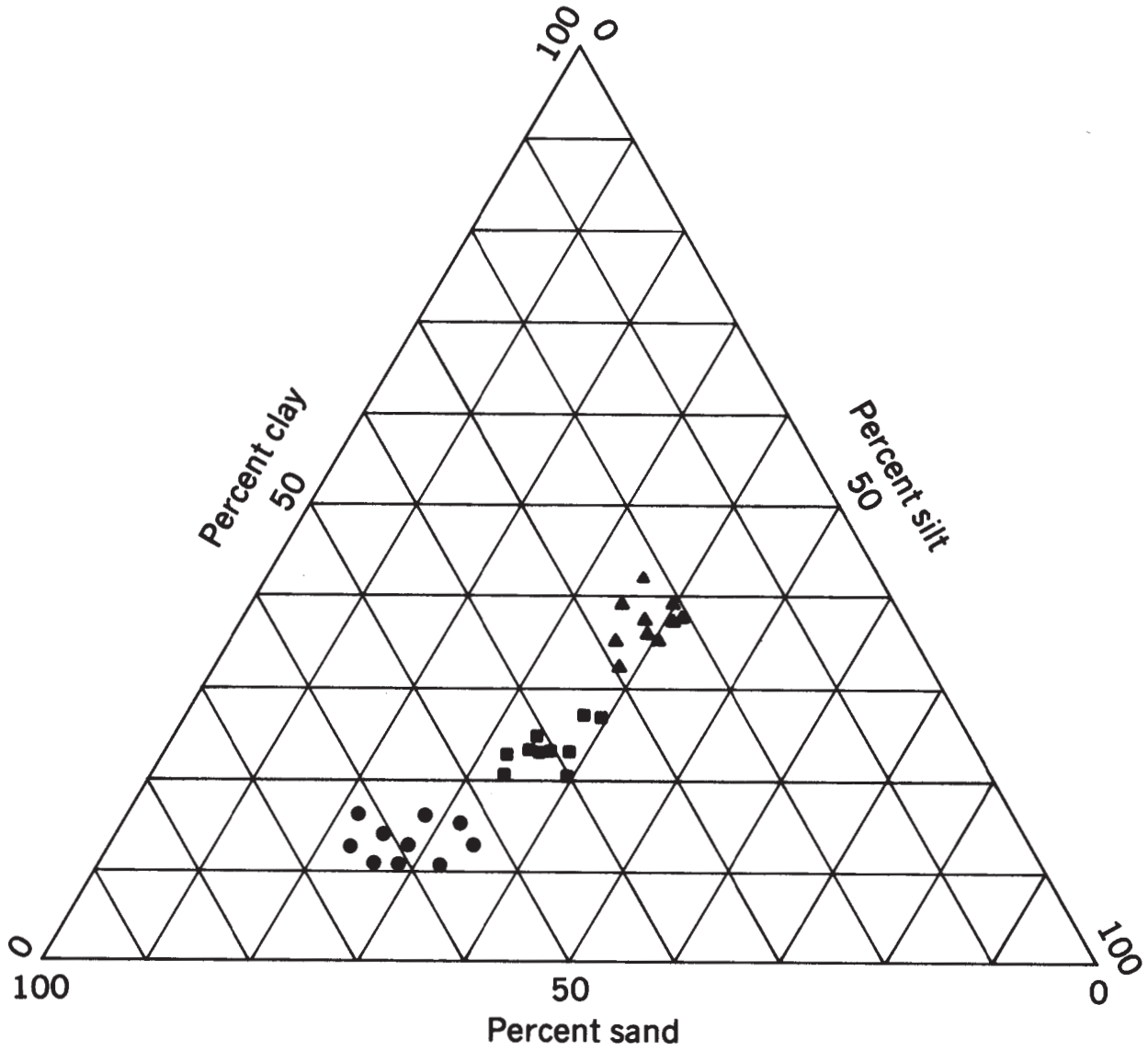

Figure 11.—The particle-size distribution of New Ulm, Wadena, and Kandiyohi Tills. Shaded squares indicate the distribution of New Ulm Till; circles, Wadena Till; and triangles, Kandiyohi Till.

Plant and Animal Life

The native vegetation in Kandiyohi County was dominantly tall and mid prairie grasses. Some scattered areas were forested. The main grasses in the uplands were bluestem, indiangrass, sideoats grama, and needleandthread. Wet areas supported such grasses as prairie cordgrass, reedgrass, and switchgrass. The most common species in the forested areas were oak, aspen, redcedar, ash, and elm.

After the glacial ice melted and the climate became favorable, plantlife was the chief factor responsible for initiating soil formation. Plant roots penetrated and loosened the new parent material. As the roots died and decayed, organic matter started to build up and the surface layer became increasingly darker.

Animal activity also affected soil formation. Earthworms tended to mix the soil. Their burrows provided channels for air and water movement. Larger burrowing animals also mixed the soil.

Human activity has more recently affected soil formation. Farming has substantially changed many soil properties and characteristics. Accelerated erosion has decreased the thickness of the surface soil and reduced

the organic matter content. In some areas the natural granular structure of the surface soil under native grasses has become blocky or cloddy because of cultivation. Some of the soils at the base of the slopes have been covered with erosional sediment. Artificial drainage has changed the moisture condition of many soils. The extent of leaching has been reduced where the runoff rate has increased. Soil compaction has reduced the permeability and infiltration rates of many soils.

Relief

Relief is an important factor in the formation of soils. Even soils that formed in the same kind of parent material can differ from one another because of variations in relief. The steeper soils generally are less well developed than the more nearly level soils. More water runs off the steeper soils. As a result, these soils are more extensively leached and have less water available for plant use.

The southern half of Kandiyohi County is primarily an undulating till plain. The northern half is dominantly a rolling to steep ground moraine that has complex slopes. The topographic position is a key to the type of soil and soil drainage class at any point on the landscape. The soils in the Wadenill-Sunburg-Delft soil association, for example, are affected by their landscape position. The well drained Wadenill soils are on convex or plane side slopes and on knolls. The well drained Sunburg soils are on knobs, ridges, and knolls. The poorly drained Delft soils are on concave toe slopes and in swales. The very poorly drained Glencoe soils, which are of minor extent in this association, are in the lowest depressions and basins.

Time

Time has a pronounced effect on soil formation. The older soils are more strongly developed than the younger ones. From a geologic perspective, the soils in Kandiyohi County are very young. They formed in material deposited during the latter part of the Wisconsin Glaciation. They are about 10,000 to 14,000 years old. The length of time has been sufficient for all the soils to show some evidence of development. The steeper soils and the soils that formed in relatively recent deposits of organic material are less well developed than the other soils in the county.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

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.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Congeliturbate. Soil material disturbed by frost action.

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.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly

continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

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.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the

solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

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.

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.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

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.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can

damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

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 multipled 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 of separates recognized in the United States are as follows:

	Millimeters
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.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

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.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-80 at Willmar, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	18.8	-0.1	9.4	44	-29	0	0.76	0.19	1.21	3	10.0
February---	25.8	6.2	16.0	48	-24	0	.84	.24	1.32	2	9.6
March------	36.4	18.1	27.3	65	-17	13	1.38	.47	2.12	4	11.3
April------	55.3	34.2	44.8	85	14	55	2.46	1.19	3.55	6	2.8
May--------	69.8	46.4	58.1	92	26	274	3.33	1.53	4.86	7	.0
June-------	78.6	56.5	67.6	96	40	528	4.96	2.59	7.03	8	.0
July-------	83.1	61.0	72.1	96	47	685	3.41	1.99	4.66	7	.0
August-----	81.0	58.9	70.0	95	45	620	3.94	1.92	5.69	7	.0
September--	71.9	49.0	60.5	93	29	319	2.65	1.35	3.78	5	.0
October----	60.4	38.6	49.5	86	18	118	1.97	.39	3.19	4	.5
November---	40.4	23.2	31.8	67	-9	0	1.22	.31	1.93	3	4.9
December---	25.7	9.0	17.4	48	-22	0	.79	.19	1.26	3	8.1
Yearly:											
Average---	53.9	33.4	43.7	---	---	---	---	---	---	---	---
Extreme---	---	---	---	97	-30	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,612	27.71	21.99	33.11	59	47.2

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-80 at Willmar, Minnesota]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 27	May 8	May 18
2 years in 10 later than--	Apr. 22	May 3	May 13
5 years in 10 later than--	Apr. 14	Apr. 24	May 4
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 9	Sept. 28	Sept. 19
2 years in 10 earlier than--	Oct. 14	Oct. 4	Sept. 24
5 years in 10 earlier than--	Oct. 25	Oct. 15	Oct. 4

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-80 at Willmar, Minnesota]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	171	151	133
8 years in 10	179	159	139
5 years in 10	194	173	152
2 years in 10	208	188	165
1 year in 10	216	195	172

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
27B	Dickinson fine sandy loam, 1 to 6 percent slopes	525	0.1
35	Blue Earth mucky silt loam	4,875	0.9
39	Wadena loam	975	0.2
41A	Estherville coarse sandy loam, 0 to 3 percent slopes	9,000	1.6
84	Brownton silty clay loam	915	0.2
94	Terril loam	775	0.1
106B	Lester loam, 2 to 8 percent slopes	615	0.1
110	Marna silty clay	7,350	1.3
112	Harps clay loam	2,025	0.4
113	Webster silty clay loam	6,500	1.2
114	Glencoe clay loam	2,875	0.5
130A	Nicollet silty clay loam, 0 to 2 percent slopes	4,650	0.8
130B	Nicollet clay loam, 2 to 5 percent slopes	4,120	0.7
134	Okoboji silty clay loam	6,100	1.1
140	Spicer silty clay loam	1,650	0.3
230A	Guckeen clay loam, 0 to 2 percent slopes	1,015	0.2
230B	Guckeen clay loam, 2 to 6 percent slopes	8,800	1.6
238B	Kilkenny clay loam, 2 to 6 percent slopes	695	0.1
238C	Kilkenny clay loam, 6 to 12 percent slopes	670	0.1
336	Delft loam	16,425	3.0
392	Biscay loam	1,675	0.3
399	Biscay loam, depressional	2,625	0.5
413	Osakis sandy loam	3,950	0.7
423	Seaforth loam	7,325	1.3
444	Canisteo silty clay loam	8,700	1.6
446A	Normania loam, 0 to 2 percent slopes	13,475	2.4
446B	Normania loam, 2 to 5 percent slopes	12,425	2.3
447	Harpster silty clay loam	1,175	0.2
462E	Sunburg fine sandy loam, 18 to 25 percent slopes	1,625	0.3
523	Houghton muck	4,325	0.8
525	Muskego muck	1,250	0.2
539	Palms muck	5,975	1.1
548	Palms muck, sandy substratum	3,350	0.6
559	Lena muck	6,100	1.1
566	Regal loam	4,510	0.8
611D	Hawick gravelly loamy coarse sand, 12 to 20 percent slopes	1,100	0.2
611F	Hawick gravelly loamy coarse sand, 20 to 35 percent slopes	1,320	0.2
613	Grovecity loam	3,025	0.5
804B	Koronis-Hawick complex, 2 to 6 percent slopes	720	0.1
804C	Koronis-Hawick complex, 6 to 12 percent slopes	2,120	0.4
804D	Koronis-Hawick complex, 12 to 20 percent slopes	1,905	0.3
804E	Koronis-Hawick complex, 20 to 30 percent slopes	1,110	0.2
805B	Wadenill-Sunburg loams, 2 to 6 percent slopes	34,875	6.3
805C	Sunburg-Wadenill complex, 6 to 12 percent slopes	22,500	4.1
805D	Sunburg-Wadenill complex, 12 to 18 percent slopes	5,050	0.9
806C	Guckeen-Arkton complex, 4 to 12 percent slopes	5,375	1.0
806D	Guckeen-Arkton complex, 12 to 18 percent slopes	845	0.2
807B	Koronis-Sunburg complex, 2 to 6 percent slopes	7,675	1.4
807C	Koronis-Sunburg complex, 6 to 12 percent slopes	9,325	1.7
807D	Koronis-Sunburg complex, 12 to 20 percent slopes	2,360	0.4
807E	Koronis-Sunburg complex, 20 to 30 percent slopes	1,075	0.2
809	Lowlein-Estherville sandy loams	1,215	0.2
810	Coriff-Fieldon complex	3,050	0.6
817	Canisteo-Seaforth complex	20,450	3.7
819B	Regal-Hawick complex, 0 to 4 percent slopes	2,175	0.4
833B	Wadenill-Sunburg-Hawick complex, 2 to 6 percent slopes	2,575	0.5
833C	Sunburg-Wadenill-Hawick complex, 6 to 12 percent slopes	2,250	0.4
833D	Sunburg-Wadenill-Hawick complex, 12 to 18 percent slopes	1,825	0.3
833E	Sunburg-Wadenill-Hawick complex, 18 to 35 percent slopes	995	0.2
842	Urban land-Udorthents complex	2,850	0.5
875B	Estherville-Hawick complex, 2 to 6 percent slopes	29,825	5.4
875C	Hawick-Estherville complex, 6 to 12 percent slopes	8,725	1.6
897B	Seaforth-Swanlake loams, 2 to 6 percent slopes	7,025	1.3
899	Harps-Okoboji complex	18,725	3.4
927	Harps-Seaforth-Okoboji complex	23,725	4.3

