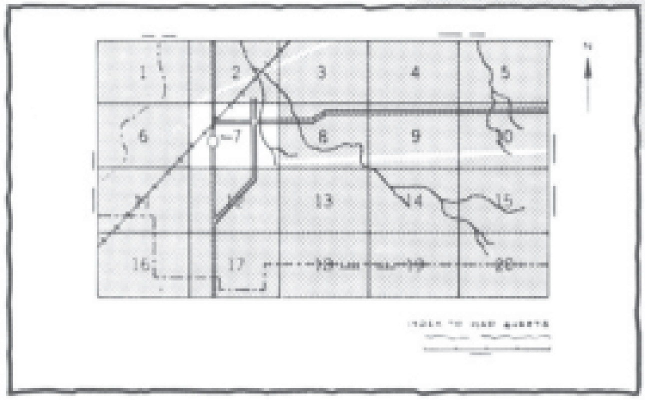
SOIL SURVEY OF

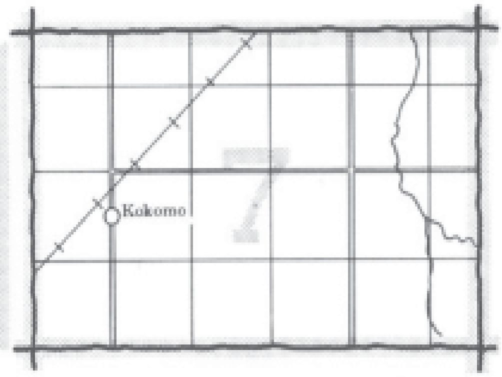
CHIPPEWA COUNTY, MINNESOTA

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

HOW TO USE

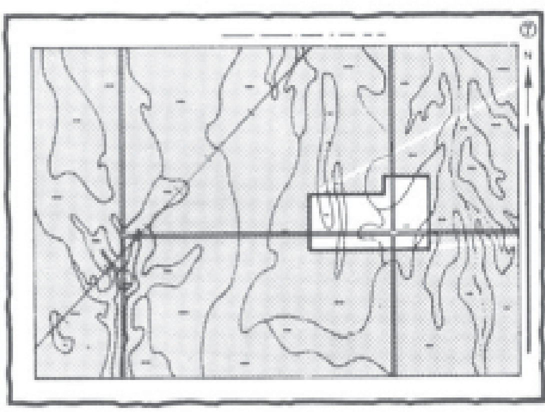
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

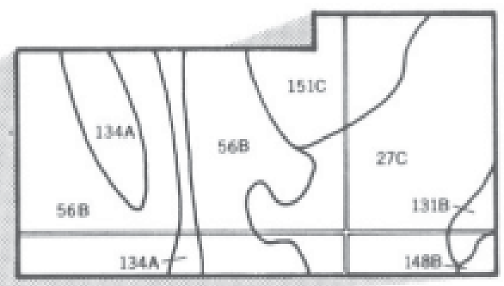




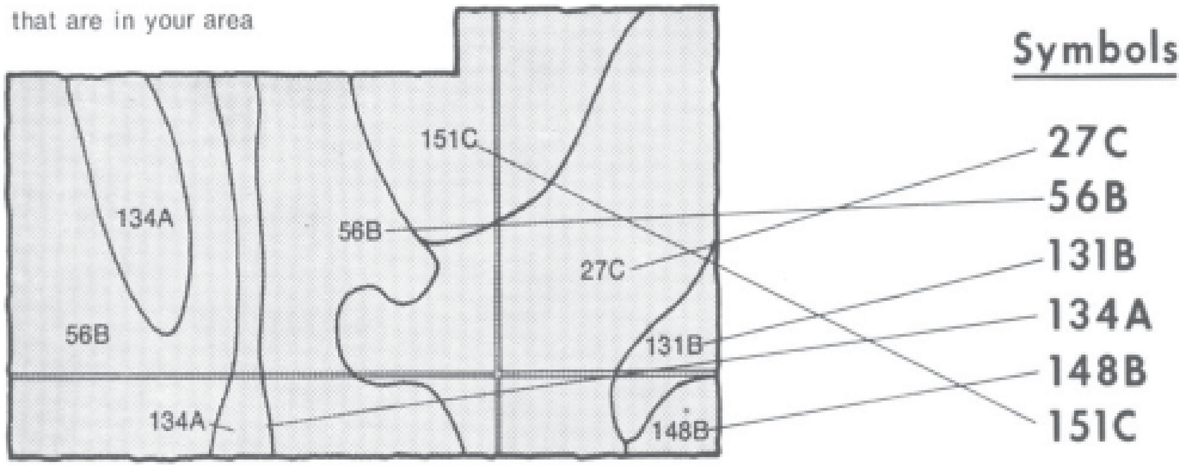
2. Note the number of the map sheet and turn to that sheet.

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



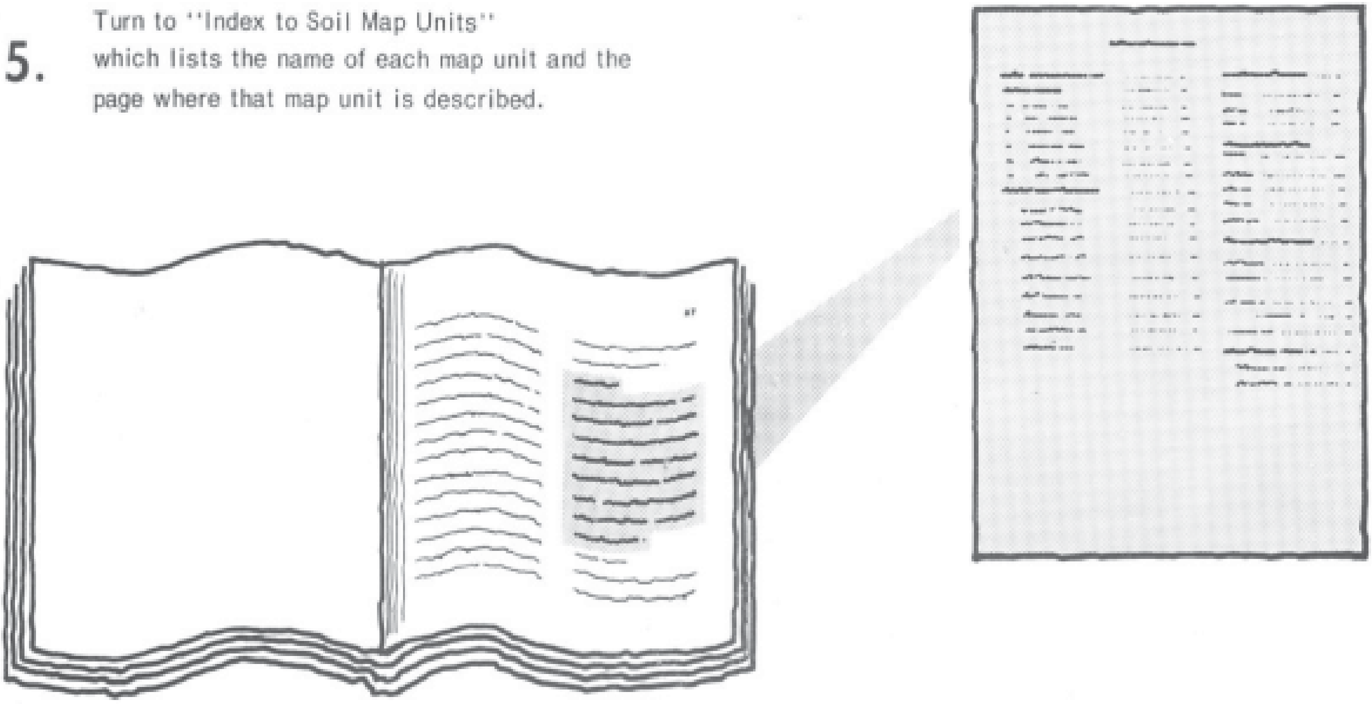


4. List the map unit symbols that are in your area

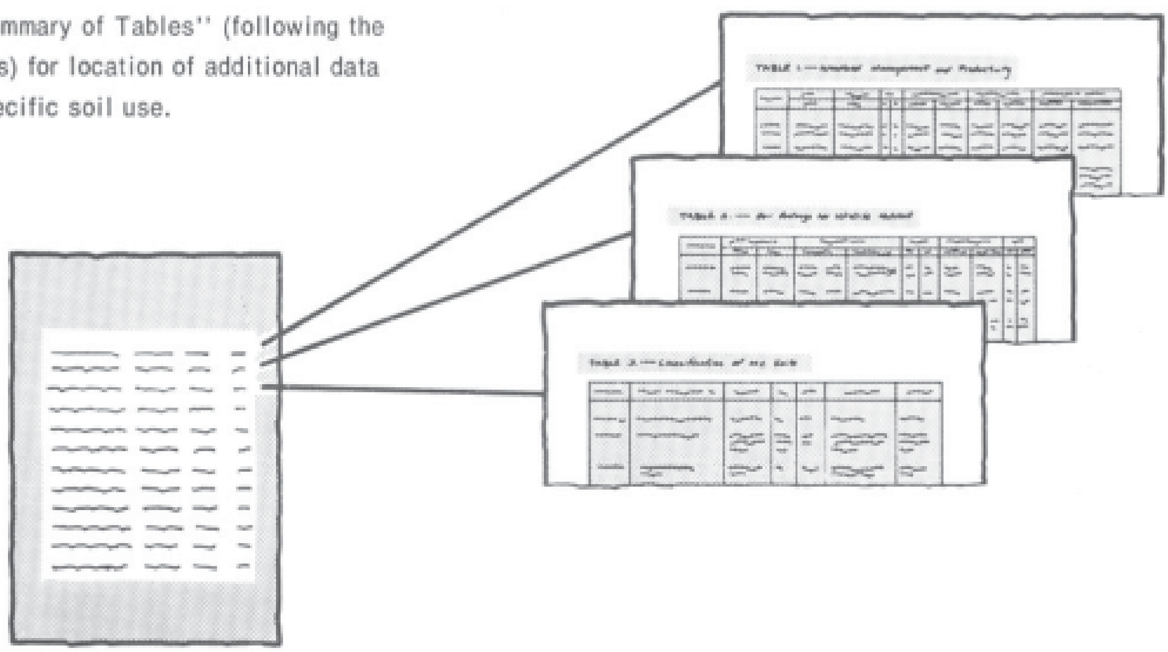


THIS SOIL SURVEY

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 is a publication of the National Cooperative Soil Survey. It is the result of a joint effort of the United States Department of Agriculture, Soil Conservation Service, and the Minnesota Agricultural Experiment Station, in cooperation with the Agricultural Extension Service, the Soil and Water Conservation Board, and the Chippewa County Soil and Water Conservation District. The survey was partly funded by the Legislative Commission for Minnesota Resources and by Chippewa County. It is part of the technical assistance furnished to the Chippewa County Soil and Water Conservation District. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1975-79. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

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.

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soil series

Issued January 1982

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summary of tables

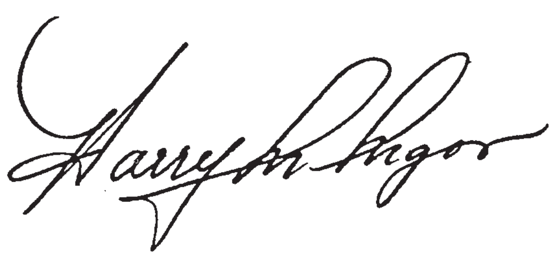
foreword

This soil survey contains information that can be used in land-planning programs in Chippewa 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, ranchers, 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 insure 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.



Harry M. Major
State Conservationist
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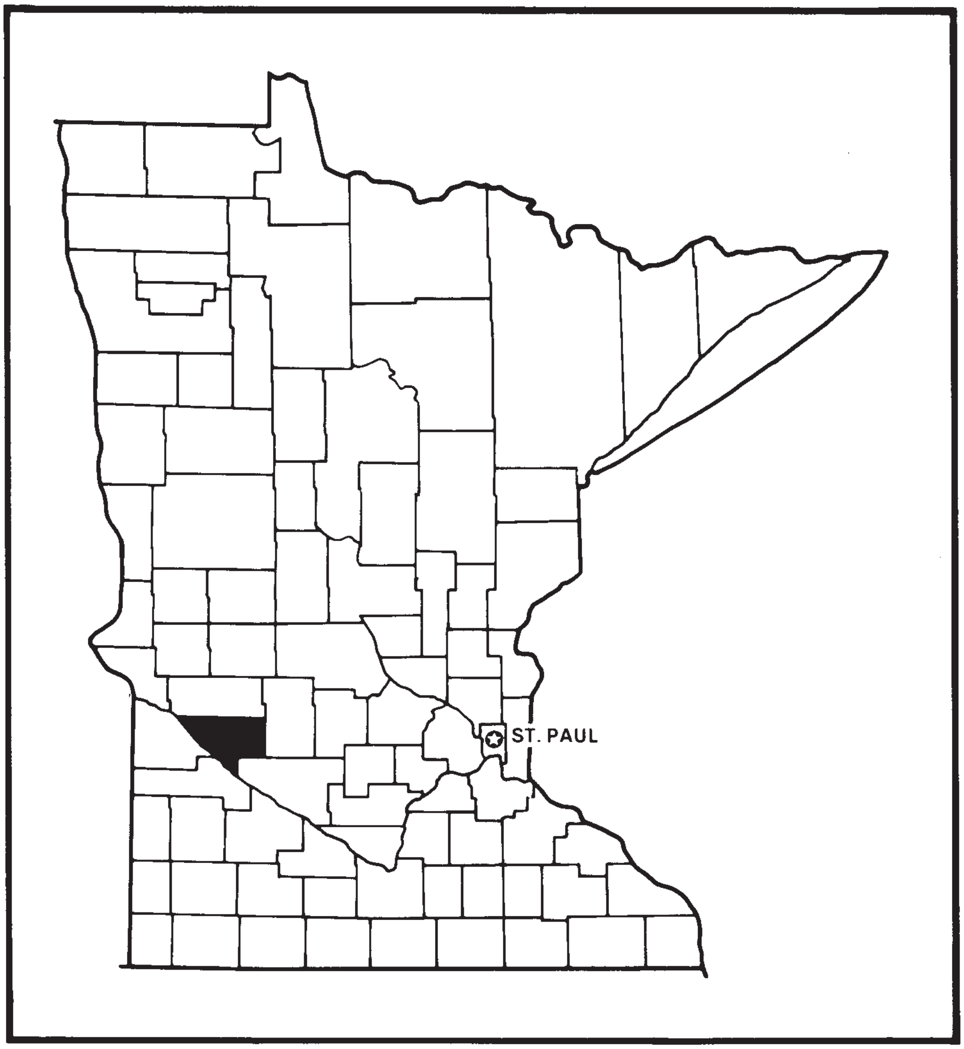

Location of Chippewa County in Minnesota.

soil survey of
Chippewa County, Minnesota

By William H. Brug, Jr., Soil Conservation Service

Fieldwork by William H. Brug, Jr., Raymond C. Genrich, Thomas C. Jackson, and Gary D. Nelson, Soil Conservation Service, and Douglas Miller and Paul G. Rem, Minnesota Agricultural Experiment Station

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

CHIPPEWA COUNTY is in the west-central part of Minnesota. It was established in 1862 and has a total area of 374,400 acres, or 585 square miles. In 1970, the population of Chippewa County was 15,109. Montevideo, the county seat, had a population of 5,661. Other cities and towns in Chippewa County are Big Bend City, Clara City, East Granite Falls, Gluek, Hagen, Maynard, Milan, Montevideo, Watson, and Wegdahl.

The surface features of Chippewa County are the result of glaciation. The glaciers shaped the landscape to gently rolling prairie. The soils are dark colored and nearly level to steep. They formed in glacial till or in water-deposited material that derived from the glacial till. The original vegetation was tall and medium prairie grasses.