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
954B	Ves-Swanlake loams, 2 to 6 percent slopes	21,450	3.9
954C	Swanlake-Ves loams, 6 to 12 percent slopes	7,075	1.3
954D	Swanlake-Ves loams, 12 to 18 percent slopes	1,625	0.3
981	Canisteo-Harps loams	41,725	7.6
999B	Ves-Swanlake-Hawick complex, 2 to 6 percent slopes	1,850	0.3
999C	Swanlake-Ves-Hawick complex, 6 to 12 percent slopes	575	0.1
1016	Udorthents, loamy	2,350	0.4
1029	Pits, gravel	3,725	0.7
1055	Aquolls and Histosols, ponded	16,700	3.0
1065B	Aquolls and Histosols, sloping	635	0.1
1900	Okoboji-Canisteo silty clay loams, depressional	17,415	3.2
1908	Biscay-Palms complex	1,115	0.2
	Water	50,612	9.3
	Total	551,682	100.0

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
27B	Dickinson fine sandy loam, 1 to 6 percent slopes
39	Wadena loam
84	Brownton silty clay loam (where drained)
94	Terril loam
106B	Lester loam, 2 to 8 percent slopes
110	Marna silty clay (where drained)
112	Harps clay loam (where drained)
113	Webster silty clay loam (where drained)
130A	Nicollet silty clay loam, 0 to 2 percent slopes
130B	Nicollet clay loam, 2 to 5 percent slopes
134	Okoboji silty clay loam (where drained)
140	Spicer silty clay loam (where drained)
230A	Guckeen clay loam, 0 to 2 percent slopes
230B	Guckeen clay loam, 2 to 6 percent slopes
238B	Kilkenny clay loam, 2 to 6 percent slopes
336	Delft loam (where drained)
392	Biscay loam (where drained)
423	Seaforth loam
444	Canisteo silty clay loam (where drained)
446A	Normania loam, 0 to 2 percent slopes
446B	Normania loam, 2 to 5 percent slopes
447	Harpster silty clay loam (where drained)
613	Grovecity loam
805B	Wadenill-Sunburg loams, 2 to 6 percent slopes
807B	Koronis-Sunburg complex, 2 to 6 percent slopes
810	Coriff-Fieldon complex (where drained)
817	Canisteo-Seaforth complex (where drained)
897B	Seaforth-Swanlake loams, 2 to 6 percent slopes
899	Harps-Okoboji complex (where drained)
927	Harps-Seaforth-Okoboji complex (where drained)
954B	Ves-Swanlake loams, 2 to 6 percent slopes
981	Canisteo-Harps loams (where drained)
1900	Okoboji-Canisteo silty clay loams, depressional (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	Spring wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	Tons	AUM*
27B---------- Dickinson	IIe	60	18	50	24	2.7	4.4
35---------- Blue Earth	IIIw	70	30	---	---	3.0	3.4
39---------- Wadena	IIs	75	25	62	30	3.0	5.0
41A---------- Estherville	IIIs	55	16	52	26	2.2	3.5
84---------- Brownton	IIw	115	36	80	40	4.0	6.0
94---------- Terril	I	125	42	90	45	5.0	6.5
106B---------- Lester	IIe	110	38	80	40	4.3	6.2
110---------- Marna	IIw	115	42	80	40	4.0	6.0
112---------- Harps	IIw	100	32	78	38	3.8	6.6
113---------- Webster	IIw	125	42	80	40	4.2	6.2
114---------- Glencoe	IIIw	95	36	80	38	3.5	5.0
130A---------- Nicollet	I	130	42	90	45	5.0	6.5
130B---------- Nicollet	IIe	120	40	80	40	4.5	6.2
134---------- Okoboji	IIIw	95	36	80	38	3.5	5.0
140---------- Spicer	IIw	115	36	80	40	4.0	6.0
230A---------- Guckeen	IIw	115	40	88	42	4.8	6.5
230B---------- Guckeen	IIe	105	38	80	40	4.5	6.2
238B---------- Kilkenny	IIe	105	36	80	40	4.2	6.0
238C---------- Kilkenny	IIIe	85	30	64	32	3.8	5.3
336---------- Delft	IIw	125	40	80	40	4.5	6.4

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	Tons	AUM*
392--Biscay	IIw	75	30	64	32	3.4	5.2
399--Biscay	IIIw	60	25	---	---	2.0	4.5
413--Osakis	IIIs	55	16	52	26	2.2	3.5
423--Seaforth	IIs	120	34	85	42	4.5	6.0
444--Canisteo	IIw	115	36	80	40	4.0	6.0
446A--Normania	I	125	42	90	45	5.0	6.5
446B--Normania	IIe	115	40	80	40	4.5	6.2
447--Harpster	IIw	110	32	78	38	4.0	6.0
462E--Sunburg	VIe	---	---	---	---	2.0	3.0
523--Houghton	IIIw	70	32	---	---	3.0	---
525--Muskego	IIIw	70	32	---	---	3.0	---
539--Palms	IIIw	75	32	---	---	3.0	---
548--Palms	IIIw	55	25	---	---	---	---
559--Lena	IIIw	70	30	---	---	3.0	---
566--Regal	IIIw	70	25	60	28	3.2	4.7
611D--Hawick	VIs	---	---	---	---	---	2.0
611F--Hawick	VIIs	---	---	---	---	---	---
613--Grovecity	I	120	40	90	45	4.5	6.0
804B--Koronis-Hawick	IIIe	80	28	66	32	3.4	4.8
804C--Koronis-Hawick	IVe	60	22	52	24	2.9	4.5
804D--Koronis-Hawick	VIe	---	---	---	---	---	4.3