The region was originally inhabited by Dakota (Sioux) Indians. Early traders and missionaries traveled up the Minnesota River to work with the Indians. Settlers followed, and conflicts arose that led to the Sioux uprising in 1862. In 1870, 1,300 acres of prairie were in cultivation. By the end of 1880, more than 40,000 acres had been plowed.

general nature of the county

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

climate

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

Chippewa County is cold in winter and is quite hot with occasional cool spells in summer. Snowstorms are frequent in winter. In the warm months, showers are often heavy when warm moist air moves in from the south. The total annual rainfall normally is adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Milan, Minnesota, in the period 1951 to 1975. 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 4 degrees. The lowest temperature on record, which occurred at Milan on January 19, 1970, is -38 degrees. In summer the average temperature is 69 degrees, and the average daily maximum temperature is 81 degrees. The highest recorded temperature, which occurred at Milan on July 29, 1975, is 103 degrees.

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

The total annual precipitation is 24 inches. Of this, 19 inches, or 75 percent, usually falls in April through September, which includes the growing season for most crops. 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 4.33 inches at Milan on June 29, 1971. In normal nears, rainfall generally is adequate for all crops. However, nearly every year some part of the county receives less than adequate moisture because precipitation in midsummer is mainly from thunderstorms. Drought is a serious problem in the affected areas, especially if the available water capacity of the soil is moderate or low. Even if the available water capacity is high, crops are adversely affected when the moisture reserves in the subsoil and underlying material are depleted.

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

Average seasonal snowfall is 40 inches. The greatest snow depth at any one time during the period of record was 40 inches. On an average of 54 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 14 miles per hour, in April.

farming

Farms in Chippewa County are decreasing in number as the average farm size increases. The number of farms dropped from 1,351 in 1964 to 1,215 in 1977. During this period, the average size of farms increased from 256 acres to 300 acres. More than 87 percent of the land area was farmed in 1978. Agriculture produces most of the income in the county.

Modern technogical advances have brought increased yields and changes in the kind of crops grown in Chippewa County. Corn is the most important crop, followed by soybeans. The trend has been toward a smaller total acreage in alfalfa and flax and a larger acreage in wheat, sunflowers, and sugar beets.

The number of farms that specialize in cash crops has increased. The number of dairy cows has declined. Beef cattle and pork production fluctuates; the trend is toward fewer but larger operations.

For additional information on farming see "Crops and pasture."

transportation and markets

One railway in the western part of the county serves Milan, Watson, Montevideo, Wegdahl, and Granite Falls. Another railway serves Granite Falls, Maynard, and Clara City. Several truck lines also serve the county.

The major highways are paved or blacktopped. U. S. Highway 59 runs parallel to the western border of the county. State Highways 7, 29, 277, 23, and 40 serve parts of the county. Graveled or blacktopped county or township roads serve the farms.

Livestock generally are taken by truck to Sioux Falls or South St. Paul. Grain elevators are located in all of the cities in the county. Most of the milk produced is marketed as whole milk and transported by truck to Litchfield.

water supply

The water supply of Chippewa County is drawn from three major sources: sand and gravel deposits in glacial drift, sedimentary rocks of Cretaceous age, and Precambrian rocks.

Hydrologic investigations by the United States Geological Survey show that ground water potential is best in the sand and gravel deposits in the glacial drift. Most municipal wells in Chippewa County are in these sand and gravel deposits. The thickest deposits have more aquifers and are the best source for municipal wells. The water in most of these wells is hard. It contains a high concentration of dissolved solids, mainly calcium, magnesium, and sulfates. The Cretaceous sedimentary rocks and the Precambrian rocks commonly yield only small amounts of water.

Livestock watering pits have been dug on bottom lands and in other areas of poorly drained soils. Farm ponds have been constructed on intermittent streams and drainageways. Some pits and ponds are spring-fed. This water is not suitable for domestic use.

physiography, relief, and drainage

Glacial ice once moved across the area that is now Chippewa County (*5*). The surface of the county is glacial till or water-worked glacial material 100 to 300 feet thick. The deposits are thickest in the northeastern corner of the county and are thinnest in the southwestern part of the county. This glacial material overlies preglacial sandstone and shale, which are underlain by granite and metamorphic rock. This rock outcrops in the Minnesota River Valley and in the Chippewa River Valley north of Montevideo.

The landform in Chippewa County is mostly a nearly level to undulating ground moraine (*3*). The surface in the eastern part of the county is largely silty and clayey lacustrine material. A large, nearly level, post-glacial lake deposit is in the central part of the county. In the northwestern corner of the county there is a large, nearly level to rolling, sandy outwash delta. Its slopes are irregular and generally are less than 150 feet long.

The Minnesota River Valley forms the western border of the county. The Minnesota River is at an elevation of 931 feet above sea level at the northwestern corner of the county and drops to 868 feet at the southern tip. Outside the Minnesota River Valley, the elevation averages 1,050 feet above sea level, gradually rising in an easterly direction. The highest point, near the southeastern corner of the county, is 1,142 feet.

The last glacial advance of ice to cover this area, the Des Moines Lobe, melted about 10,000 years ago; therefore, the surface drainage network is relatively young. Many marshy areas existed before the land was drained for cultivation.

The entire area of the county drains into the Minnesota River. Hawk Creek drains the southeastern part of the county and runs into the Minnesota River. Shakopee Creek drains the northeastern part of the county, and Dryweather Creek drains the central part. Both of these creeks flow into the Chippewa River. The Chippewa River and a number of small creeks drain the western third of the county. Other small creeks flow into the Minnesota River. An extensive system of county ditches and tile lines has modified the water flow.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, engineers, planners, developers and builders, home buyers, and others.

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general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units 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 map unit 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 or refinements in soil series concepts, and of differences in the range in slope that is used in different survey areas, some of the boundaries and soil series names on the general soil map of Chippewa County do not match those on the general soil maps of adjacent counties.

The general soil map units in this survey area have been grouped for broad interpretative purposes. Each of the broad groups and the map units in each group are described on the following pages.

Soils that formed dominantly in loamy glacial till or in a mantle of silty and loamy material over loamy glacial till; on uplands

These are nearly level to undulating, well drained to poorly drained soils that formed under prairie vegetation.

Three map units in Chippewa County make up this group. The main use is intensive farming, but the stony soils in the Ves-Canisteo map unit are largely used as pasture.

1. Canisteo-Seaforth-Doland

Nearly level to undulating, poorly drained, moderately well drained, and well drained silty soils

The soils in this map unit are on a ground moraine (fig. 1). In some places, a mantle of silty lacustrine material covers the moraine. The areas are broad and nearly level and are interspersed with drainageways and closed depressions. Many low knolls are scattered throughout. Slopes range from 0 to 6 percent.

This map unit makes up about 8 percent of the county. It is about 40 percent Canisteo soils, 25 percent Seaforth soils, 10 percent Doland soils, and 25 percent minor soils.

Canisteo soils are nearly level. They are on broad flats and on the rim of depressions. These soils are poorly drained and calcareous. The surface soil is black silty clay loam about 15 inches thick. The subsoil is dark gray, mottled silty clay loam about 9 inches thick. The underlying material is grayish brown and light olive brown, mottled, loamy glacial till.

Seaforth soils are very gently sloping. They are on knolls that are 1 to 5 feet high. These soils are moderately well drained and calcareous. The surface soil is silt loam about 11 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is brown silt loam about 8 inches thick. The underlying material is light olive brown, mottled loam.

Doland soils are undulating. They are on side slopes and on the upper part of knolls. They are well drained. The surface layer is very dark gray silt loam about 10 inches thick. The subsoil is dark grayish brown, friable silt loam about 10 inches thick. The underlying material is brown and light olive brown, calcareous, loamy glacial till.

Of minor extent in this map unit are Swanlake, Webster, Spicer, and Quam soils. The loamy Swanlake soils are near the Doland soils and typically are in higher positions on the landscape. The noncalcareous Webster soils are on small upland flats. Spicer and Quam soils are very poorly drained and are in depressions within the larger areas of Canisteo soils.

Nearly all the acreage is used for cultivated crops. Corn and soybeans are the major crops. Small grains and alfalfa are grown on small acreages. The soils are well suited to all cultivated crops commonly grown in the county. Erosion is a hazard on Doland soils. Wetness and a high content of lime are concerns on Canisteo and Seaforth soils. In some areas where the content of lime is especially high, special applications of fertilizer are needed to correct a fertility imbalance. Tile and surface ditches help drain Canisteo and Seaforth soils and some included soils that are wet. Maintaining tilth and fertility and controlling water erosion and soil blowing are other management concerns. In most places, the content of organic matter and the available water capacity are high.

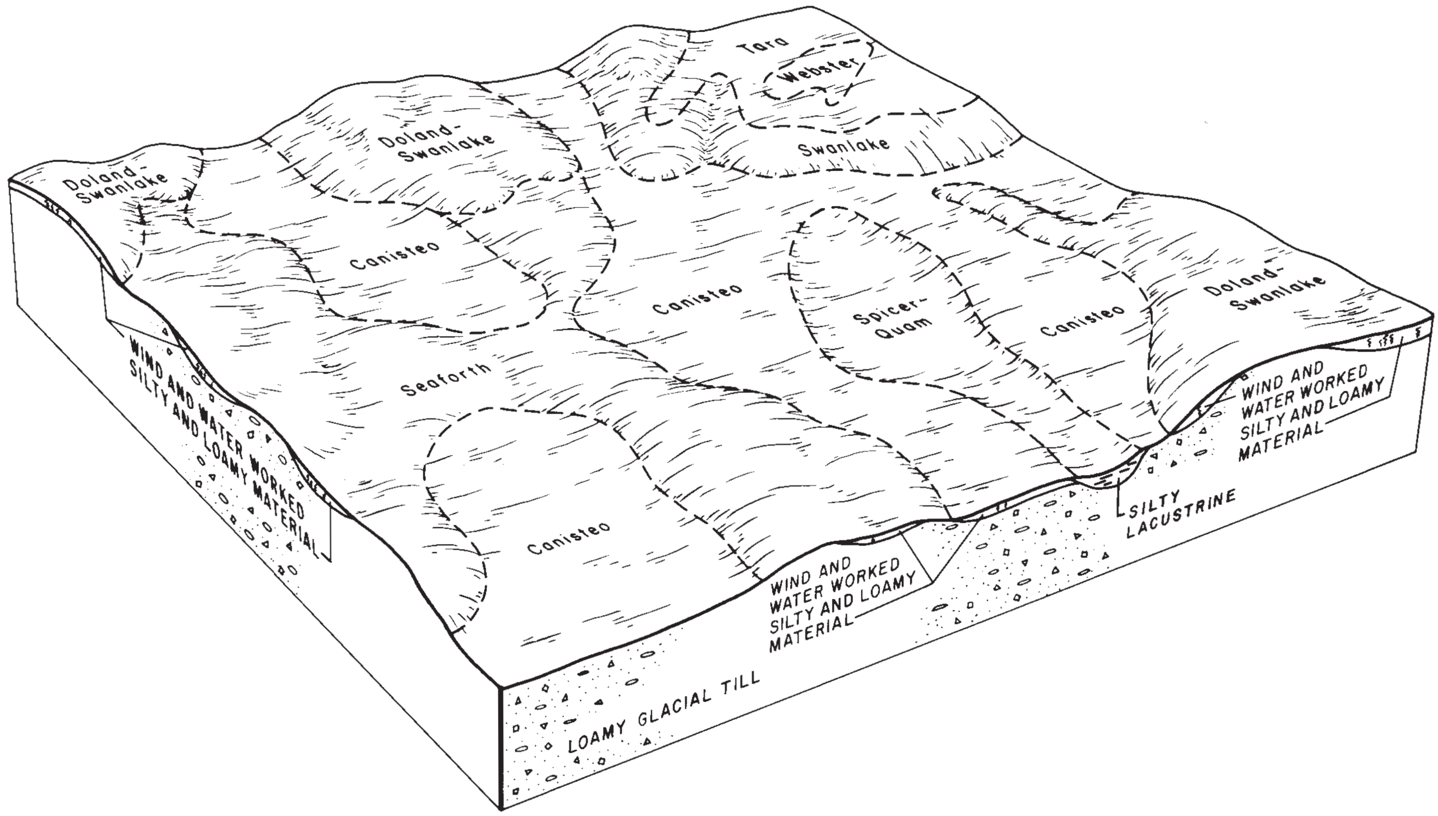

Figure 1.—Pattern of soils and underlying material in the Canisteo-Seaforth-Doland map unit.

Canisteo and Seaforth soils generally are poorly suited to building site development and sanitary facilities because of wetness. The seasonal high water table is within a depth of 6 feet. Doland soils are well suited to most of these uses. However, they are moderately limited for septic tank absorption fields by the moderate permeability.

2. Ves-Canisteo

Gently undulating and nearly level, well drained and poorly drained, stony loamy soils

The soils in this map unit are on an erosional terrace that parallels the Minnesota River. The terrace is about 40 feet higher than the valley floor. The soils are on many low knolls separated by drainageways and on small, nearly level flats. Many stones and boulders are on the surface. Slopes range from 0 to 6 percent.

This map unit makes up about 1 percent of the county. It is about 60 percent Ves stony loams, 18 percent Canisteo stony loams, and 22 percent minor soils.

Ves stony loams are gently undulating. They are on the knolls on the higher part of the landscape. Ves soils are well drained. The surface layer is black stony loam about 10 inches thick. The subsoil is dark yellowish brown loam about 9 inches thick. The underlying material is light olive brown, calcareous, loamy glacial till.

Canisteo stony loams are nearly level. They are in the shallow drainageways and on the small, nearly level flats. Canisteo soils are poorly drained and calcareous. The surface soil is stony loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark grayish brown, mottled loam about 8 inches thick. The underlying material is yellowish brown, mottled, clayey and loamy glacial till.

Of minor extent in this map unit are Storden stony loams and Egeland, Sverdrup, and Webster soils. Storden stony loams are on the steepest part of the hillside in the map unit. Egeland and Sverdrup soils are on ridges and have sandy underlying material. Webster soils are poorly drained and are on small, nearly level flats.

The soils in this map unit are used mainly as pasture. The soils are well suited to this use. Stones on the surface and in the upper layers are the main limitation to use of these soils as cropland. The soils are suited to intensive cropping if the stones and boulders are removed and if internal drainage is provided for the Canisteo soils. The stony Canisteo soils have a high water table and a high content of lime. Tile is needed for subsurface drainage, and special applications of fertilizer may be needed to correct a fertility imbalance caused by the high content of lime. In most places, the available water capacity and the content of organic matter are high.

Ves soils are well suited to use as a site for sanitary facilities and for building site development. However, removing stones may cause difficulty in construction. Canisteo soils are poorly suited to these uses because of the seasonal high water table.

3. Ves-Tara

Nearly level and gently sloping, well drained and moderately well drained loamy and silty soils

The soils in this map unit are on a ground moraine that in places has a mantle of silty lacustrine material (fig. 2). The landscape consists of knolls and ridges that are separated by swales and drainageways. Depressions are common. Slopes range from 0 to 6 percent.

This map unit makes up about 11 percent of the county. It is about 20 percent Ves and similar soils, 18 percent Tara and similar soils, and 62 percent minor soils.

Ves soils are gently sloping. They are on the knolls and ridges on the higher part of the landscape. Ves soils are well drained. They are leached of carbonates in the upper 18 inches. The surface layer is black loam about 10 inches thick. The subsoil is brown clay loam about 8 inches thick. The underlying material is light olive brown, calcareous, loamy glacial till.

Tara soils are nearly level. They are on the broad uplands and on slightly concave foot slopes and lower side slopes. Tara soils are moderately well drained. They are leached of carbonates in the upper 20 to 30 inches. The surface soil is about 18 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is about 13 inches thick. The subsoil is dark grayish brown silty clay loam in the upper part and light olive brown, calcareous silt loam in the lower part. The underlying material is light brownish gray and light olive brown, calcareous, loamy glacial till.

Of minor extent in this map unit are Storden, Canisteo, Colvin, and Spicer soils, and soils similar to Storden soils. Storden soils are well drained and are on the steeper side slopes along drainageways. Canisteo soils are poorly drained and are in drainageways and on flats. Colvin soils are poorly drained, and Spicer soils are very poorly drained. Colvin and Spicer soils are in depressions.

Nearly all the acreage of this map unit is used for cultivated crops. Corn and soybeans are the major

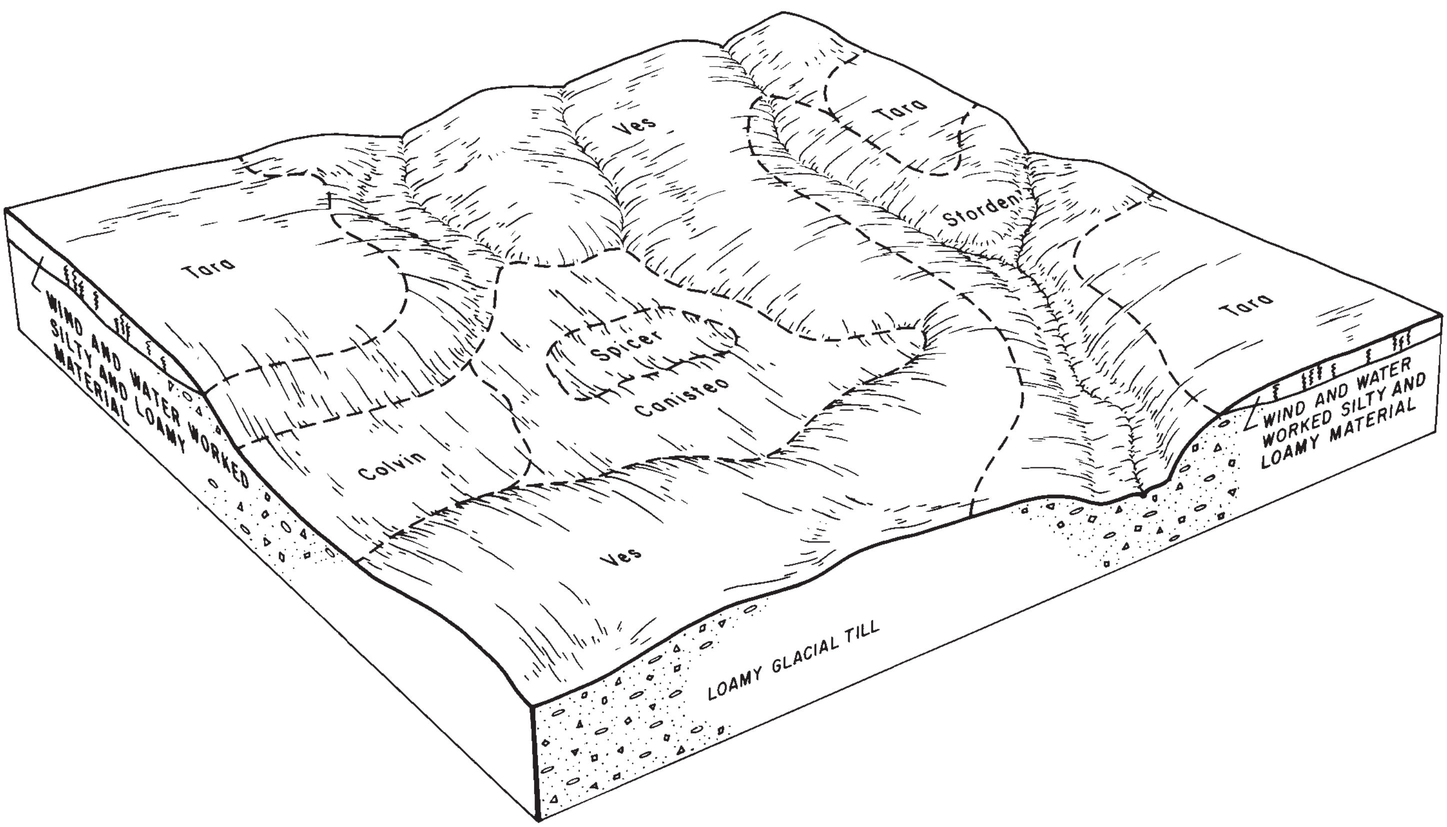

Figure 2.—Pattern of soils and underlying material in the Ves-Tara map unit.

crops. Small grains and alfalfa are also grown. The soils are well suited to all the cultivated crops commonly grown in the county. Tara soils have few limitations for use as cropland and can be cropped intensively. Erosion is a hazard on Ves soils. Maintaining tilth and fertility are other management concerns. In most places, the content of organic matter is moderate or high, and the available water capacity is high or very high.

Ves soils are well suited to building site development and onsite sanitary facilities. Tara soils have fair suitability for these uses. The seasonal high water table at 3 to 5 feet below the surface is the main limitation to the use of Tara soils as a site for buildings or sanitary facilities.

Soils that formed dominantly in silty or loamy alluvium or in loamy glacial till; on flood plains and uplands

These are nearly level, steep and very steep, poorly drained, well drained, and moderately well drained soils that formed under mixed deciduous trees and prairie grasses. They are mainly in the valleys of the Chippewa and Minnesota Rivers.

The soils in this group are largely wooded and are used as pasture. In addition, they can be used compatibly for recreation and as habitat for wildlife.

4. Calco-Swanlake-Du Page

Nearly level, steep, and very steep, poorly drained, well drained, and moderately well drained silty and loamy soils

The soils in this map unit are on the nearly level bottom lands and the adjacent steep and very steep valley walls along the Chippewa and Minnesota Rivers (fig. 3). The bottom lands are on two levels. Drainageways dissect the valley walls. Slopes are 0 to 2 percent on the bottom lands and 6 to 40 percent on the valley walls.

This map unit makes up about 3 percent of the county. It is about 34 percent Calco soils and similar soils, 18 percent Swanlake soils, 10 percent Du Page soils, and 38 percent minor soils.

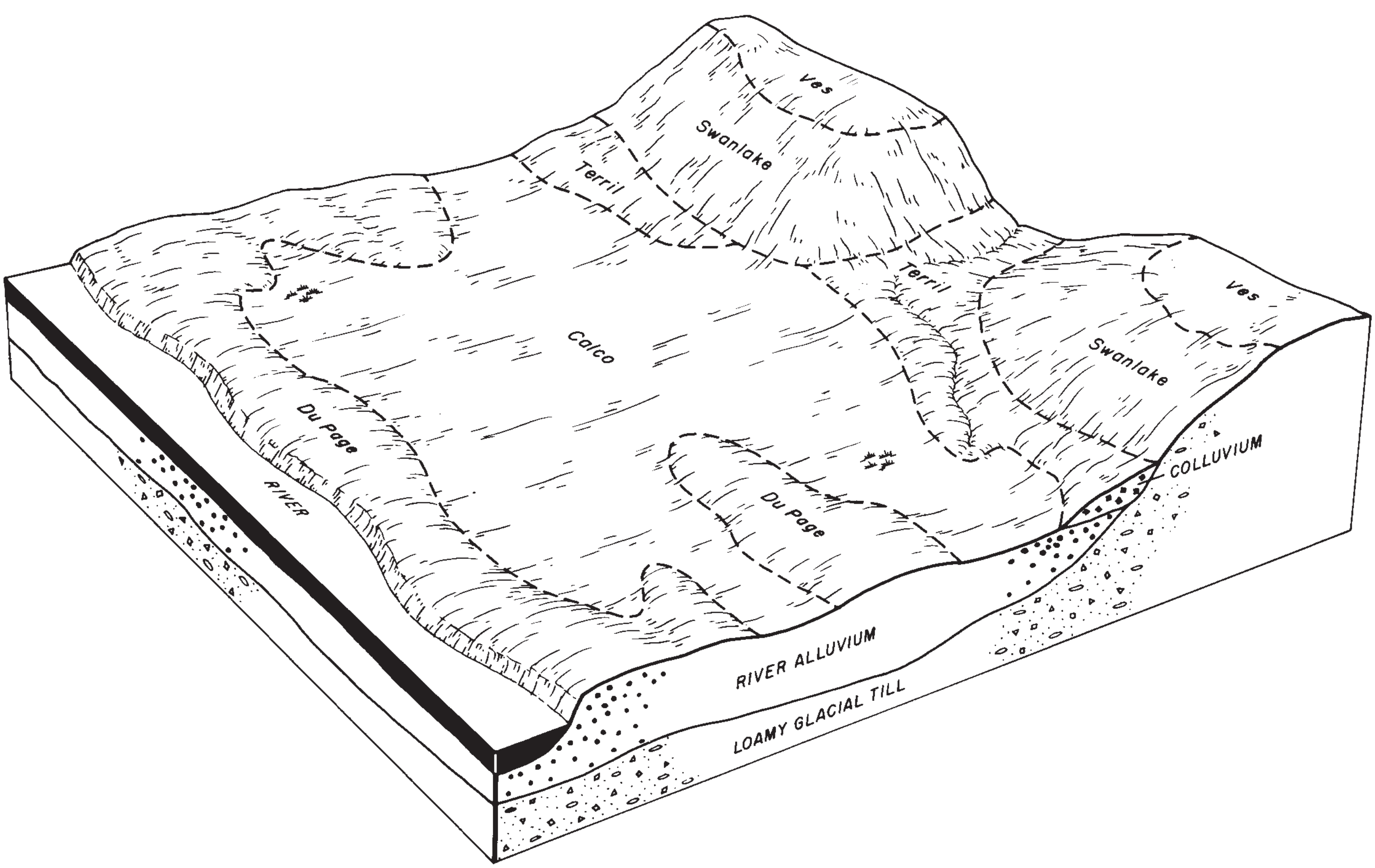

Figure 3.—Pattern of soils and underlying material in the Calco-Swanlake-Du Page map unit.

Calco soils are nearly level. They are typically on lower levels of the flood plain. Calco soils are poorly drained and calcareous. They formed in silty material that was deposited by floodwater. The surface soil is silty clay loam about 37 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark gray silty clay loam about 9 inches thick. The underlying material is dark olive gray, mottled, silty clay loam alluvium.

Swanlake soils are steep and very steep. They are on valley side slopes. Swanlake soils are well drained. Free carbonates are common throughout the profile. The surface layer is very dark gray loam about 9 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The underlying material is yellowish brown loam that grades to clay loam.

Du Page soils are nearly level. They are on slightly higher levels of the flood plain. They are moderately well drained and calcareous. The surface soil is loam about 36 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The underlying material is very dark grayish brown, mottled loam.

Of minor extent in this map unit are Storden, Doland, Terril, and Copaston soils. Storden and Doland soils are well drained and are on steep side slopes adjacent to Swanlake soils. Terril soils are moderately well drained and are on concave foot slopes. Copaston soils are well drained and are on the valley floor. Also included in this map unit are areas of marshy soils on the bottom lands.

The soils in this map unit are largely wooded and are mainly used as pasture. They have fair suitability for this use. In some small areas, Calco and Du Page soils are used for corn and soybeans. They are well suited to this use. The Swanlake soils generally are too steep to be used as cropland. Flooding on Calco and Du Page soils can damage crops in some years. Another concern in management is the high content of lime in the Calco soils, which can cause a fertility imbalance. Maintaining soil tilth and fertility are major concerns in management. The content of organic matter is moderate to high, and the available water capacity is high or very high.

Calco and Du Page soils are poorly suited to sites for houses and septic tank absorption fields because of flooding. Before roads are constructed on these soils, onsite investigation is needed to determine the need for diverting floodwater. Swanlake soils have severe limitations as a site for buildings and sanitary facilities because of the steep slopes.

Soils that formed dominantly in wind- and water-deposited silty material; on uplands

These are very gently sloping and nearly level, moderately well drained, somewhat poorly drained, and very poorly drained silty soils that formed in wind- and water-deposited material over glacial till. They formed under prairie vegetation.

The soils in this group are farmed intensively.

5. Waubay-Glyndon-Quam

Very gently sloping and nearly level, moderately well drained, somewhat poorly drained, and very poorly drained silty soils

The soils in this map unit are on a broad upland glacial till plain that has a mantle of silty lacustrine or wind-deposited material (fig. 4). The soils are on low knolls and in swales between the knolls. Small depressions are scattered throughout. Slopes range from 0 to 3 percent.

This map unit makes up about 13 percent of the county. It is about 27 percent Waubay and similar soils, 15 percent Glyndon soils, 15 percent Quam soils, and 43 percent minor soils.

Waubay soils are very gently sloping and nearly level. They are on side slopes and in swales. Waubay soils are moderately well drained. Carbonates have been leached out in the upper 20 to 36 inches. The surface soil is about 17 inches thick. The upper part is black silty clay loam, and the lower part is very dark gray silty clay loam. The subsoil is dark grayish brown silty clay loam about 10 inches thick. The underlying material is light olive brown, mottled, calcareous silt loam.

Glyndon soils are nearly level. They are on low knolls and on the rim around depressions. Glyndon soils are moderately well drained and somewhat poorly drained, and they are calcareous. They have a surface layer of black silt loam about 10 inches thick. The upper part of the underlying material is mottled, light olive brown silt loam. The lower part is light olive brown, mottled silty clay loam.

Quam soils are nearly level. They are in depressions. Quam soils are very poorly drained, and the surface has been leached of carbonates. Quam soils are subject to ponding. The surface soil is silty clay loam about 36 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is olive gray, mottled silt loam that has thin layers of sand and silt.

Of minor extent in this map unit are Doland, Perella, Swanlake, and Spicer soils. Doland and Swanlake soils are well drained and are on the upper part of knolls and on side slopes. The poorly drained Perella soils and the very poorly drained Spicer soils are in depressional areas.

Nearly all the acreage of this map unit is used for cultivated crops. Corn and soybeans are the major crops, but the soils are well suited to all the crops commonly grown in the county. Waubay soils have few limitations to use as cropland and can be cropped intensively. Glyndon and Quam soils are excessively moist, and tile and subsurface drainage is needed on these soils. Glyndon soils have a high content of calcium carbonate in the root zone. Maintaining soil tilth and fertility is one of the management concerns. In most places, the content of organic matter and the available water capacity are high.