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	Tons	AUM*
804E--Koronis-Hawick	VIIe	---	---	---	---	---	---
805B--Wadenill-Sunburg	IIe	100	34	76	38	3.8	5.4
805C--Sunburg-Wadenill	IIIe	80	23	62	30	3.3	5.0
805D--Sunburg-Wadenill	IVe	60	18	46	22	2.7	4.5
806C--Guckeen-Arkton	IIIe	85	30	68	34	4.0	5.3
806D--Guckeen-Arkton	IVe	65	22	52	26	3.0	4.9
807B--Koronis-Sunburg	IIe	100	34	76	38	3.8	5.4
807C--Koronis-Sunburg	IIIe	80	24	62	30	3.3	5.0
807D--Koronis-Sunburg	IVe	60	20	46	24	2.7	5.4
807E--Koronis-Sunburg	VIe	---	---	---	---	---	---
809--Lowlein-Estherville	IIIs	70	26	60	30	3.5	4.9
810--Coriff-Fieldon	IIw	95	30	74	36	3.8	5.8
817--Canisteo-Seaforth	IIw	120	36	84	41	4.2	6.2
819B--Regal-Hawick	IVw	---	---	---	---	2.2	3.5
833B--Wadenill-Sunburg-Hawick	IIIe	80	28	66	32	3.4	4.8
833C--Sunburg-Wadenill-Hawick	IVe	55	22	52	24	2.9	4.3
833D--Sunburg-Wadenill-Hawick	VIe	---	---	---	---	---	4.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	Tons	AUM*
833E---------- Sunburg-Wadenill-Hawick	VIIe	---	---	---	---	---	---
842**. Urban land-Udorthents							
875B---------- Estherville-Hawick	IIIs	40	---	52	26	2.0	3.0
875C---------- Hawick-Estherville	IVs	30	---	34	17	1.7	2.2
897B---------- Seaforth-Swanlake	IIe	110	32	78	38	4.0	5.7
899---------- Harps-Okoboji	IIIw	105	34	76	38	3.4	5.6
927---------- Harps-Seaforth-Okoboji	IIw	110	34	76	38	3.6	5.8
954B---------- Ves-Swanlake	IIe	110	36	76	38	4.0	5.7
954C---------- Swanlake-Ves	IIIe	90	30	64	32	3.5	4.8
954D---------- Swanlake-Ves	IVe	70	22	50	24	3.0	4.3
981---------- Canisteo-Harps	IIw	115	34	80	38	4.0	6.0
999B---------- Ves-Swanlake-Hawick	IIIe	90	32	68	34	3.6	5.1
999C---------- Swanlake-Ves-Hawick	IVe	65	24	54	26	3.1	4.5
1016. Udorthents							
1029**. Pits							
1055---------- Aquolls and Histosols	VIIIw	---	---	---	---	---	---
1065B---------- Aquolls and Histosols	VIw	---	---	---	---	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Bu	Tons	AUM*
1900---------- Okoboji-Canisteo	IIIw	100	36	80	38	3.5	5.0
1908---------- Biscay-Palms	VIw	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
27B---------- Dickinson	Lilac, Arnold red honeysuckle.	Siberian crabapple, Siberian peashrub.	Blue spruce, Black Hills spruce, Manchurian crabapple, eastern white pine, Norway spruce, Amur maple, hackberry.	Siberian elm------	---
35---------- Blue Earth	---	Redosier dogwood, black spruce.	Black ash, tall purple willow.	Black ash, golden willow, white willow, black willow.	---
39---------- Wadena	Siberian peashrub, lilac, Arnold red honeysuckle, silver buffaloberry.	Eastern redcedar, Russian-olive, Manchurian crabapple.	Jack pine, bur oak, green ash, eastern white pine, Siberian elm.	---	---
41A---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Arnold red honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
84---------- Brownton	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	White spruce, hackberry, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash, Siberian elm.	---
94---------- Terril	---	Siberian peashrub, American plum, Arnold red honeysuckle, lilac.	Russian-olive, hackberry, blue spruce, eastern redcedar.	Ponderosa pine, green ash.	Silver maple.
106B---------- Lester	---	Redosier dogwood, Siberian peashrub, lilac, American plum.	Hackberry, eastern redcedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash, Norway spruce.	---
110---------- Marna	---	Arnold red honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
112---------- Harps	---	Arnold red honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
113---------- Webster	---	Redosier dogwood, American plum, Arnold red honeysuckle, eastern redcedar.	Hackberry, Amur maple, northern white-cedar, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
114---------- Glencoe	---	Redosier dogwood, black spruce, tamarack.	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
130A, 130B-------- Nicollet	---	Redosier dogwood, Arnold red honeysuckle, lilac, American plum.	Northern white-cedar, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
134---------- Okoboji	---	Redosier dogwood, black spruce.	Black ash, tall purple willow, tamarack.	Black willow, white willow, golden willow.	---
140---------- Spicer	---	Arnold red honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
230A, 230B-------- Guckeen	American plum, lilac.	Siberian peashrub, eastern redcedar, Manchurian crabapple.	Green ash, hackberry.	Siberian elm------	---
238B, 238C-------- Kilkenny	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Blue spruce, hackberry, Amur maple, eastern redcedar.	Austrian pine, eastern white pine, green ash.	Silver maple.
336---------- Delft	---	Arnold red honeysuckle, redosier dogwood, American plum, eastern redcedar.	Hackberry, Amur maple, white spruce, tall purple willow.	Green ash, eastern white pine.	Silver maple, eastern cottonwood.
392---------- Biscay	---	Siberian peashrub, Arnold red honeysuckle.	Hackberry, ponderosa pine, blue spruce, eastern redcedar.	Golden willow, silver maple, honeylocust, green ash.	Eastern cottonwood.
399---------- Biscay	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
413---------- Osakis	---	Lilac, redosier dogwood, Siberian peashrub.	White spruce, blue spruce, Amur maple.	Norway spruce, red pine, jack pine, green ash, eastern white pine, hackberry.	---
423---------- Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Arnold red honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry, blue spruce.	Green ash, golden willow.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
444---------- Canisteo	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar, blue spruce.	Golden willow, green ash.	Eastern cottonwood.
446A, 446B-------- Normania	---	Lilac, redosier dogwood, Arnold red honeysuckle, American plum.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, hackberry, green ash.	Silver maple.
447---------- Harpster	---	Lilac, Siberian peashrub, northern white-cedar, Arnold red honeysuckle.	Hackberry, white spruce, eastern redcedar.	Golden willow, green ash, Siberian elm, black willow.	Eastern cottonwood.
462E---------- Sunburg	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
523---------- Houghton	Common ninebark---	Redosier dogwood, Arnold red honeysuckle, black spruce.	Tall purple willow, tamarack.	Golden willow, black willow, white willow.	---
525---------- Muskego	---	Nannyberry viburnum, common ninebark, black spruce, northern white-cedar, American cranberrybush, redosier dogwood.	White spruce, Japanese tree lilac, Manchurian crabapple, tamarack.	Siberian crabapple	---
539---------- Palms	Common ninebark---	Amur privet, black spruce, nannyberry viburnum, redosier dogwood.	Tall purple willow, tamarack.	Golden willow, black willow, white willow.	---
548---------- Palms	Common ninebark---	Redosier dogwood, Arnold red honeysuckle, Amur privet, black spruce.	Tall purple willow, tamarack.	Black willow, white willow, golden willow.	---
559---------- Lena	---	Redosier dogwood, nannyberry viburnum, common ninebark, American cranberrybush, northern white-cedar, black spruce.	Manchurian crabapple, white spruce.	Siberian crabapple	---
566---------- Regal	---	Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, white spruce, hackberry, Manchurian crabapple.	Green ash, golden willow, honeylocust, Siberian elm.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
611D, 611F---------- Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
613---------- Grovecity	---	Lilac, redosier dogwood, Arnold red honeysuckle, eastern redcedar, American plum.	White spruce, blue spruce, Amur maple.	Austrian pine, hackberry, green ash.	Silver maple.
804B*, 804C*, 804D*, 804E*: Koronis----------	---	Redosier dogwood, lilac, Siberian peashrub, American plum.	Blue spruce, eastern redcedar, Amur maple, hackberry, Russian-olive.	Eastern white pine, green ash.	Silver maple.
Hawick----------	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
805B*: Wadenill----------	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, red pine.	Silver maple.
Sunburg----------	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
805C*: Sunburg----------	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Wadenill----------	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, red pine.	Silver maple.
805D*: Sunburg----------	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Wadenill----------	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, red pine.	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
806C*, 806D*:					
Guckeen	---	Siberian peashrub, lilac, eastern redcedar, American plum.	Austrian pine, hackberry, Russian-olive, bur oak, green ash, Manchurian crabapple.	Green ash, Siberian elm.	---
Arkton	---	Northern white-cedar, lilac, Arnold red honeysuckle, Siberian peashrub.	Eastern redcedar, hackberry, white spruce, blue spruce.	Green ash, golden willow.	Honeylocust, eastern cottonwood.
807B*, 807C*, 807D*, 807E*:					
Koronis	---	Redosier dogwood, lilac, Siberian peashrub, American plum.	Blue spruce, eastern redcedar, Amur maple, hackberry, Russian-olive.	Eastern white pine, green ash.	Silver maple.
Sunburg	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
809*:					
Lowlein	Hedge cotoneaster	Lilac, Siberian peashrub.	Manchurian crabapple, white spruce, northern white-cedar, blue spruce, Amur maple, Russian-olive.	Hackberry, green ash, Siberian elm.	---
Estherville	Siberian peashrub	Eastern redcedar, lilac, Arnold red honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
810*:					
Coriff	---	Siberian peashrub, lilac, Arnold red honeysuckle, northern white-cedar.	Eastern redcedar, white spruce, hackberry, blue spruce.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
Fieldon	---	Northern white-cedar, lilac, Arnold red honeysuckle, Siberian peashrub.	White spruce, eastern redcedar, hackberry, blue spruce.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
817*:					
Canisteo	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar, blue spruce.	Golden willow, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
817*:					
Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Arnold red honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry, blue spruce.	Green ash, golden willow.	Eastern cottonwood.
819B*:					
Regal	---	Siberian peashrub, lilac, Arnold red honeysuckle, northern white-cedar.	Eastern redcedar, white spruce, hackberry, blue spruce.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
833B*:					
Wadenill	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, eastern white pine.	Silver maple.
Sunburg	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
833C*:					
Sunburg	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Wadenill	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, eastern white pine.	Silver maple.
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
833D*, 833E*:					
Sunburg	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Wadenill	Hedge cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, Russian-olive, blue spruce, Amur maple, hackberry.	Green ash, eastern white pine.	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
833D*, 833E*:					
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
842*:					
Urban land.					
Udorthents.					
875B*:					
Estherville	Siberian peashrub	Eastern redcedar, lilac, Arnold red honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
875C*:					
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
Estherville	Siberian peashrub	Eastern redcedar, lilac, Arnold red honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
897B*:					
Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Arnold red honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry, blue spruce.	Green ash, golden willow.	Eastern cottonwood.
Swanlake	American plum	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
899*:					
Harps	---	Arnold red honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
Okoboji	---	Redosier dogwood, black spruce.	Black ash, tall purple willow, tamarack.	Black willow, white willow, golden willow.	---

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
927*:					
Harps	---	Arnold red honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Arnold red honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry, blue spruce.	Green ash, golden willow.	Eastern cottonwood.
Okoboji	---	Redosier dogwood, black spruce.	Black ash, tall purple willow, tamarack.	Black willow, white willow, golden willow.	---
954B*:					
Ves	---	Siberian peashrub, redosier dogwood, lilac, American plum.	Eastern redcedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, red pine.	Silver maple.
Swanlake	American plum	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
954C*, 954D*:					
Swanlake	American plum	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Ves	---	Siberian peashrub, redosier dogwood, lilac, American plum.	Eastern redcedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, red pine.	Silver maple.
981*:					
Canisteo	---	Siberian peashrub, Arnold red honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar, blue spruce.	Golden willow, green ash.	Eastern cottonwood.
Harps	---	Arnold red honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
999B*:					
Ves	---	Siberian peashrub, redosier dogwood, lilac, American plum.	Eastern redcedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, red pine.	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
999B*:					
Swanlake	American plum	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
999C*:					
Swanlake	American plum	Eastern redcedar, Arnold red honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Ves	---	Siberian peashrub, redosier dogwood, lilac, American plum.	Eastern redcedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, red pine.	Silver maple.
Hawick	Siberian peashrub	Lilac, Arnold red honeysuckle, eastern redcedar, Siberian crabapple.	Austrian pine, red pine, green ash, honeylocust, Russian-olive.	Eastern white pine, Siberian elm.	---
1016. Udorthents					
1029*. Pits					
1055*, 1065B*: Aquolls.					
Histosols.					
1900*:					
Okoboji	---	Redosier dogwood, black spruce.	Black ash, tall purple willow, tamarack.	Black willow, white willow, golden willow.	---
Canisteo	---	Redosier dogwood, black spruce.	Black ash, tall purple willow, tamarack.	Black willow, golden willow, white willow.	---
1908*:					
Biscay	---	Siberian peashrub, Arnold red honeysuckle.	Hackberry, blue spruce, eastern redcedar.	Golden willow, silver maple, honeylocust, green ash.	---
Palms	Common ninebark	Redosier dogwood, Arnold red honeysuckle, Amur privet, black spruce.	Tall purple willow, tamarack.	Black willow, white willow, golden willow.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
27B---- Dickinson	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
35---- Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
39---- Wadena	Slight----	Slight----	Slight----	Slight----	Slight.
41A---- Estherville	Slight----	Slight----	Slight----	Slight----	Moderate: droughty.
84---- Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
94---- Terril	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
106B---- Lester	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
110---- Marna	Severe: wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
112---- Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
113---- Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114---- Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
130A---- Nicollet	Slight----	Slight----	Slight----	Slight----	Slight.
130B---- Nicollet	Slight----	Slight----	Moderate: slope.	Slight----	Slight.
134---- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
140---- Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
230A---- Guckeen	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight----	Slight.
230B---- Guckeen	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight----	Slight.
238B---- Kilkenny	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
238C---------- Kilkenny	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight----------	Moderate: slope.
336---------- Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
392---------- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
399---------- Biscay	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
413---------- Osakis	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.
423---------- Seaforth	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
444---------- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
446A---------- Normania	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
446B---------- Normania	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
447---------- Harpster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
462E---------- Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
523---------- Houghton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.
525---------- Muskego	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
539---------- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
548---------- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
559---------- Lena	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
566---------- Regal	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
611D---------- Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy, slope.	Severe: droughty.
611F---------- Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: droughty.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
613--Grovecity	Slight	Slight	Moderate: small stones.	Slight	Slight.
804B*:					
Koronis	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Hawick	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Severe: droughty.
804C*:					
Koronis	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Hawick	Moderate: slope, small stones.	Moderate: slope, too sandy.	Severe: slope, small stones.	Moderate: too sandy.	Severe: droughty.
804D*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy, slope.	Severe: droughty.
804E*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: droughty.
805B*:					
Wadenill	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Sunburg	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
805C*:					
Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Wadenill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
805D*:					
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Wadenill	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
806C*:					
Guckeen	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
806C*:					
Arkton	Severe: too clayey.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey.	Severe: too clayey.
806D*:					
Guckeen	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Arkton	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: too clayey.	Severe: slope, too clayey.
807B*:					
Koronis	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Sunburg	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
807C*:					
Koronis	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
807D*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
807E*:					
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
809*:					
Lowlein	Slight	Slight	Slight	Slight	Slight.
Estherville	Slight	Slight	Slight	Slight	Moderate: droughty.
810*:					
Coriff	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
817*:					
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Seaforth	Slight	Slight	Slight	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
819B*:					
Regal	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Hawick	Moderate: small stones.	Moderate: too sandy.	Severe: small stones.	Moderate: too sandy.	Severe: droughty.
833B*:					
Wadenill	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Sunburg	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Hawick	Slight	Moderate: too sandy.	Moderate: slope.	Moderate: too sandy.	Severe: droughty.
833C*:					
Sunburg	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Wadenill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Hawick	Moderate: slope, small stones.	Moderate: slope, too sandy.	Severe: slope, small stones.	Moderate: too sandy.	Severe: droughty.
833D*:					
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Wadenill	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: too sandy, slope.	Severe: droughty.
833E*:					
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Wadenill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: droughty.
842*:					
Urban land.					
Udorthents.					
875B*:					
Estherville	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Hawick	Slight	Moderate: too sandy.	Moderate: slope.	Moderate: too sandy.	Severe: droughty.

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
875C*:					
Hawick	Moderate: slope, small stones.	Moderate: slope, too sandy.	Severe: slope, small stones.	Moderate: too sandy.	Severe: droughty.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
897B*:					
Seaforth	Slight	Slight	Moderate: slope.	Slight	Slight.
Swanlake	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
899*:					
Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
927*:					
Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Seaforth	Slight	Slight	Moderate: slope.	Slight	Slight.
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
954B*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Swanlake	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
954C*:					
Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954D*:					
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
981*:					
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
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
999B*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Swanlake	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
Hawick	Slight	Moderate: too sandy.	Moderate: slope.	Moderate: too sandy.	Severe: droughty.
999C*:					
Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Severe: droughty.
1016. Udorthents					
1029*. Pits					
1055*, 1065B*: Aquolls. Histosols.					
1900*:					
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Canisteo	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1908*:					
Biscay	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Palms	Severe: flooding, ponding.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							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
27B---------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
35---------- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
39---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
41A---------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
84---------- Brownton	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94---------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
106B---------- Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
110---------- Marna	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
112---------- Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
113---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114---------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
130A, 130B---------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
134---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
140---------- Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
230A---------- Guckeen	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
230B---------- Guckeen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
238B---------- Kilkenny	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
238C---------- Kilkenny	Fair	Good	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
336---------- Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
392---------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
399---------- Biscay	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
413---------- Osakis	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
423---------- Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
444---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
446A, 446B--------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
447---------- Harpster	Fair	Fair	Good	Fair	Fair	Good	Fair	Fair	Fair	Fair.
462E---------- Sunburg	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
523---------- Houghton	Fair	Poor	Poor	Fair	Fair	Good	Good	Poor	Poor	Good.
525---------- Muskego	Good	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
539---------- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
548---------- Palms	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
559---------- Lena	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
566---------- Regal	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
611D---------- Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
611F---------- Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
613---------- Grovecity	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
804B*:										
Koronis----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hawick----------	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
804C*, 804D*:										
Koronis----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hawick----------	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
804E*:										
Koronis	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
805B*:										
Wadenill	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Sunburg	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
805C*:										
Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Wadenill	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
805D*:										
Sunburg	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Wadenill	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
806C*:										
Guckeen	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Arkton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
806D*:										
Guckeen	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Arkton	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
807B*:										
Koronis	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sunburg	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
807C*:										
Koronis	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
807D*:										
Koronis	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Sunburg	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
807E*:										
Koronis	Poor	Fair	Fair	Good	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Sunburg	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
809*:										
Lowlein	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
810*:										
Coriff	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Fieldon	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
817*:										
Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
819B*:										
Regal	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
833B*:										
Wadenill	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Sunburg	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
833C*:										
Sunburg	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Wadenill	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
833D*:										
Sunburg	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Wadenill	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
833E*:										
Sunburg	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
833E*:										
Wadenill	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
842*:										
Urban land.										
Udorthents.										
875B*:										
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
875C*:										
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
897B*:										
Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
899*:										
Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
927*:										
Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
954B*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
954C*:										
Swanlake	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
954D*:										
Swanlake	Fair	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
954D*:										
Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
981*:										
Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
999B*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
999C*:										
Swanlake	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
1016.										
Udorthents										
1029*.										
Pits										
1055*, 1065B*:										
Aquolls.										
Histosols.										
1900*:										
Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
Canisteo	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
1908*:										
Biscay	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Palms	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	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
27B---------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
35---------- Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
39---------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
41A---------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
84---------- Brownton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
94---------- Terril	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
106B---------- Lester	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
110---------- Marna	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
112---------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
113---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
114---------- Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
130A, 130B-------- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
134---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
140---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
230A, 230B-------- Guckeen	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: low strength, frost action.	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
238B---------- Kilkenny	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
238C---------- Kilkenny	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
336---------- Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
392---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
399---------- Biscay	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding.	Severe: ponding.
413---------- Osakis	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
423---------- Seaforth	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
444---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
446A, 446B-------- Normania	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
447---------- Harpster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
462E---------- Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
523---------- Houghton	Severe: ponding, excess humus.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: excess humus, ponding.
525---------- Muskego	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
539---------- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
548---------- Palms	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
559---------- Lena	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, low strength.	Severe: ponding, excess humus.

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
566--- Regal	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness.
611D, 611F--- Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty.
613--- Grovecity	Moderate: wetness.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.	Slight.
804B*:						
Koronis---	Slight---	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Slight.
Hawick---	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight---	Severe: droughty.
804C*:						
Koronis---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Hawick---	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
804D*, 804E*:						
Koronis---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick---	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty.
805B*:						
Wadenill---	Slight---	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Slight.
Sunburg---	Slight---	Slight---	Slight---	Moderate: slope.	Moderate: frost action.	Slight.
805C*:						
Sunburg---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Wadenill---	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
805D*:						
Sunburg---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Wadenill---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
806C*:						
Guckeen---	Moderate: too clayey, dense layer, slope.	Moderate: shrink-swell, slope.	Moderate: wetness, slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.

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
806C*:						
Arkton	Moderate: too clayey, wetness, slope.	Moderate: shrink-swell, slope.	Moderate: wetness, slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Severe: too clayey.
806D*:						
Guckeen	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
Arkton	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope, too clayey.
807B*:						
Koronis	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Sunburg	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
807C*:						
Koronis	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Sunburg	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
807D*, 807E*:						
Koronis	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
809*:						
Lowlein	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
810*:						
Coriff	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
817*:						
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Seaforth	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
819B*:						
Regal	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.	Moderate: wetness.
Hawick	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
833B*:						
Wadenill	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Sunburg	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Hawick	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
833C*:						
Sunburg	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Wadenill	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
833D*, 833E*:						
Sunburg	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Wadenill	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty.
842*:						
Urban land.						
Udorthents.						
875B*:						
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Hawick	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
875C*:						
Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
897B*:						
Seaforth	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
897B*:						
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.	Slight.
899*:						
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: low strength, ponding, frost action.	Severe: ponding.
927*:						
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Seaforth	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
954B*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.	Slight.
954C*:						
Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
954D*:						
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
981*:						
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

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
999B*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.	Slight.
Hawick	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: droughty.
999C*:						
Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
1016. Udorthents						
1029*. Pits						
1055*, 1065B*: Aquolls.						
1055*, 1065B*: Histosols.						
1900*:						
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
Canisteo	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1908*:						
Biscay	Severe: cutbanks cave, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding.
Palms	Severe: cutbanks cave, excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: ponding, frost action, low strength.	Severe: ponding, excess humus.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27B---------- Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
35---------- Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
39---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41A---------- Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
84---------- Brownton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
94---------- Terril	Slight----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
106B---------- Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Fair: too clayey.
110---------- Marna	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
112---------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
113---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114---------- Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
130A, 130B---------- Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
134---------- Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
140---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
230A, 230B---------- Guckeen	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, 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
238B---------- Kilkenny	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight----------	Poor: hard to pack.
238C---------- Kilkenny	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: hard to pack.
336---------- Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
392---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
399---------- Biscay	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
413---------- Osakis	Severe: poor filter, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
423---------- Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
444---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
446A, 446B---------- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
447---------- Harpster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
462E---------- Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
523---------- Houghton	Severe: ponding, percs slowly.	Severe: seepage, ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
525---------- Muskego	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: hard to pack, ponding.
539---------- Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
548---------- Palms	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
559---------- Lena	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
566---------- Regal	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, too sandy.	Severe: wetness, seepage.	Poor: seepage, too sandy, small stones.
611D, 611F---------- Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
613---------- Grovecity	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Fair: wetness.
804B*:					
Koronis----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Hawick----------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
804C*:					
Koronis----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Hawick----------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
804D*, 804E*:					
Koronis----------	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Hawick----------	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
805B*:					
Wadenill----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Sunburg----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
805C*:					
Sunburg----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
Wadenill----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
805D*:					
Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Wadenill	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
806C*:					
Guckeen	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Moderate: wetness, slope.	Fair: too clayey, slope.
Arkton	Severe: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness, slope, too clayey.	Moderate: wetness, slope.	Fair: too clayey, slope, wetness.
806D*:					
Guckeen	Severe: wetness, percs slowly, slope.	Severe: slope.	Severe: wetness, slope.	Severe: slope.	Poor: slope.
Arkton	Severe: wetness, percs slowly, slope.	Severe: slope, wetness.	Severe: slope.	Severe: slope.	Poor: slope.
807B*:					
Koronis	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Sunburg	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
807C*:					
Koronis	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Sunburg	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
807D*, 807E*:					
Koronis	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
809*:					
Lowlein	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

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
810*:					
Coriff	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
Fieldon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
817*:					
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
819B*:					
Regal	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, too sandy.	Severe: wetness, seepage.	Poor: seepage, too sandy, small stones.
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
833B*:					
Wadenill	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Sunburg	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
833C*:					
Sunburg	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
Wadenill	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
833D*, 833E*:					
Sunburg	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Wadenill	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
833D*, 833E*:					
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
842*:					
Urban land.					
Udorthents.					
875B*:					
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
875C*:					
Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
897B*:					
Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
899*:					
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.
927*:					
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, 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
954B*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
954C*:					
Swanlake	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954D*:					
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
981*:					
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
999B*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
999C*:					
Swanlake	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1016. Udorthents					
1029*. Pits					
1055*, 1065B*: Aquolls.					