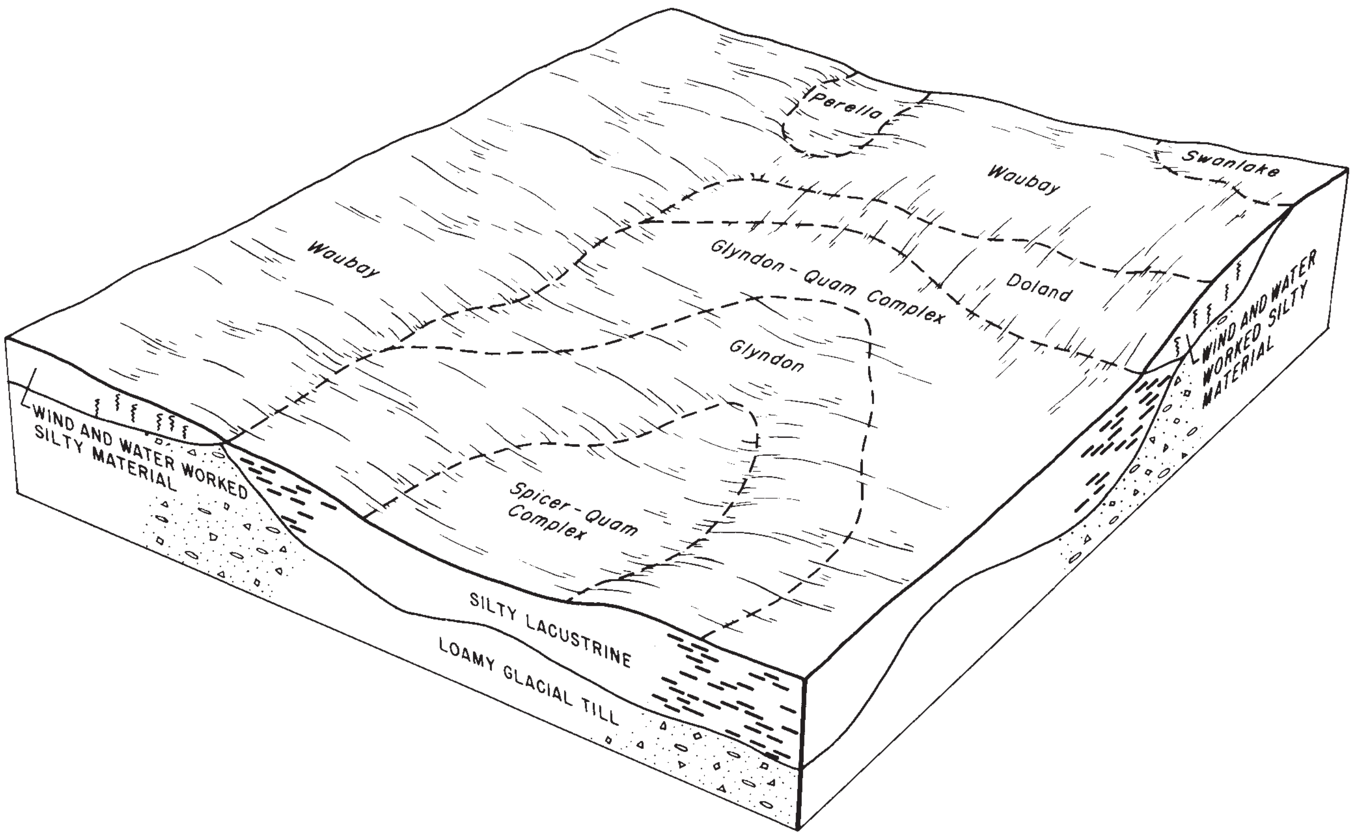

Figure 4.—Pattern of soils and underlying material in the Waubay-Glyndon-Quam map unit.

Waubay soils have fair suitability for building site development and sanitary facilities. Drainage or special precautions are needed because of the seasonal high water table. Glyndon and Quam soils generally are not used for building site development or sanitary facilities because of wetness and the hazard of ponding on Quam soils.

Soils that formed dominantly in silty and clayey lacustrine materials; on uplands

These are nearly level and very gently sloping, very poorly drained to moderately well drained soils that formed under prairie vegetation.

Four map units in Chippewa County make up this group. The main use is intensive farming.

6. Colvin-Spicer-Tara

Nearly level and very gently sloping, poorly drained, very poorly drained, and moderately well drained silty soils

The soils in this map unit are on a broad glacial till upland plain. The plain is dominantly covered with wind- and water-deposited silty and clayey material. It consists of broad flats, swales, and low knolls. Closed depressions are common. Slopes range from 0 to 6 percent.

This map unit makes up 32 percent of the county. It is about 45 percent Colvin and Spicer soils, 20 percent Tara soils, and 35 percent minor soils.

Colvin soils are nearly level. They are on the low knolls and on the rim of depressions. Colvin soils are poorly drained and calcareous. They are on the higher parts of the microrelief. The surface soil is black silty clay loam about 15 inches thick. The underlying material is dark gray and grayish brown, mottled silt loam over light olive brown, mottled silty clay loam.

Spicer soils are nearly level. They are in closed depressions. Spicer soils are very poorly drained, and they are calcareous. They are subject to ponding. The surface soil is silty clay loam about 19 inches thick. It is black at the surface and very dark gray in the lower part. The subsoil is olive gray silt loam and silty clay loam about 20 inches thick. The underlying material is light olive gray, mottled silty clay loam.

Tara soils are very gently sloping. They are on broad flats and on low knolls. Tara soils are moderately well drained. Carbonates have been leached out in the upper 20 to 36 inches. The surface layer is black silty clay loam about 8 inches thick. The subsurface layer is about

10 inches thick. It is black silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is about 13 inches thick. It is dark grayish brown silt loam in the upper part and light olive brown, calcareous silt loam in the lower part. The underlying material is light brownish gray and light olive brown, calcareous loamy glacial till.

Of minor extent in this map unit are Doland, Seaforth, and Quam soils. Doland soils are well drained, and Seaforth soils are moderately well drained; both soils are on low knolls. Quam soils are very poorly drained and are in depressions on the lowest part of the landscape.

Nearly all the acreage of this map unit is used for cultivated crops. Corn and soybeans are the major crops; small grains and alfalfa are also grown. If the Colvin and Spicer soils are artificially drained, these soils are well suited to all of the cultivated crops commonly grown in the county. Tara soils have few limitations for crops and can be cropped intensively. Spicer soils are subject to ponding. Colvin and Spicer soils have a high content of calcium carbonate in the root zone and may require special applications of fertilizer to correct a nutrient imbalance. Maintaining soil tilth and fertility are other management concerns. In most places, the organic matter content and the available water capacity are high.

Colvin and Spicer soils are poorly suited to sanitary facilities and building site development because of the seasonal high water table at or near the surface. Tara soils are poorly suited to septic tank absorption fields and have fair suitability for building site development because of the seasonal high water table at a depth of 3 to 5 feet.

7. Colvin-Spicer-Glyndon

Nearly level, poorly drained, very poorly drained, and somewhat poorly drained silty soils

The soils in this map unit are on a ground moraine that has a mantle of silty and clayey lacustrine material (fig. 5). The areas are broad and have slight rises. The rises are separated by shallow swales. Many closed depressions are scattered throughout. Slopes dominantly range from 0 to 2 percent. This map unit includes small scattered areas of very gently sloping and gently sloping soils.

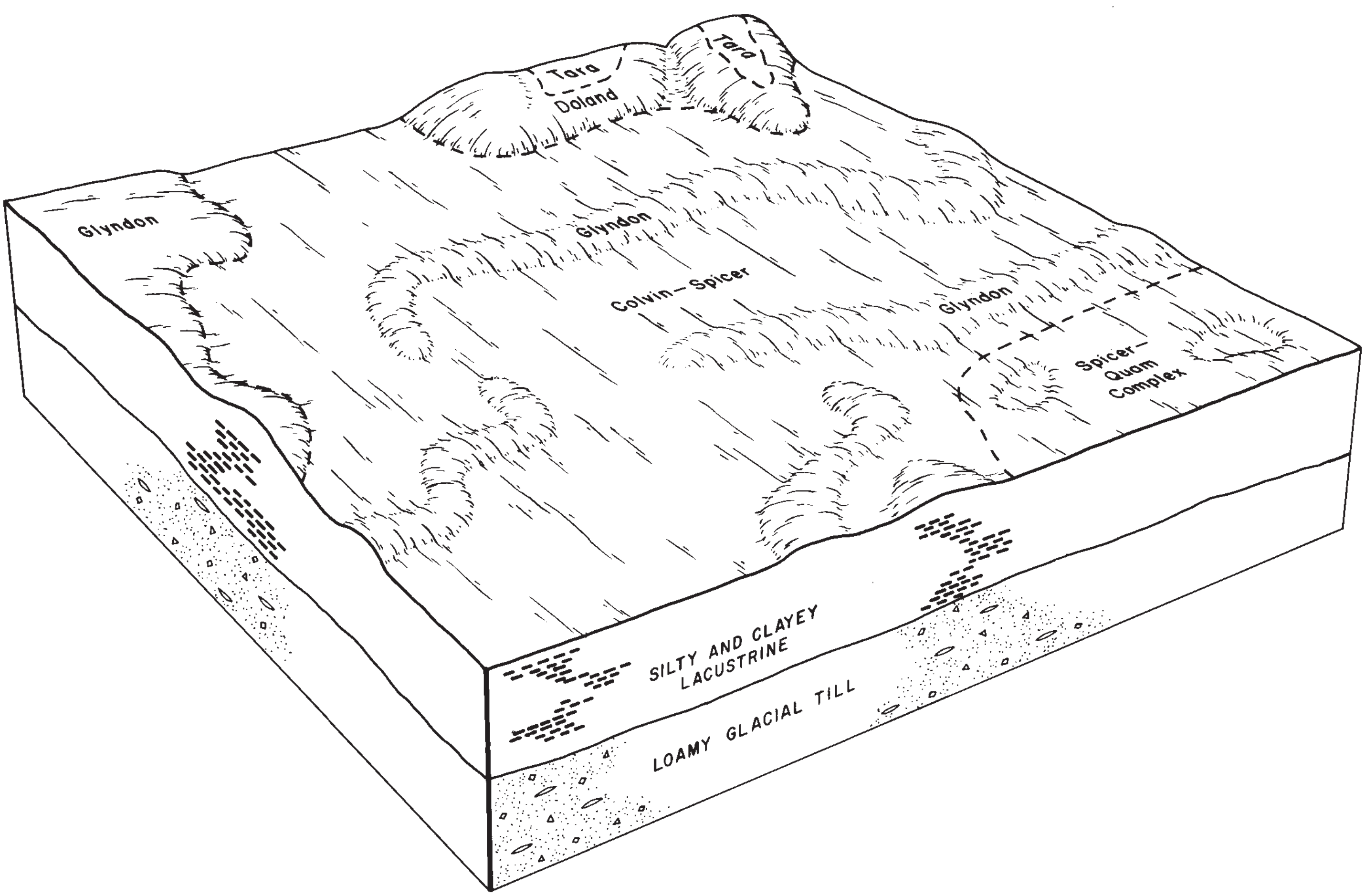

Figure 5.—Pattern of soils and underlying material in the Colvin-Spicer-Glyndon map unit.

This map unit makes up about 16 percent of the county. It is about 40 percent Colvin soils, Spicer soils, and similar soils, 12 percent Glyndon soils, and 48 percent other soils.

Colvin soils are nearly level. They are on low rises and on the rim of depressions. Colvin soils are poorly drained and calcareous. The surface soil is black silty clay loam about 15 inches thick. The underlying material is dark gray and grayish brown silt loam over light olive brown, mottled silty clay loam.

Spicer soils are nearly level. They are in depressions and swales. Spicer soils are very poorly drained, and they are calcareous. They are subject to ponding. The surface soil is silty clay loam about 19 inches thick. It is black at the surface and very dark gray in the lower part. The subsoil is olive gray silt loam and silty clay loam about 20 inches thick. The underlying material is light olive gray, mottled silty clay loam.

Glyndon soils are nearly level. They are mostly on low rises. Glyndon soils are somewhat poorly drained and calcareous. The surface layer is black silt loam 10 inches thick. The underlying material is light olive brown, mottled silt loam and silty clay loam.

Of minor extent in this map unit are Doland, Tara, and Quam soils. Doland soils are well drained, and Tara soils are moderately well drained. Doland and Tara soils are on knolls and on side slopes on the higher part of the landscape. Quam soils are very poorly drained and are in the center of depressions.

Nearly all the acreage is used for cultivated crops. Corn and soybeans are the major crops. Small grains and alfalfa are also grown. If these soils are adequately drained, they are well suited to all the cultivated crops commonly grown in the county. Wetness and ponding are the main limitations, and tile and surface drainage are needed on cropland. These soils have a high content of carbonates and may require special applications of fertilizer to correct a nutrient imbalance. Controlling soil blowing and maintaining tilth and fertility are other management concerns. In most places, the content of organic matter and the available water capacity are high.

These soils are poorly suited to sanitary facilities because of wetness. They have fair suitability for building site development. Drainage is needed if these soils are used for these purposes.

8. Perella-Colvin

Nearly level, poorly drained silty soils

The soils in this map unit are on a glacial lake plain in the central part of the county. The areas are broad and are characterized by many low rises, depressions, and shallow swales. Slopes dominantly range from 0 to 2 percent. This map unit includes small scattered areas of very gently sloping soils.

This map unit makes up about 5 percent of the county. It is about 30 percent Perella soils, 20 percent Colvin soils, and 50 percent minor soils.

Perella soils are nearly level. They are in swales and slight depressions. Perella soils are poorly drained and are subject to ponding. The surface soil is black silty clay loam about 16 inches thick. The subsoil is dark grayish brown and olive silty clay loam about 9 inches thick. The underlying material is light olive gray and olive gray, mottled silt loam.

Colvin soils are nearly level. They are on low rises and on the rim of depressions. Colvin soils are poorly drained. The surface soil is black silty clay loam about 15 inches thick. The underlying material is dark gray and grayish brown, mottled silt loam to a depth of 43 inches. Below that, it is light olive brown silty clay loam.

Of minor extent in this map unit are Tara, Quam, and Waubay soils. Tara and Waubay soils are moderately well drained. They are on knolls and side slopes on the higher parts of the landscape. Quam soils are very poorly drained and are in the center of the depressions.

Nearly all the acreage is used for cultivated crops. Corn and soybeans are the major crops. Small grains and alfalfa are also grown. These soils are well suited to use as cropland if they are adequately drained. Wetness and ponding are the main limitations, and tile and surface drainage systems are needed for crops. The high content of carbonates may require special applications of fertilizer to correct a nutrient imbalance. Maintaining soil tilth is also a concern. In most areas, the content of organic matter and the available water capacity are high.

These soils generally are not used for sanitary facilities because of wetness and the ponding on the Perella soils. They have fair suitability for building site development, but drainage is needed if they are used for this purpose.

9. McDonaldsville

Nearly level, poorly drained clayey soils

The soils in this map unit are on a glacial lakebed in the Chippewa River Valley in the north-central part of the county. Slopes are dominantly 0 to 2 percent. This map unit includes small scattered areas of very gently sloping and gently sloping soils.

This map unit makes up about 1 percent of the county. It is about 70 percent McDonaldsville soils and 30 percent minor soils.

McDonaldsville soils are nearly level. They are on a glacial lakebed that is underlain by calcareous, sandy outwash deposits. McDonaldsville soils are poorly drained. The surface soil is black silty clay about 23 inches thick. The subsoil is mottled, dark grayish brown silty clay about 9 inches thick. The underlying material is calcareous and is dominantly olive brown, mottled sand.

Of minor extent in this map unit are the sandy Sverdrup and Arvilla soils on ridges within the lakebed and the well drained Fordville soils on slopes of drainageways. The Fordville soils are underlain by sand and gravel.

Most of the acreage is cultivated. Small grains and alfalfa are the main crops. The soils are well suited to these crops. The available moisture in McDonaldsville soils is limited because of the clayey nature of the surface layer and subsoil and because of the rapidly permeable, sandy underlying material. Maintaining tilth is a concern in management. Large, hard clods form if the soil is worked when it is too wet, and the surface tends to crust as the soil dries out. Returning crop residue and adding other organic matter to the soil help to minimize these problems and to maintain and improve tilth.

These soils generally are not used for sanitary facilities because of wetness and the slow rate of absorption of the surface layer and subsoil. McDonaldsville soils have moderate to severe limitations for building site development because of the seasonal high water table, low strength, and the risk of damage caused by the shrinking and swelling of the soil.

Soils that formed dominantly in outwash material; on uplands

These are nearly level to rolling, well drained and somewhat excessively drained silty and loamy soils. They formed in loamy and sandy glacial outwash on deltaic deposits under prairie vegetation.

Two map units in Chippewa County make up this group. The main use is intensive farming.

10. Fordville-Sverdrup

Nearly level and gently sloping, well drained and somewhat excessively drained silty and loamy soils

The soils in this map unit are on glacial outwash plains and on former lake beaches. They are in a single long, narrow area, which consists of ridges interspersed with swales. Some depressions are scattered throughout. Slopes range from 0 to 6 percent.

This map unit makes up about 2 percent of the county. It is about 18 percent Fordville soils, 15 percent Sverdrup soils, and 67 percent minor soils.