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
1055*, 1065B*: Histosols.					
1900*:					
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Canisteo	Severe: ponding.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
1908*:					
Biscay	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
Palms	Severe: ponding.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
27B Dickinson	Good	Probable	Improbable: too sandy.	Good.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
39 Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
41A Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
84 Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
94 Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
106B Lester	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
110 Marna	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
112 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
113 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114 Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
130A, 130B Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
134 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
140 Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
230A, 230B Guckeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
238B Kilkenny	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
238C---------- Kilkenny	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
336---------- Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
392---------- Biscay	Fair: wetness.	Probable----------	Probable----------	Fair: area reclaim, thin layer.
399---------- Biscay	Poor: wetness.	Probable----------	Probable----------	Poor: area reclaim, wetness.
413---------- Osakis	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
423---------- Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
444---------- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
446A, 446B---------- Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
447---------- Harpster	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
462E---------- Sunburg	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
523---------- Houghton	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: wetness, excess humus.
525---------- Muskego	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
539---------- Palms	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
548---------- Palms	Poor: wetness, low strength.	Probable----------	Improbable: too sandy.	Poor: excess humus, wetness.
559---------- Lena	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
566---------- Regal	Fair: wetness.	Probable----------	Probable----------	Poor: small stones, area reclaim.
611D---------- Hawick	Fair: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
611F---------- Hawick	Poor: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
613---------- Grovecity	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
804B*:				
Koronis----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Hawick----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
804C*:				
Koronis----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Hawick----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.
804D*:				
Koronis----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick----------	Fair: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
804E*:				
Koronis----------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick----------	Poor: slope.	Probable----------	Probable----------	Poor: small stones, area reclaim, slope.
805B*:				
Wadenill----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sunburg----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
805C*:				
Sunburg----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Wadenill----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
805D*:				
Sunburg----------	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
805D*:				
Wadenill	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
806C*:				
Guckeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, too clayey.
Arkton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
806D*:				
Guckeen	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Arkton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
807B*:				
Koronis	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
807C*:				
Koronis	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
807D*:				
Koronis	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sunburg	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
807E*:				
Koronis	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sunburg	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
809*:				
Lowlein	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
810*:				
Coriff	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
810*:				
Fieldon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
817*:				
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
819B*:				
Regal	Fair: wetness.	Probable	Probable	Poor: small stones, area reclaim.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
833B*:				
Wadenill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
833C*:				
Sunburg	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Wadenill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
833D*:				
Sunburg	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Wadenill	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
833E*:				
Sunburg	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Wadenill	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
833E*:				
Hawick	Poor: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
842*:				
Urban land.				
Udorthents.				
875B*:				
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
875C*:				
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
897B*:				
Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
899*:				
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.
927*:				
Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
954B*:				
Ves	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
954B*:				
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
954C*:				
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
954D*:				
Swanlake	Fair: slope, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
981*:				
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
999B*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
999C*:				
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
1016. Udorthents				
1029*. Pits				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1055*, 1065B*: Aquolls.				
Histosols.				
1900*:				
Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Canisteo	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1908*:				
Biscay	Poor: wetness.	Probable	Probable	Poor: area reclaim, wetness.
Palms	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
27B---------- Dickinson	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Soil blowing, too sandy.	Favorable.
35---------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Severe: slow refill.	Ponding, frost action.	Ponding--------	Wetness.
39---------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
41A---------- Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
84---------- Brownton	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness--------	Wetness, percs slowly.
94---------- Terril	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
106B---------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
110---------- Marna	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Percs slowly, frost action.	Wetness--------	Wetness, percs slowly.
112---------- Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
113---------- Webster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
114---------- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Severe: slow refill.	Frost action, ponding.	Ponding--------	Wetness.
130A---------- Nicollet	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Frost action---	Wetness--------	Favorable.
130B---------- Nicollet	Moderate: seepage, slope.	Moderate: piping.	Moderate: deep to water, slow refill.	Frost action, slope.	Wetness--------	Favorable.
134---------- Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
140---------- Spicer	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness, erodes easily.	Wetness, erodes easily.
230A---------- Guckeen	Slight---------	Moderate: piping, wetness.	Severe: slow refill.	Percs slowly, frost action.	Erodes easily, wetness.	Erodes easily, percs slowly.

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
230B---------- Guckeen	Moderate: slope.	Moderate: piping, wetness.	Severe: slow refill.	Percs slowly, frost action, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.
238B---------- Kilkenny	Moderate: seepage, slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Favorable------	Favorable.
238C---------- Kilkenny	Severe: slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Slope----------	Slope.
336---------- Delft	Slight---------	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness--------	Wetness.
392---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
399---------- Biscay	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, frost action.	Ponding, too sandy.	Wetness.
413---------- Osakis	Severe: seepage.	Severe: seepage.	Moderate: deep to water, slow refill, cutbanks cave.	Deep to water	Too sandy, soil blowing.	Droughty.
423---------- Seaforth	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
444---------- Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
446A---------- Normania	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Frost action---	Wetness--------	Favorable.
446B---------- Normania	Moderate: seepage, slope.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Slope, frost action.	Wetness--------	Favorable.
447---------- Harpster	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness--------	Wetness.
462E---------- Sunburg	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
523---------- Houghton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Frost action, subsides, ponding.	Ponding, soil blowing.	Wetness.
525---------- Muskego	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, percs slowly.	Ponding, soil blowing, percs slowly.	Wetness, percs slowly.
539---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
548---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
559---------- Lena	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
566---------- Regal	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, too sandy.	Wetness, droughty.
611D, 611F-------- Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
613---------- Grovecity	Severe: seepage.	Severe: piping.	Moderate: deep to water.	Frost action---	Wetness--------	Favorable.
804B*: Koronis----------	Severe: seepage.	Slight---------	Severe: no water.	Deep to water	Soil blowing---	Favorable.
Hawick----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Droughty.
804C*, 804D*, 804E*: Koronis----------	Severe: seepage, slope.	Slight---------	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
Hawick----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
805B*: Wadenill----------	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
Sunburg----------	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
805C*, 805D*: Sunburg----------	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope----------	Slope.
Wadenill----------	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
806C*, 806D*: Guckeen----------	Severe: slope.	Moderate: piping, wetness.	Severe: slow refill.	Deep to water	Slope, erodes easily.	Slope, erodes easily, rooting depth.
Arkton----------	Severe: slope.	Moderate: piping, wetness.	Severe: no water.	Frost action, slope.	Slope, erodes easily, wetness.	Slope, erodes easily, rooting depth.
807B*: Koronis----------	Severe: seepage.	Slight---------	Severe: no water.	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
807B*:						
Sunburg	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
807C*, 807D*, 807E*:						
Koronis	Severe: seepage, slope.	Slight	Severe: no water.	Deep to water	Slope, soil blowing.	Slope.
Sunburg	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
809*:						
Lowlein	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Favorable	Erodes easily, soil blowing, wetness.	Erodes easily.
Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
810*:						
Coriff	Severe: seepage.	Severe: piping, wetness.	Severe: cutbanks cave.	Frost action	Erodes easily, wetness.	Wetness, erodes easily.
Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy, soil blowing.	Wetness.
817*:						
Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
Seaforth	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
819B*:						
Regal	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, too sandy.	Wetness, droughty.
Hawick	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Droughty.
833B*:						
Wadenill	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Sunburg	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Hawick	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.

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
833C*, 833D*, 833E*:						
Sunburg	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
Wadenill	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
842*:						
Urban land.						
Udorthents.						
875B*:						
Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
Hawick	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
875C*:						
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
Estherville	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
897B*:						
Seaforth	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
Swanlake	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
899*:						
Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.
927*:						
Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
Seaforth	Moderate: seepage.	Moderate: piping.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
954B*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Swanlake	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
954C*, 954D*:						
Swanlake	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
981*:						
Canisteo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
Harps	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action	Wetness	Wetness.
999B*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Swanlake	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
Hawick	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
999C*:						
Swanlake	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
1016. Udorthents						
1029*. Pits						
1055*, 1065B*: Aquolls. Histosols.						
1900*:						
Okoboji	Moderate: seepage.	Severe: ponding.	Severe: slow refill.	Ponding, frost action.	Erodes easily, ponding.	Wetness, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
1900*:						
Canisteo	Severe: seepage.	Severe: ponding.	Moderate: slow refill.	Ponding, frost action.	Ponding	Wetness.
1908*:						
Biscay	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, flooding, frost action.	Ponding, too sandy.	Wetness.
Palms	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
27B---------- Dickinson	0-16	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	16-29	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	29-60	Sand, loamy fine sand, fine sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
35---------- Blue Earth	0-10	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	10-60	Mucky silty clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
39---------- Wadena	0-20	Loam----------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	20-27	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
	27-60	Stratified gravelly coarse sand to loamy coarse sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	55-100	35-95	10-80	2-10	---	NP
41A---------- Estherville	0-13	Coarse sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	90-100	90-100	50-75	25-50	20-30	2-10
	13-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-5	55-90	50-85	10-40	2-25	---	NP
84---------- Brownton	0-18	Silty clay loam, clay.	MH, CH	A-7	0	100	98-100	90-98	85-95	50-65	20-35
	18-34	Silty clay, clay	MH, CH	A-7	0	100	98-100	90-98	85-95	50-80	25-40
	34-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-98	75-90	60-75	30-50	15-25
94---------- Terril	0-37	Loam----------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	37-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
106B---------- Lester	0-8	Loam----------	ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	50-70	30-40	5-15
	8-28	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	28-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
110---------- Marna	0-20	Silty clay, clay	MH, ML	A-7	0	98-100	90-100	90-100	85-95	45-65	15-30
	20-36	Clay, silty clay, silty clay loam.	CH, MH	A-7	0	98-100	90-100	90-100	85-95	50-80	20-45
	36-60	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-98	75-95	60-80	35-50	15-25
112---------- Harps	0-16	Clay loam, loam	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	16-32	Loam, clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	32-60	Loam----------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
113---------- Webster	0-20	Silty clay loam	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	20-28	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
	28-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114---------- Glencoe	0-39	Clay loam--------	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	39-44	Loam, clay loam	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	44-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
130A---------- Nicollet	0-18	Silty clay loam	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	18-29	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	29-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
130B---------- Nicollet	0-10	Clay loam--------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	10-21	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	21-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
134---------- Okoboji	0-10	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	10-32	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	32-43	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	43-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
140---------- Spicer	0-22	Silty clay loam, silt loam.	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	22-32	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	32-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
230A, 230B------- Guckeen	0-14	Clay loam, silty clay.	ML, CL	A-7	0	100	95-100	95-100	80-95	40-50	15-20
	14-28	Silty clay, silty clay loam, clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-65	15-30
	28-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	90-98	85-95	60-75	30-50	10-25
238B, 238C------- Kilkenny	0-9	Clay loam--------	ML, MH	A-7	0	95-100	95-100	80-95	70-85	40-60	10-25
	9-36	Clay loam, clay, silty clay loam.	MH, CH	A-7	0	95-100	90-98	80-95	65-80	50-70	25-35
	36-60	Clay loam, loam	CL, ML	A-7, A-6	0-5	95-100	90-98	75-90	60-75	35-50	10-25
336---------- Delft	0-30	Loam----------	CL	A-6, A-7	0	95-100	90-98	75-90	60-80	30-45	10-20
	30-36	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	90-98	70-90	50-75	25-40	7-15
	36-60	Loam, clay loam, sandy loam.	CL, ML, CL-ML	A-6, A-4	0-5	90-100	85-100	55-90	50-85	20-40	3-15
392---------- Biscay	0-18	Loam----------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	18-28	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
	28-60	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
399---------- Biscay	0-21	Loam----------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	21-30	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	30-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
413---------- Osakis	0-12	Sandy loam-------	SM, SM-SC	A-4, A-2	0	95-100	85-100	50-70	25-40	<25	NP-7
	12-18	Loam, sandy loam	SM, ML, CL-ML, SM-SC	A-4, A-2	0	95-100	85-100	55-90	25-70	20-35	1-8
	18-60	Loamy coarse sand, gravelly coarse sand, very gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	30-95	20-85	10-50	0-10	<20	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
423---------- Seaforth	0-10	Loam----------	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	10-19	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
	19-60	Loam----------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
444---------- Canisteo	0-17	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	17-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	27-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
446A, 446B------- Normania	0-15	Loam----------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	15-25	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	25-60	Loam, clay loam	CL	A-6, A-4	0-5	90-100	85-100	80-90	55-80	30-40	8-15
447---------- Harpster	0-17	Silty clay loam	CL, CH	A-7	0	100	95-100	95-100	90-100	45-60	20-35
	17-26	Silty clay loam	CL, CH	A-7	0	100	95-100	95-100	85-100	40-60	20-35
	26-60	Silty clay loam, silt loam, loam.	CL, CH	A-6, A-7	0	100	95-100	95-100	70-100	35-55	20-35
462E---------- Sunburg	0-7	Fine sandy loam	SC, SM, SM-SC	A-4, A-2	0-5	85-95	75-95	50-80	30-50	15-30	2-10
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
523---------- Houghton	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
525---------- Muskego	0-19	Sapric material	PT	A-8	0	---	---	---	---	---	---
	19-60	Coprogenous earth	OL	A-5	0	95-100	95-100	85-100	75-96	41-50	2-8
539---------- Palms	0-27	Sapric material	PT	A-8	---	---	---	---	---	---	---
	27-60	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
548---------- Palms	0-27	Sapric material	PT	A-8	0	---	---	---	---	---	---
	27-39	Loam, silt loam, sandy clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-80	20-35	5-15
	39-60	Sand, loamy coarse sand, gravelly loamy coarse sand.	SM, SP-SM, SP, GP	A-2, A-4, A-3, A-1	0-5	60-95	40-95	20-80	2-40	---	NP
559---------- Lena	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
566---------- Regal	0-14	Loam----------	CL, CL-ML	A-4, A-6	0	95-100	85-100	65-85	50-75	25-40	5-20
	14-18	Loam, sandy clay loam, sandy loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0	95-100	85-100	60-85	35-70	20-35	5-15
	18-60	Gravelly loamy sand, gravelly coarse sand, sand.	SP, SM, SP-SM	A-1, A-2, A-3	0-5	60-95	40-85	10-75	2-30	<20	NP
611D, 611F------- Hawick	0-11	Gravelly loamy coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	11-16	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	50-95	35-70	5-25	---	NP
	16-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
613---------- Grovecity	0-16	Loam----------	CL, ML, CL-ML	A-4, A-6	0-3	95-100	85-100	65-90	50-70	20-40	2-15
	16-27	Sandy loam, fine sandy loam, loam.	SM, SC, CL, ML	A-4, A-6	0-3	95-100	85-100	50-85	35-65	<35	2-13
	27-60	Fine sandy loam, sandy loam, loam.	SM, SC, CL, ML	A-4, A-6	0-3	95-100	85-100	50-85	35-65	<35	NP-15
804B*, 804C*, 804D*, 804E*: Koronis--------	0-7	Sandy loam-------	SM, SC, SM-SC	A-4, A-2	0-5	85-100	80-95	50-80	30-50	20-30	3-10
	7-29	Sandy clay loam, loam, fine sandy loam.	SC, CL	A-6	0-5	85-100	80-95	70-90	35-70	30-40	10-20
	29-60	Sandy loam, fine sandy loam, loam.	SM-SC, SC	A-4, A-2	0-5	85-100	80-95	50-85	25-50	20-30	5-10
Hawick---------	0-10	Gravelly loamy coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	10-22	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	22-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
805B*: Wadenill--------	0-10	Loam----------	CL-ML, CL	A-4, A-6	0-5	95-100	75-95	75-90	50-70	20-35	4-15
	10-31	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
	31-60	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
Sunburg---------	0-8	Loam----------	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	15-35	5-15
	8-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
805C*, 805D*: Sunburg---------	0-8	Loam----------	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	15-35	5-15
	8-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
Wadenill--------	0-10	Fine sandy loam	SM-SC, SM, ML, CL-ML	A-4	0-5	95-100	75-95	50-80	35-60	<35	4-10
	10-31	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
	31-60	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
806C*: Guckeen---------	0-12	Silty clay loam, silty clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-60	15-25
	12-26	Silty clay, silty clay loam, clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-65	15-30
	26-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	90-98	85-95	60-75	30-50	10-25