Fordville soils are nearly level and gently sloping. They are on ridges and in swales. These soils are well drained. They are leached of carbonates in the upper 20 to 40 inches. The surface soil is black silt loam about 14 inches thick. The upper part of the subsoil is very dark grayish brown loam about 6 inches thick. The middle part is dark yellowish brown loam about 8 inches thick, and the lower part is dark grayish brown clay loam about 3 inches thick. The contrasting underlying material is grayish brown and yellowish brown sand mixed with some fine gravel.

Sverdrup soils are nearly level and gently sloping. They are on side slopes and in swales. These soils are somewhat excessively drained. They are leached of carbonates in the upper 15 to 40 inches. The surface layer is very dark gray fine sandy loam about 10 inches thick. The upper part of the subsoil is brown sandy loam 10 inches thick. The lower part is loamy sand about 4 inches thick. The underlying material is brown and dark yellowish brown, calcareous sand.

Of minor extent in this map unit are Marysland soils and similar soils, Egeland soils, and Clontarf soils. Marysland soils are poorly drained and are in drainageways and in nearly level areas. The well drained Egeland soils and the moderately well drained Clontarf soils are in swales and on side slopes. This map unit also includes many sand and gravel pits.

Most of the acreage is cultivated. The soils have fair suitability for use as cropland. A high percentage of the acreage is used for small grains because of the low to moderate available water capacity. These soils are well suited to hay crops and to use as pasture. Soil blowing can be a severe hazard, especially if these soils are fall plowed. It is a major concern in management. The main management needs are controlling erosion and increasing fertility, the content of organic matter, and the available water capacity.

Fordville and Sverdrup soils are well suited to building site development and to local roads and streets. The caving of walls of shallow excavations is a limitation. Seepage can contaminate underground water if these soils are used for sanitary facilities.

11. Rothsay-Sverdrup-Egeland

Nearly level to rolling, well drained and somewhat excessively drained loamy soils

The soils in this map unit are on ridges and swales on former lake beaches and on glacial outwash plains. The ridges generally are long and narrow. Some small depressions are scattered throughout. Slopes range from 0 to 12 percent.

This map unit makes up about 8 percent of the county. It is 25 percent Rothsay soils, 17 percent Sverdrup soils, 8 percent Egeland soils, and 50 percent minor soils.

Rothsay soils are gently sloping and gently undulating. They are mainly on side slopes and on the edges of broad ridgetops. They are well drained and are leached of carbonates in the upper 15 to 30 inches. The surface layer is very dark gray loam about 10 inches thick. The upper part of the subsoil is dark brown and brown loam about 9 inches thick. The lower part is yellowish brown very fine sandy loam about 11 inches thick. The underlying material is yellowish brown and brown very fine sandy loam.

Sverdrup soils are on ridges, on summits, and on side slopes. They are nearly level to rolling and are somewhat excessively drained. They are leached of carbonates in the upper 15 to 40 inches. The surface layer is very dark gray fine sandy loam about 10 inches thick. The subsoil is about 14 inches thick. It is brown sandy loam in the upper part and brown loamy sand in the lower part. The underlying material is brown and dark yellowish brown sand.

Egeland soils are nearly level to gently sloping. They are in swales and on side slopes. They are well drained and are leached of carbonates in the upper 20 to 40 inches. The surface soil is black and very dark gray sandy loam about 14 inches thick. The subsoil is brown over dark grayish brown sandy loam about 23 inches thick. The underlying material, to a depth of about 48 inches, is light olive brown fine sandy loam. Below that, it is light olive brown loamy fine sand.

Of minor extent in this map unit are Marysland, Maddock, Zell, Torning, Perella, and Quam soils. Marysland and Perella soils are poorly drained and are in broad, nearly level drainageways. Maddock, Zell, and Torning soils are well drained and are on ridges. Quam soils are very poorly drained and are in upland depressions.

Most of the acreage is cultivated. Much of the acreage is used for small grains because of the low to moderate available water capacity of Egeland and Sverdrup soils. These soils are well suited to hay and pasture. These soils are droughty. The available water capacity of Rothsay soils is high. Egeland and Sverdrup soils are highly susceptible to soil blowing. The main management needs are controlling erosion and increasing fertility, the content of organic matter, and the available water capacity.

These soils are well suited to building site development. Septic tank absorption fields work on these soils, but seepage and rapid permeability in the sandier soils can cause ground water contamination. On Egeland and Sverdrup soils, the walls of shallow excavations may slough or cave in. The steeper soils have moderate to severe limitations for building site development because of the slope.

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, Egeland sandy loam, 0 to 2 percent slopes, is one of several phases in the Egeland 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 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. Perella-Colvin silty clays 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 a mapped area 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 Aquents, 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.

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

31D—Storden loam, 12 to 18 percent slopes. This is a moderately steep, well drained soil on ridges and side slopes adjacent to drainageways, ponds, and lakes. The surface is convex and is dotted with a few stones and boulders. Slopes are about 150 feet long. The areas generally are long and narrow and range from about 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light olive brown loamy glacial till. The soil generally has free lime throughout. In places, part or all of the surface layer does not have free lime.

Included with this soil in mapping are small areas of Canisteo, Webster, Terril, Doland, and Ves soils. Canisteo and Webster soils are poorly drained and are in drainageways that dissect areas of the map unit. Terril soils are moderately well drained and are on the lower part of the side slopes. Doland and Ves soils are on the side slopes. The included soils make up 5 to 15 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is very rapid. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is low. The content of available phosphorus is very low, and the content of available potassium is medium.

In many areas, this soil is used as pasture. It is well suited to use as pasture and hayland. However, as a result of overgrazing, the native grasses have been replaced by less productive grasses and by weeds. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the pasture and help to keep the pasture and the soil in good condition. A few potential sites for pond reservoirs are in areas of this soil.

In a few small areas, this soil is used for cultivated crops. It has fair suitability for crops. Erosion is a very severe hazard. Because of the very rapid runoff, this soil is droughty. Swales should be shaped and seeded to grassed waterways to prevent gullies from forming. In places, diversion terraces can be built on the higher part of the slope to prevent the formation of gullies.

This soil is too steep for windbreaks, but it is suitable for other plantings. Erosion is a severe hazard if the surface is disturbed and left without cover. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees and shrubs. Weeds and grasses can be controlled by approved herbicides or by cultivation.

This soil is poorly suited to septic tank absorption fields because of the moderately steep slopes. In some places, effluent may seep laterally downslope and come to the surface at a lower elevation. Extensive land shaping may be needed to place the filter field on the contour. This soil is suited to dwellings and roads if they are designed to accommodate the slope. Mulching the surface and seeding grasses or sodding immediately following construction help to reduce erosion.

This soil is in capability subclass IVe.

35—Blue Earth mucky silt loam. This is a nearly level, very poorly drained soil in lake basins and depressions. It is subject to ponding. The lake basins commonly are as much as 8 to 10 feet deep. Fragments of snail shells and clamshells are on the surface and in the layers below. The areas range from 40 to several hundred acres in size.

Typically, the surface soil is highly organic. It is black mucky silt loam about 20 inches thick. The underlying material to a depth of about 60 inches is very dark gray, mottled, calcareous silty clay loam. In some places, the organic material is more than 10 feet thick.

Included with this soil in mapping are small areas of Canisteo and Seaforth soils. Canisteo soils are poorly drained, and Seaforth soils are moderately well drained. Both soils formed entirely in glacial till. The included soils typically are on the edges of areas of the Blue Earth soil and make up 5 to 10 percent of most mapped areas.

Permeability is moderate. The available water capacity is high or very high. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is very high. The content of available phosphorus is medium, and the content of available potassium is very high. Where this soil has been only partly drained by surface ditches and drainage tile, the seasonal high water table is on or near the surface.

In most areas, this soil is cropped. In some of the undrained areas, it is used for grazing or wild hay. This soil is well suited to all crops commonly grown in the county if it is adequately drained and fertilized. Excess lime in the surface layer can cause problems in maintaining fertility. Liberal amounts of potassium and phosphorus may be needed. Soil blowing is a hazard in large open areas. If fall plowing is necessary, the surface should be left rough, and some residue should be left on the surface. If this soil is worked when it is too wet, hard clods form.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime restrict the number of species that can grow well. Only those trees and shrubs that tolerate a high content of lime should be planted. Surface water must be removed or kept from accumulating on the soil before trees are planted. Site preparation needs to be completed in the fall before planting to provide a proper seedbed and to reduce plant competition. Competing weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not used as a site for sanitary facilities or buildings bacause of wetness and the hazard of ponding. In places, it is necessary to build roads across areas of this soil. Damage caused by ponding and frost heave can be reduced by artificially draining excess water from the soil and by building roads well above the zone of wetness. Damage resulting from low strength can be reduced by removing the organic material and constructing roads on more suitable base material.

This soil is in capability subclass IIIw.

45B—Maddock loamy fine sand, 1 to 6 percent slopes. This is a gently undulating, well drained soil on side slopes that typically are less than 100 feet long. The surface is convex. The areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 10 inches thick. The subsoil is dark grayish brown fine sand about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand.

Included with this soil in mapping are small areas of Marysland soils. Marysland soils are poorly drained and are in drainageways. Also included are some areas of the loamy Torning soils on the higher parts of the landscape. The included soils make up 5 to 10 percent of most mapped areas.

Permeability is rapid. Surface runoff is slow. The available water capacity is low. The surface layer is mildly alkaline. The content of organic matter is low. The content of available phosphorus is low, and that of available potassium is medium.

In most places, this soil is farmed. It is suited to small grains, corn, soybeans, and grasses and legumes for hay and pasture. The soil is droughty because of the low available water capacity. Minimum tillage and the return of all crop residue to the soil help to increase the water-holding capacity, to reduce evaporation, and to reduce the hazard of erosion. Field windbreaks and stripcropping also help to conserve moisture and to control soil blowing.

This soil is suited to use as pasture and hayland. These uses are effective in controlling erosion. Good pasture management that includes a program of fertilization, pasture rotation, and proper stocking rates improves forage production and helps to reduce erosion.

This soil has fair suitability for the trees used locally in windbreaks. Tree growth is restricted by the droughtiness of the soil. Seedling mortality is also a problem. Competing plants need to be controlled by careful site preparation and by weed control after planting. A mulch between seedlings helps to conserve moisture by controlling evaporation and helps to reduce plant competition.

This soil is well suited as a site for low buildings and for roads. Erosion is a slight hazard, and care should be taken to keep erosion to a minimum during construction. Disturbed areas should be revegetated immediately following construction. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. The hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IVs.

45C—Maddock loamy fine sand, 6 to 12 percent slopes. This is a sloping or rolling, well drained soil in convex areas where slopes typically are less than 80 feet long. The areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is very dark gray loamy fine sand about 10 inches thick. The subsoil is brown loamy sand about 13 inches thick. The upper part of the underlying material is yellowish brown sand about 28 inches thick. The lower part to a depth of 60 inches is brown fine sandy loam.

Included with this soil in mapping are small areas of Torning soils in similar positions on the landscape. Torning soils have less sand and a thicker surface layer than the Maddock soil. The included soils make up as much as 8 percent of some mapped areas.

Permeability is rapid. Surface runoff is slow. The available water capacity is low. The surface layer is mildly alkaline. The content of organic matter is low. The content of available phosphorus is low, and that of available potassium is medium.

In most places, this soil is farmed. It is suited to small grains and to grasses and legumes. The main concerns are droughtiness and the hazard of erosion. Minimum tillage and the return of crop residue to the soil help to increase the water-holding capacity and to reduce evaporation and the hazard of erosion. Field windbreaks and stripcropping also help to control soil loss. Where slopes are suitable, contour farming helps to reduce water erosion.

This soil is suited to use as pasture or hayland. Good pasture management that includes a program of fertilization, pasture rotation, and proper stocking rates improves forage production and helps to reduce erosion.

This soil has fair suitability for the trees used locally in windbreaks. Tree growth is restricted by the droughty nature of the soil. Seedling mortality is a problem because of droughtiness. Competing weeds and grasses need to be controlled by careful site preparation and by weed control after planting. A mulch between seedlings helps to reduce evaporation and control competing plants.

This soil is well suited as a site for low buildings and for roads. Erosion is a moderate hazard. Care should be taken to keep erosion to a minimum during construction. Disturbed areas should be revegetated immediately following construction. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IVs.

60—Glyndon silt loam. This is a nearly level, moderately well drained and somewhat poorly drained, calcareous soil on rises and on the rim around depressions. The areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is black silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled silt loam in the upper part and light olive brown, mottled silty clay loam in the lower part.

Included with this soil in mapping are small areas of Colvin, Canisteo, Quam, Seaforth, and Spicer soils. Colvin and Canisteo soils are in positions similar to those of the Glyndon soil; they are poorly drained. Quam and Spicer soils are very poorly drained and are in depressions. Seaforth soils are moderately well drained and formed on the top of low rises. The included soils make up as much as 15 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is medium or high. The seasonal high water table is at a depth of 2.5 to 6 feet.

In most places, this soil is farmed. It is well suited to corn, soybeans, sugar beets, and small grains. Either tile or surface drainage can be used on this soil. The return of all crop residue helps to maintain the content of organic matter and to keep the soil in good tilth. Conservation practices, for example, minimum tillage and stubble mulching, aid in keeping the surface layer friable and reduce soil losses by erosion. Leaving crop residue on the surface in fall-plowed fields helps to control soil blowing. Green manure crops help to maintain good soil structure and tilth.

This soil is well suited to trees and shrubs in windbreaks and in environmental plantings. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by approved herbicides. If the site for a windbreak is in sod, plowing and disking in the summer or fall before planting help to reduce the loss of moisture and to control unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. It has fair suitability as a site for buildings and for roads. Wetness and frost action can cause construction difficulties and can result in damage to structures. This damage can be reduced or prevented by artificially draining the excess water from the soil and by building above the high level of the water table.

This soil is in capability class I.

85—Calco silty clay loam. This is a nearly level, poorly drained, calcareous soil on flood plains. The areas are long and narrow and range in size from 5 to 80 acres. This soil is subject to occasional flooding.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black and very dark gray silty clay loam about 27 inches thick. The subsoil is mottled, very dark gray silty clay loam about 9 inches thick. The underlying material to a depth of about 60 inches is dark olive gray, mottled silty clay loam. The soil is calcareous throughout. In places, this soil has thin layers of sandy material.

Included with this soil in mapping are small areas of Du Page soils and areas of Calco soils, in shallow channels and oxbows, that are frequently flooded. Du Page soils are moderately well drained and are in higher positions on the flood plain. Also included are small areas of soils that are underlain by bedrock at a depth of less than 40 inches and small areas of very poorly drained soils that are covered by marsh vegetation. The included soils make up 2 to 8 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is slow. The surface layer is mildly alkaline. The organic matter content is high. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is 1 foot to 3 feet below the surface.

In most areas, this soil is cropped or is used for grazing. If this soil is drained, it is well suited to all the crops commonly grown in the county. The major limitations are wetness and flooding. In places, the surface layer has a high content of lime, which causes a fertility imbalance. Drainage tile is difficult to install in most areas, and sufficiently sloping outlets are hard to locate on the bottom land. Dikes that protect the soil from flooding are practical in places. If the soil is worked when it is too wet, clods form that are difficult to break up.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. Wetness, occasional flooding, and the high content of lime limit the number of species that can grow well. Only those trees and shrubs that tolerate a high content of lime should be planted. Site preparation needs to be completed in the fall before planting because clods tend to form if the soil is worked early in spring when it is too wet. Weeds and grasses in newly established windbreaks can be controlled by shallow cultivation or approved herbicides.

This soil generally is not suited to sanitary facilities or buildings because of wetness and flooding. In places, it may be necessary to build roads across areas of this soil. Constructing roads on raised and well-compacted fill material and providing adequate side ditches and culverts help to prevent flood damage.

This soil is in capability subclass IIw.