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	
806C*:											
Arkton----------	0-9	Clay, clay loam	CH, CL	A-7	0-3	95-100	85-100	75-100	65-95	40-60	15-30
	9-27	Clay, silty clay, clay loam.	CH, CL	A-7	0-3	95-100	85-100	75-100	70-95	40-60	15-35
	27-60	Clay loam, loam	CL, CH	A-6, A-7	0-3	95-100	85-100	70-100	55-90	35-60	11-30
806D*:											
Guckeen----------	0-12	Silty clay loam, clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-60	15-25
	12-26	Silty clay, silty clay loam, clay.	MH, ML, CL, CH	A-7	0	100	95-100	95-100	80-95	40-65	15-30
	26-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	90-98	85-95	60-75	30-50	10-25
Arkton----------	0-9	Clay----------	CH, CL	A-7	0-3	90-100	85-100	75-100	65-95	40-60	15-30
	9-22	Clay, silty clay, clay loam.	CH, CL	A-7	0-3	90-100	85-100	75-100	70-95	40-60	15-35
	22-60	Clay loam, loam	CL, CH	A-6, A-7	0-3	90-100	85-100	70-100	55-90	35-60	11-30
807B*, 807C*, 807D*, 807E*:											
Koronis---------	0-8	Sandy loam, fine sandy loam.	SM, SC, SM-SC	A-4, A-2	0-5	85-100	80-95	50-80	30-50	20-30	3-10
	8-26	Sandy clay loam, loam, fine sandy loam.	SC, CL	A-6	0-5	85-100	80-95	70-90	35-70	30-40	10-20
	26-60	Sandy loam, fine sandy loam, loam.	SM-SC, SC	A-4, A-2	0-5	85-100	80-95	50-85	25-50	20-30	5-10
Sunburg---------	0-8	Loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	15-35	5-15
	8-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
809*:											
Lowlein----------	0-14	Sandy loam--------	SM, SM-SC	A-4	0	90-100	90-100	60-75	35-50	<20	NP-5
	14-24	Sandy loam, fine sandy loam.	SM, SM-SC	A-4	0	90-100	85-100	60-80	35-50	<20	NP-5
	24-31	Loamy sand, sand, fine sand.	SM, SP-SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	31-60	Loam, silt loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-100	80-90	55-80	25-40	5-15
Estherville------	0-10	Sandy loam--------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	90-100	50-75	25-50	20-30	2-10
	10-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
810*:											
Coriff----------	0-10	Loam----------	ML, CL, CL-ML	A-4	0	90-100	85-100	80-90	50-80	20-30	2-10
	10-24	Sandy loam, fine sandy loam.	SM-SC, SM	A-4	0	90-100	85-100	60-80	35-50	<20	NP-5
	24-33	Sand, fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	90-100	85-100	50-75	5-35	---	NP
	33-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	90-100	80-90	50-80	25-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
810*:											
Fieldon	0-17	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	35-50	<20	NP-5
	17-27	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	27-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
817*:											
Canisteo	0-22	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	22-30	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	30-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
Seaforth	0-10	Loam	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	10-19	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
	19-60	Loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
819B*:											
Regal	0-17	Loam	CL, CL-ML	A-4, A-6	0	95-100	85-100	65-85	50-75	25-40	5-20
	17-60	Gravelly loamy sand, gravelly coarse sand, sand.	SP, SM, SP-SM	A-1, A-2, A-3	0-5	70-95	40-85	10-75	2-30	<20	NP
Hawick	0-10	Gravelly loamy coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	10-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
833B*:											
Wadenill	0-10	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	75-95	75-90	50-70	20-35	4-15
	10-24	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
	24-60	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
Sunburg	0-7	Loam	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	15-35	5-15
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12
Hawick	0-10	Loamy coarse sand	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	10-14	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	14-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
833C*, 833D*, 833E*:											
Sunburg	0-7	Loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0-5	85-95	75-95	75-90	50-75	15-35	5-15
	7-60	Loam, fine sandy loam, sandy loam.	CL, ML, SC, SM	A-4, A-6, A-2	0-5	85-95	75-95	50-85	25-60	15-33	3-12