89—McDonaldsville silty clay. This is a nearly level, poorly drained soil on a glacial lake plain. The underlying material is sandy glacial outwash. This soil is in a single extensive area on the lake plain.

Typically, the surface soil is black silty clay about 23 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay about 9 inches thick. The calcareous underlying material to a depth of about 60 inches is olive brown sandy loam in the upper part and olive brown and dark yellowish brown sand in the lower part. In some places, the fine textured surface soil and subsoil are more than 40 inches thick. Also, in some places, internal drainage is not so poor.

Included with this soil in mapping are small areas of the silty Calco soils in positions similar to those of the McDonaldsville soil. Calco soils make up as much as 15 percent of the map unit.

Permeability is slow in the surface soil and subsoil and rapid in the underlying material. Surface runoff is slow. The content of organic matter is high. The available water capacity is moderate. The surface layer is slightly acid or neutral. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is at a depth of 0 to 3 feet.

If this soil is adequately drained, it is well suited to most of the crops commonly grown in the county. In dry years, the clayey nature of the surface soil and subsoil limits the amount of available soil moisture during the growing season. Maintaining soil tilth is a major concern. Returning crop residue to the soil or regularly adding other organic material helps to improve tilth and the moisture-holding capacity and to reduce soil blowing.

This soil is well suited to most trees commonly used for windbreaks in the county. Trees that tolerate wetness need to be selected. Tree seedlings establish themselves and grow well if competing plants are controlled or removed. Adequate site preparation helps, and weed control after planting may be necessary.

This soil generally is not used as a site for buildings or sanitary facilities. Wetness and the clayey nature of the soil are severe limitations to these uses. If roads are built across areas of this soil, the surface soil and subsoil should be replaced with material that has greater strength and is less susceptible to shrinking and swelling.

This soil is in capability subclass IIw.

94B—Terril loam, 2 to 6 percent slopes. This is a gently sloping, moderately well drained soil on foot slopes. The areas are long and narrow and range from 5 to 60 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is about 20 inches thick. It is black loam in the upper part and very dark gray loam in the lower part. The subsoil, to a depth of about 40 inches, is dark brown loam. The underlying material is calcareous, yellowish brown loam to a depth of about 60 inches. In places, there are thin gravelly, sandy, or cobbly layers in the underlying material. In some places, the surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of Storden and Swanlake soils. These soils are well drained and generally are on side slopes on the upper part of foot slopes. Also included are small areas of Du Page soils, which are moderately well drained and are subject to flooding, and some wet spots. The included soils make up 3 to 8 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is medium or slow. The surface layer is neutral or slightly acid. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is medium.

In most places, this soil is cropped. However, because it commonly is adjacent to steeper soils, in many areas it is used for grazing. A few sites along the Minnesota River Valley are wooded. This soil is well suited to corn, small grains, soybeans, and alfalfa. Erosion is a slight hazard. Minimum tillage and the return of crop residue to the soil help to control erosion and to conserve moisture. Wherever water collects on and flows across this soil, grassed waterways are needed to prevent erosion and to keep gullies from forming.

This soil is well suited to tress and shrubs in windbreaks. Weeds and grasses in newly established windbreaks can be controlled by shallow cultivation or approved herbicides. Site preparation late in summer or in fall before planting helps to increase the moisture supply of the soil and to kill unwanted vegetation.

This soil is well suited to sanitary facilities and building site development. Low strength can result in damage to roads. This damage can be reduced by using material that has greater strength for the road base or subbase.

This soil is in capability subclass IIe.

113—Webster silty clay loam. This is a nearly level, poorly drained soil on flats near the foot of slopes and in drainageways. The areas generally are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface soil is black silty clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light olive brown, mottled, calcareous loam. In some places, there are thin layers of sandy material in the lower part of the soil. In some drainageways, the surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of Seaforth, Canisteo, Colvin, and Ves soils. Canisteo and Colvin soils are poorly drained and are on the rim of depressions. Seaforth soils are moderately well drained and are in slightly higher positions on the landscape. Ves soils are well drained and are on the more convex slopes. The included soils make up 5 to 10 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. After heavy rains or snowmelt in spring, water runs off slowly. The surface layer typically is neutral. The content of organic matter is high. The content of available phosphorus is low, and that of available potassium is medium or high. Where the soil has not been drained, the high water table is at a depth of 1 foot to 2 feet in spring and during wet periods.

This soil is mainly used for corn, soybeans, small grains, and forage grasses and legumes. Drainage and maintenance of fertility and tilth are needed to make and keep this soil suitable for these crops. Subsurface tile lines generally provide adequate drainage. Deep tillage helps to aerate the soil. Fall plowing helps to speed up the drying and warming of the soil in spring. Returning crop residue to the soil helps to maintain the content of organic matter. Tilth can be maintained by proper timing of cultivation and by using a crop rotation that includes forage grasses and legumes.

This soil has fair suitability for trees and shrubs in windbreaks. If adequate subsurface drainage is provided, many kinds of trees and shrubs can grow successfully. Site preparation should be completed in the fall before planting, because clods tend to form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not used as a site for sanitary facilities and buildings because of seasonal wetness. In places, it may be necessary to build roads across areas of this soil. Low strength and frost heave can result in damage to roads. Roads need to be constructed on more suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

127A—Sverdrup fine sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat excessively drained soil on summits and side slopes and on former lake beaches. The surface is convex. The areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 11 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown, very friable loamy sand. The underlying material to a depth of about 60 inches is brown and pale brown, calcareous loamy sand and loamy fine sand. In some places, the surface layer and subsoil are loamy sand. In places, there are silty and loamy layers in the sandy underlying material.

Included with this soil in mapping are small areas of Fordville, Tara, and Waubay soils. Fordville soils have a loamy surface soil and a loamy subsoil. Tara and Waubay soils are moderately well drained and are loamy throughout. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderately rapid in the upper part of the soil and rapid in the underlying sandy material. Surface runoff is slow. This soil takes in water readily, but the available water capacity is low or moderate. The surface layer is neutral or slightly acid. The content of organic matter is moderate. The content of available phosphorus is very low, and the content of available potassium is medium.

In most areas, this soil is cropped. In some areas, it is used for grazing. This soil has fair suitability for all the crops commonly grown in the county. Because the available water capacity is low, droughtiness is the major limitation. Soil blowing is a hazard, particularly after fall tillage (fig. 6). Leaving crop residue on the surface during winter helps to trap snow, conserve moisture, and reduce soil blowing. Minimum tillage practices, for example, chisel plowing, also reduce soil blowing and moisture loss. A single-row shelterbelt reduces soil blowing and the loss of moisture through evaporation and transpiration.

This soil is poorly suited to trees and shrubs. It is droughty, and the mortality in windbreaks can be high. Trees planted on this soil generally grow slowly and tend to have a shorter life than trees of the same species on soils that are underlain by finer textured material. Field windbreaks are effective in controlling soil blowing, but care is needed to keep young trees or shrubs from being damaged by windblown particles of soil. A cover of grass or of crop residue from corn or small grains reduces the risk of soil blowing.

This soil is well suited as a site for low buildings and for roads. Although it readily absorbs the effluent from septic tanks, this soil is too sandy to adequately filter and treat the effluent. Consequently, nearby water

Figure 6.—An area of Sverdrup fine sandy loam, 0 to 2 percent slopes. Conservation tillage is needed to prevent soil blowing.

supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIIs.

127B—Sverdrup fine sandy loam, 2 to 6 percent slopes. This is a gently sloping, somewhat excessively drained soil on ridges and side slopes. The areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 10 inches thick. The subsoil is about 14 inches thick. It is brown, very friable sandy loam in the upper part and brown, very friable loamy sand in the lower part. The underlying material to a depth of about 60 inches is brown and dark yellowish brown, calcareous sand. In some places, the subsoil and underlying material are gravelly. In cropped areas, the surface layer is lighter in color.

Included in mapping are small areas of Doland, Fordville, and Rothsay soils. Doland and Rothsay soils formed entirely in loamy material. They are mainly on the edges of areas of the Sverdrup soil. Fordville soils have more gravel in the underlying material. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderately rapid in the upper part of the soil and rapid in the underlying sand. Surface runoff is slow. The available water capacity is low or moderate. The surface layer is neutral or slightly acid. The content of organic matter is moderate. The content of available phosphorus is very low, and that of available potassium is medium.

In most areas, the soil is cropped or is used for grazing. This soil has fair suitability for all the crops commonly grown in the county. Droughtiness is the major limitation. The soil is easy to work, but it is subject to soil blowing unless it is protected. Minimum tillage and the return of all crop residue to the soil help to control erosion and conserve moisture. Leaving crop residue on the surface during winter helps to trap snow and conserve moisture. A single-row shelterbelt helps to control erosion and conserve moisture.

This soil is poorly suited to trees or shrubs. The mortality in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. Trees planted on this soil generally grow slowly, are stunted, and tend to have a shorter life than trees of the same species on soils that are underlain by finer textured material. A cover of grass or of crop residue from corn or small grains reduces the risk of soil blowing.

This soil is well suited as a site for low buildings and for roads. Erosion is a slight hazard. Care should be taken to keep erosion to a minimum during construction of buildings and roads. Disturbed areas should be revegetated immediately following construction. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIIs.

127C—Sverdrup fine sandy loam, 6 to 12 percent slopes. This is a rolling, somewhat excessively drained soil on side slopes and summits of ridges. The surface is convex. Slopes are 50 to 150 feet long. The areas range from 3 to 20 acres in size.

Typically, the surface layer is very dark gray fine sandy loam about 10 inches thick. The subsoil is about 12 inches thick. It is brown, very friable sandy loam in the upper part and brown, very friable loamy sand in the lower part. The underlying material to a depth of about 60 inches is brown and dark yellowish brown, calcareous sand. In places, the subsoil and underlying material are gravelly. Where this soil is cultivated, the surface layer is significantly lighter in color.

Included with this soil in mapping are small areas of Doland, Fordville, Rothsay, and Storden soils. Doland, Rothsay, and Storden soils formed entirely in loamy material. They generally are on the edges of areas of the Sverdrup soil. Fordville soils have gravel in the underlying material. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying sand. Surface runoff is medium. The available water capacity is low or moderate. The surface layer typically is neutral. The content of organic matter is moderate. The content of available phosphorus is very low, and the content of available potassium is low or medium.

In most areas, this soil is used for grazing or is cropped. If cultivated, this soil has fair suitability for small grains and alfalfa. Because the available water capacity is low, droughtiness is the major limitation. Also, erosion is a severe hazard. Spring tillage, heavy applications of manure, and return of all crop residue to the soil are needed. Terraces generally are not built on this soil because it is too shallow over sand. Gullies should be reshaped and seeded to form grassed waterways. Field windbreaks are effective in controlling soil blowing.

This soil is poorly suited to many kinds of trees and shrubs. The mortality in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. Trees on this soil generally grow slowly and are stunted. Also, they tend to have a shorter life than trees of the same species on soils that are underlain by finer textured material. Care is needed to keep young trees or shrubs from being damaged by windblown particles of soil. A cover of grass or of crop residue reduces the risk of soil blowing.

This soil is well suited to building site development. If it is used as a site for a building or road, special design and care in selecting the site are needed to reduce the risk of erosion. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using a suitable filtering material in the filter field.

This soil is in capability subclass IVe.

141A—Egeland sandy loam, 0 to 2 percent slopes. This is a nearly level, well drained soil in gentle swales and drainageways or on former lake beaches. Surfaces are concave. The areas are as broad as they are long and range from 10 to 30 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 6 inches thick. The subsoil is brown sandy loam in the upper part and very dark grayish brown sandy loam in the lower part. It is about 23 inches thick. The underlying material to a depth of about 48 inches is light olive brown, calcareous fine sandy loam. Below that to a depth of about 60 inches it is light olive brown, calcareous loamy fine sand. In places, loamy or silty material is at a depth of 3 to 6 feet.

Included with this soil in mapping are small areas of Maddock, Sverdrup, Torning, and Rothsay soils. Maddock and Sverdrup soils are sandy. They have a lower available water capacity than the Egeland soil. Torning soils have a thinner dark colored surface layer and are on steeper parts of the landscape. Rothsay soils are silty throughout and have a higher available water capacity than the Egeland soil. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. The available water capacity is moderate. Surface runoff is slow. The surface layer in most places ranges from slightly acid to neutral. The content of organic matter is moderate. The content of available phosphorus is low, and the content of available potassium is medium.

In most areas, this soil is cropped. Except in years of below normal rainfall, it is moderately well suited to corn, soybeans, small grains, and alfalfa. Droughtiness is the major limitation. This soil is subject to soil blowing, especially after fall plowing. Leaving crop residue on the surface during winter helps to hold snow on the ground. The snow provides moisture for the next crop. The surface layer can be easily worked into a good seedbed. Other management needs are increasing fertility, maintaining the content of organic matter, and increasing the available water capacity. Grassed waterways help to prevent gullying into the sandy underlying material. This soil is well suited to irrigation. It can be row cropped intensively if water for irrigation is available.

The suitability of this soil for trees and shrubs in windbreaks is fair. Because the available water capacity is moderate, many trees and shrubs are likely to die if drought occurs while they are becoming established. On exposed sites, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a mulch of crop residue. Competition for moisture generally is critical. Competing weeds and grasses can be controlled by shallow cultivation or approved herbicides.

This soil is well suited as a site for low buildings and for roads. Although it readily absorbs the effluent from septic tanks, this soil is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIIs.

141B—Egeland sandy loam, 2 to 6 percent slopes. This is a well drained, gently undulating and gently sloping soil on ridges and side slopes. The areas are irregular in shape and range from 5 to 35 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 5 inches thick. The subsoil is brown sandy loam in the upper part and dark grayish brown sandy loam in the lower part. It is about 23 inches thick. The underlying material to a depth of about 48 inches is light olive brown, calcareous fine sandy loam. Below that to a depth of 60 inches it is light olive brown, calcareous loamy fine sand. In some places, there is loamy or silty material at a depth between 3 and 6 feet. In places, the surface layer has a brownish cast as a result of the loss of organic matter by cropping and erosion and because part of the brownish subsoil is mixed with the surface layer.

Included with this soil in mapping are small areas of Maddock, Sverdrup, Torning, and Rothsay soils. Maddock and Sverdrup soils are sandy. Torning soils have a thinner dark-colored surface layer than the Egeland soil and are on steeper parts of the landscape. Rothsay soils are silty throughout and have a higher available water capacity. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. Surface runoff is slow or medium. The available water capacity is moderate. In most places, the surface layer is neutral or slightly acid. The content of organic matter is moderate or low. The content of available phosphorus is very low, and the content of available potassium is medium.

In most areas, this soil is cropped or is used for grazing. This soil is best suited to small grains, soybeans, and alfalfa. It is less well suited to corn. The major concerns in management are the moderate hazard of erosion and the moderate available water capacity. Soil blowing and water erosion can be reduced by spring plowing. Leaving stubble and corn stalks on the surface during winter holds snow on the ground. The snow provides moisture for the next crop. Grassed waterways help to prevent the formation of gullies that can cut into the sandy underlying material.

The suitability of this soil for trees and shrubs in windbreaks is fair. Because the available water capacity is moderate, many trees and shrubs are likely to die if drought occurs while they are becoming established. On some exposed sites, soil blowing is a hazard to young trees or shrubs. Soil blowing and water erosion can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Competing weeds and grasses can be controlled by shallow cultivation or approved herbicides.

This soil is well suited as a site for low buildings and for roads. Erosion is a slight hazard, and care should be taken to keep erosion to a minimum. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIIe.

234—Tonka silty clay loam. This is a nearly level, poorly drained soil in closed basins and depressions. The areas are round or slightly elongated and range from 5 to 20 acres in size. This soil is subject to ponding.