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
833C*, 833D*, 833E*:											
Wadenill-------	0-10	Loam----------	CL-ML, CL	A-4, A-6	0-5	95-100	75-95	75-90	50-70	20-35	4-15
	10-24	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
	24-60	Loam, sandy loam, fine sandy loam.	CL, ML, SM, SC	A-4, A-6	0-5	95-100	75-95	60-85	35-60	20-35	2-12
Hawick---------	0-10	Gravelly loamy coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	10-14	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	14-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
842*:											
Urban land.											
Udorthents.											
875B*:											
Estherville-----	0-12	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	90-100	50-75	25-50	20-30	2-10
	12-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Hawick----------	0-12	Loamy coarse sand	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	12-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
875C*:											
Hawick----------	0-10	Gravelly loamy coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	10-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
Estherville-----	0-8	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	90-100	50-75	25-50	20-30	2-10
	8-14	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	14-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
897B*:											
Seaforth--------	0-15	Loam----------	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	15-21	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
	21-60	Loam----------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
897B*:											
Swanlake--------	0-9	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	9-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
899*:											
Harps----------	0-17	Loam----------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	17-27	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
	27-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
Okoboji---------	0-10	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	10-31	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	31-36	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	36-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
927*:											
Harps----------	0-10	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	10-31	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
	31-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
Seaforth--------	0-10	Loam----------	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	10-22	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
	22-60	Loam----------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
Okoboji---------	0-26	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	26-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
954B*:											
Ves----------	0-10	Loam----------	CL, ML	A-6, A-4, A-7	0-5	90-100	90-100	80-100	60-80	30-50	7-20
	10-20	Loam, clay loam	CL	A-6, A-7	0-5	90-100	90-100	80-95	55-75	30-50	10-20
	20-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Swanlake--------	0-9	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	9-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
954C*, 954D*:											
Swanlake--------	0-9	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	9-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
Ves----------	0-10	Loam----------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	10-20	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	20-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
981*:											
Canisteo--------	0-21	Loam----------	OL, CL	A-7	0-5	98-100	95-100	85-98	60-90	40-50	15-20
	21-29	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	98-100	90-100	85-95	65-85	38-50	25-35
	29-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
981*:											
Harps----------	0-15	Loam----------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-55	15-35
	15-28	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
	28-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
999B*:											
Ves----------	0-14	Loam----------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	14-23	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	23-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Swanlake--------	0-10	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	10-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
Hawick----------	0-10	Loamy coarse sand	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	10-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
999C*:											
Swanlake--------	0-10	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	10-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	70-90	50-70	20-35	5-15
Ves----------	0-14	Loam----------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	14-23	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	23-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Hawick----------	0-10	Loamy sand-------	SM, SP-SM	A-1, A-2	0-5	85-100	80-95	40-70	10-25	---	NP
	10-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
1016. Udorthents											
1029*. Pits											
1055*, 1065B*: Aquolls.											
Histosols.											
1900*:											
Okoboji----------	0-32	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	32-43	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	43-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1900*:											
Canisteo--------	0-17	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	17-30	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-85	35-50	15-25
	30-60	Clay loam, loam	CL, SM, SC, ML	A-4, A-6	0-5	90-100	80-95	60-90	40-80	30-40	5-15
1908*:											
Biscay----------	0-20	Loam----------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	20-26	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
	26-60	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
Palms----------	0-21	Sapric material	PT	A-8	0	---	---	---	---	---	---
	21-29	Clay loam, silty clay loam, loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-80	20-35	5-15
	29-60	Loamy coarse sand, gravelly loamy coarse sand, sand.	SM, SP-SM, SP, GP	A-2, A-4, A-3, A-1	0-5	60-100	40-100	20-100	2-40	---	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
27B----------	0-16	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3	2-4
Dickinson	16-29	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.6-6.5	Low----------	0.20			
	29-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	Low----------	0.15			
35----------	0-10	18-27	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L	10-25
Blue Earth	10-60	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low----------	0.28			
39----------	0-20	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	4-6
Wadena	20-27	18-30	1.35-1.50	0.6-2.0	0.14-0.19	6.1-7.3	Low----------	0.32			
	27-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10			
41A----------	0-13	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
Estherville	13-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	18-60	0-8	1.50-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10			
84----------	0-18	35-55	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	High---------	0.28	5	4	4-8
Brownton	18-34	40-55	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	High---------	0.28			
	34-60	25-35	1.45-1.70	0.2-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28			
94----------	0-37	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	4-5
Terril	37-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32			
106B----------	0-8	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6	2-4
Lester	8-28	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.6-6.5	Moderate-----	0.28			
	28-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.37			
110----------	0-20	40-50	1.20-1.30	0.06-0.2	0.18-0.22	6.1-7.3	High---------	0.28	5	4	4-8
Marna	20-36	35-60	1.25-1.40	0.06-0.2	0.13-0.16	6.1-7.8	High---------	0.28			
	36-60	24-35	1.45-1.70	0.2-2.0	0.14-0.19	7.4-8.4	Moderate-----	0.28			
112----------	0-16	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L	4-5
Harps	16-32	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
	32-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
113----------	0-20	27-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate-----	0.24	5	6	6-7
Webster	20-28	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	28-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
114----------	0-39	27-35	1.35-1.45	0.2-0.6	0.18-0.22	6.6-7.8	Moderate-----	0.28	5	6	5-10
Glencoe	39-44	25-35	1.35-1.50	0.2-0.6	0.15-0.19	6.6-7.8	Moderate-----	0.28			
	44-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low----------	0.28			
130A----------	0-18	27-35	1.15-1.25	0.6-2.0	0.17-0.22	6.1-7.3	Moderate-----	0.24	5	6	4-8
Nicollet	18-29	24-35	1.25-1.35	0.6-2.0	0.15-0.19	6.1-7.3	Moderate-----	0.32			
	29-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
130B----------	0-10	27-35	1.15-1.25	0.6-2.0	0.17-0.22	6.1-7.3	Moderate-----	0.24	5	6	4-8
Nicollet	10-21	24-35	1.25-1.35	0.6-2.0	0.15-0.19	6.1-7.3	Moderate-----	0.32			
	21-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
134----------	0-10	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High---------	0.37	5	4	9-18
Okoboji	10-32	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37			
	32-43	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37			
	43-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28			
140----------	0-22	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L	4-8
Spicer	22-32	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37			
	32-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	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	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
230A, 230B------- Guckeen	0-14 14-28 28-60	35-50 35-50 24-40	1.20-1.30 1.25-1.35 1.35-1.85	0.2-0.6 0.06-0.6 0.06-0.6	0.16-0.19 0.13-0.16 0.15-0.17	6.1-7.3 6.1-7.3 7.4-8.4	Moderate----- Moderate----- Moderate-----	0.28 0.28 0.37	3	4	4-6
238B, 238C------- Kilkenny	0-9 9-36 36-60	27-30 35-45 25-35	1.15-1.25 1.25-1.35 1.35-1.45	0.2-0.6 0.2-0.6 0.2-2.0	0.17-0.19 0.15-0.19 0.14-0.16	5.6-6.5 5.6-6.5 7.4-7.8	Moderate----- Moderate----- Moderate-----	0.28 0.28 0.37	5	6	2-4
336-------------- Delft	0-30 30-36 36-60	24-27 18-32 15-32	1.40-1.65 1.30-1.40 1.40-1.55	0.2-2.0 0.2-0.6 0.2-2.0	0.18-0.20 0.19-0.22 0.15-0.19	6.1-7.8 6.6-7.8 7.4-8.4	Moderate----- Low---------- Low----------	0.24 0.32 0.32	5	6	4-8
392-------------- Biscay	0-18 18-28 28-60	18-27 18-30 1-6	1.20-1.30 1.25-1.35 1.55-1.65	0.6-2.0 0.6-2.0 6.0-20	0.20-0.22 0.17-0.19 0.02-0.04	6.1-7.8 6.6-7.8 7.4-8.4	Moderate----- Moderate----- Low----------	0.28 0.28 0.10	4	6	4-8
399-------------- Biscay	0-21 21-30 30-60	18-27 18-30 1-6	1.20-1.30 1.25-1.35 1.55-1.65	0.6-2.0 0.6-2.0 6.0-20	0.20-0.22 0.17-0.19 0.02-0.04	6.1-7.8 6.6-7.8 7.4-8.4	Moderate----- Moderate----- Low----------	0.28 0.28 0.10	4	6	4-8
413-------------- Osakis	0-12 12-18 18-60	8-18 8-18 0-5	1.30-1.50 1.30-1.50 1.50-1.70	2.0-6.0 2.0-6.0 6.0-20	0.14-0.18 0.14-0.19 0.02-0.04	6.1-7.3 6.1-7.3 7.4-8.4	Low---------- Low---------- Low----------	0.28 0.28 0.10	3	3	2-4
423-------------- Seaforth	0-10 10-19 19-60	20-27 26-30 20-27	1.30-1.45 1.30-1.50 1.35-1.60	0.6-2.0 0.6-2.0 0.6-2.0	0.20-0.22 0.17-0.19 0.17-0.19	7.4-8.4 7.4-8.4 7.4-8.4	Moderate----- Low---------- Low----------	0.28 0.28 0.28	5	4L	4-6
444-------------- Canisteo	0-17 17-27 27-60	27-35 20-35 22-32	1.20-1.30 1.35-1.50 1.45-1.60	0.6-2.0 0.6-2.0 0.6-2.0	0.20-0.22 0.15-0.19 0.14-0.16	7.4-8.4 7.4-8.4 7.4-8.4	Moderate----- Moderate----- Low----------	0.32 0.32 0.32	5	4L	4-8
446A, 446B------- Normania	0-15 15-25 25-60	22-27 22-32 22-32	1.20-1.35 1.30-1.40 1.40-1.50	0.6-2.0 0.6-2.0 0.6-2.0	0.20-0.23 0.17-0.19 0.17-0.19	6.1-7.3 6.1-7.8 7.4-8.4	Moderate----- Moderate----- Low----------	0.24 0.24 0.32	5	6	4-8
447-------------- Harpster	0-17 17-26 26-60	27-35 27-35 22-35	1.05-1.25 1.20-1.50 1.25-1.55	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.24 0.18-0.22 0.17-0.22	7.4-8.4 7.4-8.4 7.4-8.4	Moderate----- Moderate----- Moderate-----	0.28 0.28 0.28	5	4L	5-6
462E------------- Sunburg	0-7 7-60	12-20 10-18	1.35-1.55 1.40-1.60	2.0-6.0 2.0-6.0	0.16-0.18 0.11-0.19	7.4-8.4 7.4-8.4	Low---------- Low----------	0.24 0.24	5	3	1-4
523-------------- Houghton	0-60	---	0.15-0.45	0.2-6.0	0.35-0.45	6.1-7.3	----------	----	2	2	>70
525-------------- Muskego	0-19 19-60	2-4 18-35	0.10-0.21 0.30-1.10	2.0-6.0 0.06-0.2	0.35-0.45 0.18-0.24	5.6-7.3 7.4-8.4	---------- Moderate-----	---- 0.28	2	2	>50
539-------------- Palms	0-27 27-60	--- 7-27	0.25-0.45 1.45-1.75	0.2-6.0 0.6-2.0	0.35-0.45 0.14-0.22	5.6-7.8 6.6-8.4	---------- Low----------	---- ----	2	2	>75
548-------------- Palms	0-27 27-39 39-60	--- 7-35 0-10	0.25-0.45 1.45-1.70 1.50-1.65	0.2-6.0 0.6-2.0 6.0-20	0.35-0.45 0.16-0.20 0.04-0.10	5.6-7.8 6.6-7.8 7.4-7.8	---------- Moderate----- Low----------	---- ---- ----	2	2	>75
559-------------- Lena	0-60	---	0.15-0.45	0.2-6.0	0.35-0.45	7.4-8.4	----------	----	3	3	>60
566-------------- Regal	0-14 14-18 18-60	18-27 15-27 0-5	1.20-1.40 1.30-1.55 1.50-1.65	0.6-2.0 0.6-2.0 6.0-20	0.17-0.22 0.15-0.20 0.02-0.06	6.6-8.4 7.4-8.4 7.4-8.4	Low---------- Low---------- Low----------	0.24 0.24 0.10	3	4L	6-8
611D, 611F------- Hawick	0-11 11-16 16-60	2-10 1-10 1-5	1.50-1.65 1.50-1.65 1.55-1.65	6.0-20 >6.0 >20	0.03-0.10 0.03-0.10 0.02-0.06	6.1-7.8 6.1-7.8 7.4-8.4	Low---------- Low---------- Low----------	0.10 0.10 0.10	3	8	1-2

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
613----------	0-16	12-22	1.30-1.50	2.0-6.0	0.20-0.22	6.1-7.3	Low----------	0.20	5	4	4-8
Grovecity	16-27	10-18	1.30-1.55	2.0-6.0	0.12-0.19	6.1-7.8	Low----------	0.20			
	27-60	8-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.20			
804B*, 804C*, 804D*, 804E*:											
Koronis--------	0-7	6-16	1.25-1.45	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	5	3	1-4
	7-29	18-24	1.30-1.50	0.6-6.0	0.15-0.19	5.6-7.3	Low----------	0.28			
	29-60	12-20	1.35-1.60	2.0-6.0	0.11-0.16	7.4-8.4	Low----------	0.28			
Hawick---------	0-10	2-10	1.50-1.65	6.0-20	0.03-0.10	6.1-7.8	Low----------	0.10	3	8	1-3
	10-22	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	22-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
805B*:											
Wadenill--------	0-10	12-22	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	5	4-5
	10-31	8-18	1.30-1.55	2.0-6.0	0.12-0.19	6.1-7.3	Low----------	0.24			
	31-60	8-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.28			
Sunburg---------	0-8	14-22	1.30-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.24	5	4L	1-4
	8-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.24			
805C*, 805D*:											
Sunburg---------	0-8	14-22	1.30-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.24	5	4L	1-4
	8-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.24			
Wadenill--------	0-10	12-20	1.35-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low----------	0.24	5	3	2-5
	10-31	8-18	1.30-1.55	2.0-6.0	0.12-0.19	6.1-7.3	Low----------	0.24			
	31-60	8-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.28			
806C*:											
Guckeen---------	0-12	35-50	1.20-1.30	0.2-0.6	0.16-0.19	6.1-7.3	Moderate-----	0.28	3	7	4-6
	12-26	35-50	1.25-1.35	0.06-0.6	0.13-0.16	6.1-7.3	Moderate-----	0.28			
	26-60	24-40	1.35-1.85	0.06-0.6	0.15-0.17	7.4-8.4	Moderate-----	0.37			
Arkton----------	0-9	30-45	1.30-1.60	0.2-0.6	0.13-0.19	6.6-8.4	Moderate-----	0.24	5	4	2-5
	9-27	30-45	1.40-1.70	0.2-0.6	0.10-0.19	7.4-8.4	Moderate-----	0.24			
	27-60	25-40	1.55-1.80	0.2-0.6	0.13-0.19	7.4-8.4	Moderate-----	0.37			
806D*:											
Guckeen---------	0-12	35-50	1.20-1.30	0.2-0.6	0.16-0.19	6.1-7.3	Moderate-----	0.28	3	7	4-6
	12-26	35-50	1.25-1.35	0.06-0.6	0.13-0.16	6.1-7.3	Moderate-----	0.28			
	26-60	24-40	1.35-1.85	0.06-0.6	0.15-0.17	7.4-8.4	Moderate-----	0.37			
Arkton----------	0-9	40-45	1.30-1.60	0.2-0.6	0.13-0.19	6.6-8.4	Moderate-----	0.24	5	4	2-5
	9-22	30-45	1.40-1.70	0.2-0.6	0.10-0.19	7.4-8.4	Moderate-----	0.24			
	22-60	25-40	1.55-1.80	0.2-0.6	0.13-0.19	7.4-8.4	Moderate-----	0.37			
807B*, 807C*, 807D*, 807E*:											
Koronis--------	0-8	6-16	1.25-1.45	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	5	3	1-4
	8-26	18-24	1.30-1.50	0.6-6.0	0.15-0.19	5.6-7.3	Low----------	0.28			
	26-60	12-20	1.35-1.60	2.0-6.0	0.11-0.16	7.4-8.4	Low----------	0.28			
Sunburg---------	0-8	12-22	1.30-1.55	0.6-6.0	0.16-0.22	7.4-8.4	Low----------	0.24	5	4L	1-4
	8-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.24			
809*:											
Lowlein---------	0-14	10-18	1.30-1.50	2.0-6.0	0.13-0.15	6.1-7.3	Low----------	0.20	5	3	4-7
	14-24	10-18	1.35-1.45	2.0-6.0	0.12-0.14	6.1-7.3	Low----------	0.24			
	24-31	1-10	1.55-1.65	6.0-20	0.06-0.11	6.1-7.3	Low----------	0.15			
	31-60	18-27	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
809*:											
Estherville-----	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
	10-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	18-60	0-8	1.50-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10			
810*:											
Coriff----------	0-10	12-20	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	6-8
	10-24	10-18	1.35-1.45	2.0-6.0	0.12-0.15	7.4-8.4	Low----------	0.20			
	24-33	1-10	1.50-1.70	6.0-20	0.09-0.14	7.4-8.4	Low----------	0.20			
	33-60	18-35	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Fieldon---------	0-17	10-18	1.30-1.50	2.0-6.0	0.15-0.17	7.4-8.4	Low----------	0.20	5	3	4-7
	17-27	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	Low----------	0.20			
	27-60	5-15	1.40-1.60	6.0-20	0.05-0.07	7.4-8.4	Low----------	0.20			
817*:											
Canisteo--------	0-22	27-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L	4-8
	22-30	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32			
	30-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32			
Seaforth--------	0-10	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.28	5	4L	4-6
	10-19	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28			
	19-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28			
819B*:											
Regal-----------	0-17	18-30	1.20-1.40	0.6-2.0	0.17-0.22	6.6-8.4	Low----------	0.24	3	4L	6-9
	17-60	0-5	1.50-1.65	6.0-20	0.02-0.06	7.4-8.4	Low----------	0.10			
Hawick----------	0-10	2-10	1.50-1.65	6.0-20	0.03-0.10	6.1-7.8	Low----------	0.10	3	8	1-3
	10-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
833B*:											
Wadenill--------	0-10	12-22	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	5	2-5
	10-24	8-18	1.30-1.55	2.0-6.0	0.12-0.19	6.1-7.3	Low----------	0.24			
	24-60	8-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.28			
Sunburg---------	0-7	14-22	1.30-1.50	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.24	5	4L	1-4
	7-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.24			
Hawick----------	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low----------	0.17	3	2	1-3
	10-14	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	14-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
833C*, 833D*, 833E*:											
Sunburg---------	0-7	14-22	1.30-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.24	5	4L	1-4
	7-60	10-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.24			
Wadenill--------	0-10	12-22	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	5	2-5
	10-24	8-18	1.30-1.55	2.0-6.0	0.12-0.19	6.1-7.3	Low----------	0.24			
	24-60	8-18	1.40-1.60	2.0-6.0	0.11-0.19	7.4-8.4	Low----------	0.28			
Hawick----------	0-10	2-10	1.50-1.65	6.0-20	0.03-0.10	6.1-7.8	Low----------	0.10	3	8	1-3
	10-14	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	14-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
842*:											
Urban land.											
Udorthents.											
875B*:											
Estherville-----	0-12	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
	12-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	18-60	0-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
875B*:											
Hawick	0-12	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low	0.17	3	2	1-3
	12-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low	0.10			
875C*:											
Hawick	0-10	2-10	1.50-1.65	6.0-20	0.03-0.10	6.1-7.8	Low	0.10	3	8	1-4
	10-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low	0.10			
Estherville	0-8	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	2-4
	8-14	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	14-60	0-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low	0.10			
897B*:											
Seaforth	0-15	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.28	5	4L	4-6
	15-21	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
	21-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
Swanlake	0-9	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	9-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
899*:											
Harps	0-17	25-27	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L	4-5
	17-27	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
	27-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
Okoboji	0-10	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High	0.37	5	4	9-15
	10-31	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37			
	31-36	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-7.8	High	0.37			
	36-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
927*:											
Harps	0-10	27-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L	4-6
	10-31	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
	31-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
Seaforth	0-10	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.28	5	4L	4-6
	10-22	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
	22-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
Okoboji	0-26	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High	0.37	5	4	9-15
	26-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37			
954B*:											
Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	10-20	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	20-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Swanlake	0-9	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	9-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
954C*, 954D*:											
Swanlake	0-9	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	9-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Ves	0-10	20-27	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	10-20	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	20-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
981*:											
Canisteo	0-21	22-27	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
	21-29	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	29-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	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	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
981*:											
Harps	0-15	25-27	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L	4-5
	15-28	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
	28-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
999B*:											
Ves	0-14	20-27	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	14-23	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	23-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Swanlake	0-10	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	10-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Hawick	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low	0.17	3	2	1-3
	10-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low	0.10			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low	0.10			
999C*:											
Swanlake	0-10	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	10-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Ves	0-14	20-27	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	14-23	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	23-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Hawick	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low	0.17	3	2	1-3
	10-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low	0.10			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low	0.10			
1016. Udorthents											
1029*. Pits											
1055*, 1065B*: Aquolls.											
Histosols.											
1900*:											
Okoboji	0-32	35-40	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High	0.37	5	4	9-18
	32-43	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37			
	43-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
Canisteo	0-17	27-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.32	5	4L	4-8
	17-30	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	30-60	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low	0.32			
1908*:											
Biscay	0-20	18-27	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate	0.28	4	6	4-8
	20-26	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.28			
	26-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.10			
Palms	0-21	---	0.25-0.45	0.2-6.0	0.35-0.45	5.6-7.8	---	---	2	2	>75
	21-29	7-35	1.45-1.70	0.6-2.0	0.16-0.20	6.1-7.8	Moderate	---			
	29-60	0-10	1.50-1.65	2.0-20	0.04-0.10	7.4-7.8	Low	---			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "occasional," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
27B---------- Dickinson	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
35---------- Blue Earth	B/D	None--------	---	---	+2-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
39---------- Wadena	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
41A---------- Estherville	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
84---------- Brownton	C/D	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	---	High-----	High-----	Low.
94---------- Terril	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
106B---------- Lester	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
110---------- Marna	C/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
112---------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
113---------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
114---------- Glencoe	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
130A, 130B-------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jun	---	High-----	High-----	Low.
134---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
140---------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
230A, 230B-------- Guckeen	C	None--------	---	---	2.0-3.5	Apparent	Mar-Jun	---	High-----	High-----	Low.
238B, 238C-------- Kilkenny	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Moderate.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
336---------- Delft	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
392---------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	Moderate	Low.
399---------- Biscay	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	Moderate	Low.
413---------- Osakis	B	None--------	---	---	3.0-6.0	Apparent	Nov-Jun	---	Moderate	Low------	Low.
423---------- Seaforth	B	None--------	---	---	3.0-6.0	Apparent	Mar-Jun	---	High-----	High-----	Low.
444---------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
446A, 446B-------- Normania	B	None--------	---	---	3.0-6.0	Apparent	Mar-Jun	---	High-----	High-----	Low.
447---------- Harpster	B/D	None--------	---	---	1.0-2.0	Apparent	Mar-Jun	---	High-----	High-----	Low.
462E---------- Sunburg	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
523---------- Houghton	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	55-60	High-----	High-----	Low.
525---------- Muskego	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	35-45	High-----	Moderate	Moderate.
539---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	25-32	High-----	High-----	Moderate.
548---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	25-30	High-----	High-----	High.
559---------- Lena	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	50-90	High-----	High-----	Low.
566---------- Regal	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	Moderate	High-----	Low.
611D, 611F-------- Hawick	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
613---------- Grovecity	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jun	---	High-----	Moderate	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
804B*, 804C*, 804D*, 804E*:											
Koronis	B	None	---	---	>6.0	---	---	---	Moderate	Low	Moderate.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
805B*:											
Wadenill	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Sunburg	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
805C*, 805D*:											
Sunburg	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Wadenill	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
806C*, 806D*:											
Guckeen	C	None	---	---	3.5-5.0	Apparent	Mar-Jun	---	High	High	Low.
Arkton	C	None	---	---	3.0-6.0	Apparent	Mar-Jun	---	High	High	Low.
807B*, 807C*, 807D*, 807E*:											
Koronis	B	None	---	---	>6.0	---	---	---	Moderate	Low	Moderate.
Sunburg	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
809*:											
Lowlein	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	---	Moderate	Moderate	Low.
Estherville	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
810*:											
Coriff	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
Fieldon	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
817*:											
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	---	High	High	Low.
819B*:											
Regal	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	Moderate	High	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
833B*:											
Wadenill	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
833B*:											
Sunburg	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
833C*, 833D*, 833E*:											
Sunburg	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Wadenill	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
842*:											
Urban land.											
Udorthents.											
875B*:											
Estherville	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
875C*:											
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
Estherville	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
897B*:											
Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	---	High	High	Low.
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
899*:											
Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jun	---	High	High	Low.
927*:											
Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	---	High	High	Low.
Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jun	---	High	High	Low.
954B*:											
Ves	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
954B*:											
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
954C*, 954D*:											
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
981*:											
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
999B*:											
Ves	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
999C*:											
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
Hawick	A	None	---	---	>6.0	---	---	---	Low	Low	Low.
1016. Udorthents											
1029*. Pits											
1055*, 1065B*: Aquolls.											
Histosols.											
1900*:											
Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jun	---	High	High	Low.
Canisteo	B/D	None	---	---	+1-1.0	Apparent	Nov-Jun	---	High	High	Low.
1908*:											
Biscay	B/D	Occasional	Brief	Nov-May	+1-1.0	Apparent	Jan-Dec	---	High	Moderate	Low.
Palms	A/D	None	---	---	+1-1.0	Apparent	Jan-Dec	25-30	High	High	High.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquolls	Loamy, mixed, mesic Haplaquolls
Arkton	Fine-loamy, mixed, mesic Aquic Hapludolls
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Brownton	Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Coriff	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fieldon	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Grovecity	Coarse-loamy, mixed, mesic Aquic Hapludolls
Guckeen	Fine, montmorillonitic, mesic Aquic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Harpster	Fine-silty, mesic Typic Calciaquolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
Histosols	Euic, mesic Histosols
Houghton	Euic, mesic Typic Medisaprists
Kilkenny	Fine, montmorillonitic, mesic Mollic Hapludalfs
Koronis	Fine-loamy, mixed, mesic Mollic Hapludalfs
Lena	Euic, mesic Typic Medisaprists
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Lowlein	Coarse-loamy, mixed, mesic Typic Hapludolls
Marna	Fine, montmorillonitic, mesic Typic Haplaquolls
Muskego	Coprogenous, euic, mesic Limnic Medisaprists
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Osakis	Sandy, mixed Aquic Haploborolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Regal	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Sunburg	Coarse-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Udorthents	Loamy, mesic Udorthents
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Wadenill	Coarse-loamy, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls

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