Typically, the surface soil is about 30 inches thick. In the upper 9 inches, it is black silty clay loam. The subsurface layer is black silt loam in the upper part and dark gray silt loam in the lower part. The subsoil is dark gray, mottled silty clay loam about 24 inches thick. The underlying material to a depth of about 60 inches is olive gray silty clay loam. In some places, the soil is more silty than is typical, and in other places it is less silty.

Permeability is slow. Runoff is ponded. The available water capacity is high. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high. Under cultivation, the surface layer has a characteristic gray color. It is slightly acid or neutral. The seasonal high water table is on the surface or within a depth of 1 foot.

In most areas, this soil is drained and is used for crops. If not drained, this soil is marshy and is well suited to use as habitat for wetland wildlife. If drained, this soil is well suited to all of the crops commonly grown in the county. Tile is needed to provide subsurface drainage, and open ditches are needed to remove surface water. Fall plowing permits earlier preparation of a seedbed in spring. Leaving fall-plowed fields rough and leaving some residue on the surface help to control soil blowing. If this soil is worked when it is too wet, hard clods form that are difficult to break up. Green manure crops help to maintain good tilth.

If surface water is removed, this soil has fair suitability for trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more kinds of trees and shrubs can be grown successfully. Site preparation should be completed in the fall before planting because clods tend to form if the soil is worked early in spring when it is too wet. Competing weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not suited to sanitary facilities or as a site for buildings because of wetness and the hazard of ponding. Because of frost heave and the low strength of the soil, roads built across areas of this soil need to be constructed on suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIIw.

246—Marysland loam. This is a nearly level, poorly drained, calcareous soil in channels on stream deltas and outwash plains. In some places, this soil is flooded during snowmelt in spring or after heavy rains. The areas are long and narrow and range from 30 to several hundred acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 7 inches thick. The layer below that, to a depth of about 27 inches, is very dark gray, mottled loam over grayish brown sandy loam. The layer below that to a depth of about 60 inches is light olive brown and olive brown sand. The soil is calcareous throughout and has an accumulation of limy material within the top 16 inches. In some places, the surface layer is 24 to 36 inches thick. In a few places, the surface layer and subsoil are leached of free lime. Also, in a few places, the underlying material is loamy or silty.

Included with this soil in mapping are small areas of Terril soils and of Canisteo stony loam. Terril soils are moderately well drained. They formed entirely in loamy material. The Canisteo soil formed in loamy material. It has a large number of stones on the surface. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the surface layer and rapid in the underlying sand. Surface runoff is slow. The available water capacity is moderate. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high. The content of available phosphorus is very low, and the content of available potassium is medium. The seasonal high water table is at a depth of 1 foot to 2.5 feet.

In most areas, this soil is cropped. In some areas where it is only partly drained, the soil is used for grazing. If it is adequately drained, this soil is well suited to corn, soybeans, small grains, and alfalfa. The surface layer has a high content of lime, which causes a fertility imbalance. If crop growth is poor after adequate drainage has been provided, fertilizers that contain a liberal amount of potassium and phosphorus are needed. Fall tillage makes it possible to prepare a good seedbed earlier in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. Wetness and the high content of lime restrict the kinds of trees and shrubs that can grow well. The high content of lime interferes with the uptake of nutrients in many woody plants. Trees and shrubs that tolerate a high content of lime are best adapted to this soil. Site preparation should be completed in the fall before planting because clods often form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not suited to use as a site for sanitary facilities and buildings because of wetness and the hazard of flooding. Constructing roads on raised and well compacted fill material and providing adequate side ditches and culverts help protect the roads from damage caused by frost action.

This soil is in capability subclass IIw.

290B—Rothsay loam, 2 to 6 percent slopes. This is a gently sloping and gently undulating, well drained soil on side slopes and broad ridges. The areas are either long and narrow or broad and irregular and range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The upper part of the subsoil is dark brown and brown loam about 9 inches thick. The lower part is yellowish brown very fine sandy loam about 11 inches thick. The underlying material to a depth of about 60 inches is calcareous, yellowish brown and brown, mottled very fine sandy loam. In places, the underlying material is loam or clay loam. Also, in some places, the surface soil is more than 16 inches thick.

Included with this soil in mapping are small areas of moderately well drained Waubay soils on plane and concave parts of the landscape. Also included are some areas of Perella soils, which are poorly drained and are in depressions and drainageways. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. Surface runoff is slow or medium. The available water capacity is high. In most places, reaction in the surface layer is neutral. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high.

In most areas, this soil is cropped. It is well suited to all of the crops commonly grown in the county. Erosion is a slight hazard. In some places, the soil is well suited to terracing and contour farming. Minimum tillage practices, for example, chisel plowing, help to control erosion. On fall-plowed fields, leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing in winter and spring. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed where water collects and flows across this soil.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. Soil blowing and water erosion can be controlled by leaving crop residue on the surface. If the site for a windbreak is in sod, plowing and disking in the summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

This soil is well suited to use as a site for sanitary facilities and to building site development. This soil is subject to frost action, which can cause damage to roads. The design of roads should compensate for frost action, and the roads should be built on suitable base material.

This soil is in capability subclass IIe.

324B—Torning very fine sandy loam, 2 to 6 percent slopes. This is a gently sloping or gently undulating, well drained soil on outwash plains and delta plains. The areas are long and narrow and range from 5 to 15 acres in size.

Typically, the surface layer is dark grayish brown, very friable, very fine sandy loam about 10 inches thick. The underlying material to a depth of 42 inches is brown very fine sandy loam and loamy fine sand. Below that to a depth of about 60 inches it is yellowish brown silt loam. The soil is calcareous throughout. In places, however, the soil is leached of free lime.

Included with this soil in mapping are small areas of poorly drained soils in drainageways and at the edges of the mapped areas. The included soils make up 5 to 10 percent of most mapped areas.

Permeability is moderately rapid. Runoff is medium. The surface layer is mildly alkaline. This soil has a high content of lime, which causes an imbalance of plant nutrients and a deficiency of phosphorus and potassium. The available water capacity is low.

This soil is moderately suited to corn, small grains, and alfalfa. Drought is a moderately severe hazard. The soil is subject to soil blowing unless it is protected. Minimum tillage and the return of all crop residue to the soil help to control erosion and conserve moisture. Leaving stubble on the surface during winter helps to reduce soil loss and conserve moisture. Windbreaks help to control wind erosion and conserve moisture.

The suitability of this soil for trees and shrubs in windbreaks is fair. The available water capacity is low, and seedling mortality may be high if drought occurs before the young trees have become established. Maintaining a cover of crop residue helps to control soil blowing. Weeds and grasses can be controlled by cultivation or approved herbicides.

This soil is well suited to building site development and sanitary facilities.

This soil is in capability subclass IIIs.

338—Waubay silty clay loam. This is a nearly level and very gently sloping, moderately well drained soil on side slopes and in shallow, concave swales. The surface is slightly concave. Slopes are about 150 to 200 feet long. The areas generally are irregular in shape; some areas along side slopes are long and narrow. Areas range from 5 to 80 acres in size.

Typically, the surface soil is about 17 inches thick. It is black silty clay loam in the upper 8 inches and very dark gray silty clay loam below that. The subsoil is dark grayish brown, friable silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam. In some places, the underlying material is loam and clay loam.

Included with this soil in mapping are small areas of Perella, Rothsay, Doland, Spicer, and Quam soils. Perella soils are poorly drained and are in depressions on flat parts of the landscape. Rothsay and Doland soils are well drained and are on higher parts of the landscape. The very poorly drained Spicer and Quam soils are in depressions. The included soils make up 2 to 15 percent of most mapped areas.

Permeability is moderate. The available water capacity is high or very high. Surface runoff is slow. The surface layer is neutral in most places. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is cropped. It is well suited to all of the crops commonly grown in the county. This soil has few limitations and can be cropped intensively. Leaving crop residue on the surface of fall-plowed fields helps to control soil blowing. Green manure crops help to maintain good structure and tilth.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by approved herbicides. If the site for a windbreak is in sod, plowing and disking in the summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness and the moderate permeability. Placing the filter field above the surface soil in a properly designed and constructed sewage treatment mound helps to overcome wetness. The absorption field needs to be enlarged to adjust to the absorption capacity of the soil material. This soil has fair suitability as a site for dwellings and roads. Wetness, low strength, and frost action can cause construction difficulties and can result in damage to structures. Buildings and roads can be protected from damage by constructing them on more suitable base material and by provding drainage.

This soil is in capability class I.

339A—Fordville silt loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on glacial outwash plains. The surface is plane to concave. Typically, the areas are broad and have smooth boundaries. They range from 5 to 40 acres in size.

Typically, the surface soil is black silt loam about 14 inches thick. The upper part of the subsoil is very dark grayish brown silt loam about 6 inches thick. The middle part is dark yellowish brown loam about 8 inches thick. The lower part is dark grayish brown clay loam about 8 inches thick. The contrasting underlying material to a depth of 60 inches is grayish brown and yellowish brown sand mixed with some fine gravel.

Included with this soil in mapping are small areas of Arvilla, Clontarf, Marysland, and Sverdrup soils. Arvilla soils have a thinner dark-colored surface soil, and they are shallower to sand and gravel. Clontarf soils have more sand in the surface soil and subsoil. Marysland soils are poorly drained and are in depressions. Sverdrup soils are sandy throughout. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the surface soil and subsoil and rapid in the underlying sand and gravel. Surface runoff is slow. The available water capacity is moderate or low. The surface layer is neutral or slightly acid. The content of organic matter is naturally high. The content of available phosphorus is very low, and the content of available potassium is medium. Roots are restricted by the sand and gravel below a depth of 20 to 40 inches.

In most areas, this soil is used as cropland. Where it is interspersed among more droughty soils, it is commonly used for grazing. This soil has fair suitability for corn and soybeans. It is well suited to small grains and alfalfa. Droughtiness is the major limitation. This soil is subject to soil blowing, especially after plowing in the fall. Leaving crop residue on the surface during winter helps control soil blowing and helps to hold snow on the ground. The snow provides moisture for the next crop. Other management needs are increasing fertility, maintaining the content of organic matter, and increasing the available water capacity. Grassed waterways generally prevent gullying into the coarse textured underlying material. This soil is well suited to irrigation and can be row cropped intensively if water for irrigation is available.

The suitability of this soil for trees and shrubs in windbreaks is fair. Because the available water capacity is moderate or low, many trees and shrubs are likely to die if drought occurs while they are becoming established. On exposed sites where the soil is intermingled with sandy soils, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a mulch of crop residue. Competition for moisture generally is critical. Competing weeds and grasses can be controlled by shallow cultivation or approved herbicides.

This soil is well suited as a site for low buildings and for roads. Although it readily absorbs the effluent from septic tanks, this soil is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIs.

339B—Fordville loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on glacial lacustrine and outwash plains. The surface is very slightly convex and concave. The areas typically are long and narrow and have smooth boundaries. They range from 5 to 20 acres in size.

Typically, the surface soil is black loam about 12 inches thick. The subsoil is about 18 inches thick. It is very dark grayish brown loam and silt loam in the upper part and dark grayish brown clay loam in the lower part. The contrasting underlying material to a depth of 60 inches is grayish brown and yellowish brown sand. In places, some fine gravel is mixed with the underlying material.

Included with this soil in mapping are small areas of Arvilla, Clontarf, and Sverdrup soils. Arvilla soils have a thinner dark-colored surface soil and are shallower to sand and gravel than Fordville soils. Clontarf soils are in shallow drainageways that cross the mapped areas, and they have more sand in the surface soil and subsoil. Sverdrup soils are sandy throughout. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the surface soil and the subsoil and rapid in the underlying sand and gravel. Surface runoff is medium. The available water capacity is moderate or low. The surface layer is neutral or slightly acid. The content of organic matter is high. The content of available phosphorus is very low, and the content of available potassium is medium. Roots are restricted by the underlying sand and gravel below a depth of 20 to 40 inches.

In most areas, this soil is cropped or is used for grazing. It is best suited to small grains, soybeans, and alfalfa. It is less well suited to corn. The major concerns in management are the moderate hazard of erosion and the moderate available water capacity. The hazards of soil blowing and water erosion can be reduced by leaving crop residue on the surface during winter. The residue holds snow on the ground, and the snow provides moisture for the next crop. Grassed waterways help to prevent the formation of gullies that cut into the sand and gravel.

The suitability of this soil for trees and shrubs in windbreaks is fair. Because of the moderate available water capacity, many trees and shrubs are likely to die if drought occurs while they are becoming established. Soil blowing and water erosion can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Competing weeds and grasses can be controlled by shallow cultivation or approved herbicides.

This soil is well suited as a site for buildings and for roads. Erosion is a slight hazard. Care should be taken to keep erosion to a minimum during construction of buildings and roads. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to filter and treat the effluent adequately. Consequently, contamination of nearby water supplies can result. Using suitable filtering material in the filter field reduces the hazard of contamination.

This soil is in capability subclass IIe.

341B—Arvilla sandy loam, 1 to 6 percent slopes. This is a gently undulating or gently sloping, somewhat excessively drained soil on former lake plains and outwash plains. The surface is convex. The areas are broad and irregular in shape and range from 5 to 25 acres in size.

Typically, the surface soil is black sandy loam about 14 inches thick. The subsoil is dark brown sandy loam about 4 inches thick. The underlying material to a depth of 60 inches is brown and dark brown loamy sand and sand mixed with some gravel. In places, there are varying amounts of gravel in the underlying material.

Included with this soil in mapping are small areas of Clontarf, Fordville, Sverdrup, and McDonaldsville soils. Clontarf and Fordville soils have less sand in the surface soil and in the upper part of the subsoil. Sverdrup soils do not have gravelly underlying material. McDonaldsville soils formed in a clayey mantle over sand and gravel. The included soils make up 10 to 15 percent of most mapped areas.

Permeability is moderately rapid in the surface soil and the subsoil and rapid in the underlying material. Surface runoff is slow to medium. The available water capacity is low or very low. The surface layer typically is neutral, but in a few areas it is mildly alkaline. The content of organic matter is moderate or low. The content of available phosphorus is very low, and the content of available potassium is low or medium. Roots are restricted by the underlying gravelly sand at a depth of 14 to 20 inches.

In most areas, this soil is cropped or is used for grazing. It is moderately suited to small grains and meadow crops. Because the available water capacity is low, droughtiness is a limitation. Except in years when rainfall is both adequate and timely, the soil is too droughty for corn. Meadow crops tend to use up soil moisture. If they are grown for 2 successive years in a rotation, the moisture supply may be insufficient for corn or small grains in the following year. Erosion is a hazard. Minimum tillage and crop residue left on the surface of the soil help to control erosion and to conserve moisture where the slopes are too irregular for contouring. Leaving stubble on the surface during winter helps to reduce soil blowing, traps snow, and conserves moisture. A single-row shelterbelt also helps to control erosion and conserve moisture.

This soil is poorly suited to many kinds of trees and shrubs. Mortality is high if drought occurs while the trees and shrubs are becoming established. Trees on this soil generally grow slowly and tend to have a shorter life than trees of the same species on soils that are underlain by finer textured material. Young trees and shrubs may be damaged by windblown particles of soil. A cover of grass or of crop residue from corn or small grains reduces the risk of soil blowing.

This soil is well suited as a site for low buildings and for roads. Care should be taken to keep erosion to a minimum during construction of buildings and roads. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IIIe.

341C—Arvilla sandy loam, 6 to 12 percent slopes. This is a sloping, somewhat excessively drained soil on strongly convex surfaces on former lake plains and outwash plains. Individual areas typically are long and irregular in shape and range in size from 5 to 20 acres.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is dark grayish brown sandy loam about 7 inches thick. The underlying material to a depth of 60 inches is grayish brown and brown, loose gravelly coarse sand. In some places, the underlying material has gravel in varying amounts and sizes.

Included with this soil in mapping are small areas of Clontarf, Fordville, Sverdrup, and McDonaldsville soils. Clontarf and Fordville soils have less sand in the surface soil and in the upper part of the subsoil. Sverdrup soils do not have gravelly underlying material. McDonaldsville soils formed in a clayey mantle over sand and gravel. These included soils make up 10 to 15 percent of most mapped areas.

Permeability is moderately rapid in the surface layer and the subsoil and rapid in the underlying material. Surface runoff is medium. The available water capacity is low or very low. The surface layer typically is neutral, but in some areas it is mildly alkaline. The content of organic matter is moderate or low. The content of available phosphorus is very low, and the content of available potassium is low or medium. Roots are restricted by the underlying gravelly sand at a depth of 14 to 18 inches.

In most areas, this soil is used for crops. This soil generally is too droughty for corn. It is best suited to hay and small grains. Erosion is a severe hazard. A winter cover crop, spring plowing, heavy applications of manure, and crop residue left on the soil reduce soil blowing and help to conserve moisture. Terraces generally are not built on this soil because it is too shallow over gravelly sand. Waterways need to be maintained and, in some places, to be reestablished. Gullies should be shaped and seeded to form grassed waterways.

This soil is poorly suited to many kinds of trees and shrubs. Mortality in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. Special care in site preparation and in planting and weed control help to reduce seedling mortality. Trees on this soil generally grow slowly and tend to have a shorter life than trees of the same species on soils that are underlain by finer textured material. Windblown particles of soil can damage young trees or shrubs. A cover of grasses or of crop residue from corn or small grains reduces the risk of soil blowing and water erosion.

This soil is well suited as a site for buildings and for roads. Care should be taken to keep erosion to a minimum during construction of buildings and roads. Disturbed areas should be revegetated immediately following construction. Although this soil readily absorbs the effluent from septic tanks, it is too sandy to adequately filter and treat the effluent. Consequently, nearby water supplies can become contaminated. This hazard of contamination can be reduced by using suitable filtering material in the filter field.

This soil is in capability subclass IVe.

344—Quam silty clay loam. This is a nearly level, very poorly drained soil in broad, shallow, closed depressions on uplands. The areas generally are round and range from 5 to 50 acres in size. This soil is subject to ponding.

Typically, the surface soil is silty clay loam about 36 inches thick. It is black in the upper 19 inches and very dark gray and mottled below that. The underlying material to a depth of 60 inches is mottled, olive gray silt loam. In places, the surface soil is less than 24 inches thick.

Included with this soil in mapping and making up 4 to 8 percent of most mapped areas are small areas of Canisteo and Webster soils. The Canisteo and Webster soils are poorly drained and are on the edges of the mapped areas, on the rim of depressions, and on flats.

Permeability is moderately slow. The available water capacity is high or very high. Surface runoff is ponded or very slow. Typically, the surface soil is neutral. The content of organic matter is high or very high. The content of available phosphorus is medium to low, and the content of available potassium is very high. On undrained sites, a seasonal high water table is at or near the surface.

In most areas, this soil is drained and is used as cropland. Where it has not been drained, this soil is marshy and is well suited to use as habitat for wetland wildlife. If drained, this soil is well suited to all of the crops commonly grown in the county. Tile drainage and open ditches are needed to adequately drain the soil. Fall plowing permits earlier preparation of a seedbed in spring. If fall-tilled fields are left rough and some residue is left on the surface, soil blowing can be controlled. If this soil is worked when it is too wet, hard clods form that are difficult to break up. Green manure crops help to maintain good tilth in the surface layer.

In areas where surface water is not a problem, this soil is well suited to trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more kinds of trees and shrubs can be grown successfully. Site preparation needs to be completed in the fall before planting, because in many years working the soil early in spring when it is too wet causes clods to form. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not suited to sanitary facilities or dwellings because of wetness and the hazard of ponding. Low strength and frost heave can result in damage to roads built across areas of this soil. Roads need to be constructed on suitable base material and protected from wetness by drainage.

This soil is in capability subclass IIw.

371—Clontarf fine sandy loam. This is a very gently sloping, moderately well drained soil on outwash plains and stream deltas. The surface is convex. The areas are broad and irregular in shape and range from 20 to 50 acres in size.

Typically, the surface soil is black fine sandy loam about 19 inches thick. The subsoil is about 10 inches thick. It is very dark grayish brown sandy loam in the upper 5 inches and dark brown loamy sand below that. The underlying material to a depth of about 60 inches is olive brown loamy sand. In some places, the surface soil and the upper part of the subsoil have a higher content of sand and coarse sand than is typical.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Maddock, Egeland, and Sverdrup soils. Maddock and Egeland soils are well drained and are on higher parts of the landscape. Sverdrup soils are somewhat excessively drained.

Permeability is moderately rapid in the surface soil and the subsoil and rapid in the underlying material. The available water capacity is moderate. Surface runoff is slow. The surface layer is neutral or slightly acid. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is medium. The seasonal high water table is at a depth of 3 to 5 feet.

In most areas, this soil is cropped. Except in droughty years, it is well suited to corn, soybeans, small grains, and alfalfa. This soil is subject to soil blowing, especially in winter after fall tillage. Leaving crop residue on the surface helps to reduce the risk of soil blowing and to hold soil moisture. Field windbreaks also reduce the risk of soil blowing and the loss of moisture through evaporation and transpiration. The main management needs are increasing fertility, maintaining the content of organic matter, and increasing the available water capacity. The surface layer is easy to work and can be made into a good seedbed.

The suitability of this soil for trees and shrubs in windbreaks is fair. The available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs while they are becoming established. In some areas, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Competing weeds and grasses can be controlled by shallow cultivation or approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. There is also a risk of contamination of the ground water by effluent. Septic tank absorption fields can be placed above the surface soil in a mound of suitable filtering material. This soil is suited as a site for low buildings and for roads and streets. Wetness and frost action can cause difficulties in construction and can result in damage to structures. This damage can be reduced by artificially draining excess water from the soil and by building above the zone of wetness.

This soil is in capability subclass IIIs.

421B—Ves loam, 2 to 6 percent slopes. This is a gently sloping or gently undulating, well drained soil on low hills and on the lower part of side slopes. Surfaces are convex. Slopes are 30 to 100 feet long. The areas range from 5 to several hundred acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is brown clay loam about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous, loamy glacial till. Fragments of shale are common in the subsoil and underlying material. In some places, sandy and gravelly material is at the surface.

Included with this soil in mapping are small areas of Seaforth, Storden, Swanlake, Webster, Spicer, and Quam soils. Seaforth soils are moderately well drained and calcareous. They are on convex slopes slightly lower on the landscape than the Ves soil. Storden and Swanlake soils are well drained and calcareous. They are on the steeper convex part of hillsides. Webster soils are poorly drained and are in drainageways. The very poorly drained Spicer and Quam soils are in shallow depressions. The included soils make up 10 to 15 percent of most mapped areas.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. In most places, the surface layer is neutral. The content of organic matter is moderate. The content of available phosphorus is low, and the content of available potassium is high.

In most areas, this soil is cropped. It is well suited to all of the crops commonly grown in the county. Erosion is a slight hazard. The short, complex slopes generally are not well suited to terracing and contour farming. Minimum tillage practices, for example, chisel plowing, help to control erosion. On fall-plowed fields, leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing in winter and spring. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed where water collects and flows across this soil.

This soil is well suited to shrubs and trees in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

This soil is well suited as a site for sanitary facilities and for building site development. It has low strength and is subject to some frost heave. Damage resulting from low strength can be reduced by building the base of roads with material that has greater strength. Damage caused by frost heave can be reduced by proper design

of the roadbed to prevent water from ponding in ditches.
This soil is in capability subclass IIe.

423—Seaforth silt loam. This is a very gently sloping, moderately well drained, calcareous soil on low flats on the till plain. The areas are irregular in shape and range from 3 to 5 acres in size.

Typically, the surface soil is about 11 inches thick. It is black silt loam in the upper 7 inches and very dark grayish brown silt loam below that. The subsoil is brown, friable silt loam about 8 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled loam. The soil generally is calcareous throughout. In places, the surface layer is leached of free lime. Also, in places, the subsoil and underlying material contain salts.

Included with this soil in mapping are small areas of Canisteo, Colvin, Spicer, and Ves soils. Canisteo soils are poorly drained and are on the lower edge of knolls and in depressions between the knolls. Ves soils are moderately well drained and are in higher positions on the landscape. Colvin soils are poorly drained, and Spicer soils are very poorly drained; these soils are on the rim of depressions and on low rises. The included soils make up 6 to 13 percent of most mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is medium or slow. The surface layer is mildly alkaline or moderately alkaline because the content of lime is high. The content of organic matter is high. The content of available phosphorus is very low, and the content of available potassium is high. The seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is cropped. If adequately fertilized, this soil is suited to all of the crops commonly grown in the county. In places the high content of lime in the surface layer causes a fertility imbalance. The imbalance, however, can be corrected by using fertilizers that contain a liberal amount of potassium and phosphorus. Drainage of this soil is not needed, but drainage of the adjoining soils generally makes managing this soil easier. Leaving crop residue on the surface reduces the risk of soil blowing on fall-plowed fields during winter and spring.

The suitability of this soil for trees and shrubs in windbreaks is fair. The high content of lime adversely affects the uptake of plant nutrients. Chlorosis, which results from a lack of iron, is common in plants and is best controlled by planting trees and shrubs that can tolerate the high content of lime. Soil blowing can be controlled on bare knobs by maintaining a cover of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. Septic tank absorption fields should be placed above the surface layer in mounds of soil material to keep the absorption field above the zone of wetness. This soil has fair suitability as a site for low buildings and for roads. Wetness and frost action can cause construction difficulties and can result in damage to structures. This damage can be reduced or prevented by artificially draining the excess water from the soil and by building above the zone of wetness.

This soil is in capability subclass IIs.

434—Perella silty clay loam. This is a nearly level, poorly drained soil in drainageways and swales. The surface is slightly concave. In some areas, this soil is ponded after snowmelt in the spring or after heavy rains. The areas are long and narrow or irregular in shape and typically range from 3 to 100 acres in size.

Typically, the surface soil is black silty clay loam about 16 inches thick. The subsoil is 22 inches thick. It is very dark gray and olive silty clay loam in the upper 9 inches and light olive gray, mottled silt loam below that. The underlying material is olive gray, mottled, calcareous silt loam. In places, the subsoil has a higher content of clay.

Included with this soil in mapping and making up 5 to 10 percent of most mapped areas are small areas of Quam and Waubay soils. Quam soils are very poorly drained and are in depressions. Waubay soils are moderately well drained and are on the upper end of drainageways and on broad uplands.

Permeability is moderately slow. The available water capacity is high or very high. Surface runoff is very slow or ponded. The surface layer generally is neutral, but in some places, it is mildly alkaline. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is at or above the surface in spring and in wet periods except where the soil has been artificially drained.

In most areas, this soil is cropped. In few areas, it is used for grazing or wild hay. Drainage and maintenance of fertility and tilth are needed to make and keep the soil suitable for crops. Subsurface tile lines can provide adequate drainage. Deep tillage and deep-rooted legumes help to aerate this soil. Tilth can be maintained by returning crop residue to the soil and by using a crop rotation that includes forage grasses and legumes. Fall plowing permits earlier preparation of a seedbed in spring.

The choice of trees and shrubs used for windbreaks is limited to those species that tolerate wetness. This soil needs to be drained and competing vegetation needs to be controlled for trees and shrubs to attain the best survival and growth rate.

This soil generally is not used as a site for sanitary facilities or buildings because of wetness and ponding. In places it is necessary to build roads across areas of this soil. Damage caused by frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the high level of the water table. Damage resulting from low strength can be reduced by strengthening the soil or building the base of roads with material that has greater strength.

This soil is in capability subclass IIw.

444—Canisteo silty clay loam. This is a nearly level, poorly drained, calcareous soil in drainageways and on flats. The surface generally is very slightly convex. In drainageways, the areas are long and narrow; on flats, they are broad and irregular in shape. The areas range in size from 3 to several hundred acres.

Typically, the surface soil is black, calcareous silty clay loam about 15 inches thick. The subsoil is dark gray, mottled, calcareous silty clay loam about 9 inches thick. The underlying material is grayish brown and light olive brown, mottled, calcareous, loamy glacial till. In some places, the loamy glacial till is exposed at the surface. Also, in some places, there is a high content of gypsum.

Included with this soil in mapping and making up 5 to 25 percent of most mapped areas are small areas of Doland, Quam, Spicer, and Tara soils. Doland soils are well drained and are on more convex slopes. Quam and Spicer soils are very poorly drained and are in shallow, closed depressions. Tara soils are moderately well drained and generally are in higher positions on the landscape.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The surface layer is mildly alkaline or moderately alkaline. The content of lime is high. The content of organic matter is high. The content of available phosphorus is low or very low, and the content of available potassium is medium or high. The seasonal high water table is at a depth of 1 foot to 3 feet.

In most areas, this soil is cropped. In some areas where it has not been drained, the soil is used for grazing. This soil is well suited to intensive cropping if it is adequately drained and if all crop residue is returned. If crop growth is poor after adequate drainage has been provided, fertilizers that contain a liberal amount of potassium and phosphorus may be needed to help correct a fertility imbalance caused by the high content of lime. In some areas, the ground water contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used. Fall tillage permits rapid preparation of a seedbed in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. Chlorosis, which generally is caused by a lack of iron, is common in trees and shrubs and is best controlled by planting trees and shrubs that can tolerate the high content of lime. Drainage helps to lower the seasonal high water table and favors deeper rooting. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not used as a site for sanitary facilities and buildings because of seasonal wetness. The water table may be within 1 foot of the surface during wet periods of the year. Roads built across areas of this soil may be damaged because of wetness and frost action. The damage can be reduced by draining excess water from the soil and by building above the high level of the water table. Roads should be designed to prevent ponding of water in ditches. This soil has low strength, and coarser soil material needs to be used for road base or subgrade to ensure better performance.

This soil is in capability subclass IIw.

574—Du Page loam. This is a nearly level, moderately well drained soil on bottom land that is subject to occasional flooding. It is on the highest part of the bottom land, generally adjacent to streams. The areas are long and narrow or irregular in shape and range from 3 to 50 acres in size.

Typically, the surface soil is calcareous loam about 11 inches thick. It is very dark gray in the upper part and very dark grayish brown in the lower part. The underlying material to a depth of about 60 inches is very dark grayish brown, calcareous loam.

Included with this soil in mapping and making up 10 to 15 percent of most mapped areas are small areas of Calco and Terril soils. Calco soils are poorly drained and are in slightly lower positions on the flood plain, generally adjacent to the uplands. Terril soils are moderately well drained and are at the foot of upland slopes that border the river bottoms.

Permeability is moderate. The available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline in most places. The content of organic matter is moderate. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is cropped. It is well suited to all of the crops commonly grown in the county. Diversions are needed in some areas to divert the runoff from adjoining uplands. Legume and grass crops help to keep the surface layer loose and porous and the underlying layers permeable.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Roads built across areas of this soil may be damaged because of low strength. The damage can be reduced by strengthening the soil or building the base of roads with material that has greater strength.

This soil is in capability subclass IIw.

591B—Doland silt loam, 2 to 6 percent slopes. This is a gently sloping to undulating, well drained soil on side slopes and low knolls. Most areas are dissected by shallow drainageways. Most areas are irregular in shape; some areas on side slopes are long and narrow. The areas range from 3 to 30 acres in size.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsoil is friable, dark grayish brown silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is brown and light olive brown, calcareous loam. In a few areas, the surface layer is loam. Also, in some places, the silt mantle is over 30 inches thick.

Included with this soil in mapping are small areas of Tara, Perella, and Quam soils. Tara soils are moderately well drained and are on slightly concave surfaces. Perella soils are poorly drained and are in drainageways. Quam soils are very poorly drained and are in depressions. Also included are small areas where deposits of sand and gravel are in the underlying material. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high.

In most areas, this soil is cropped. It is well suited to all of the crops commonly grown in the county. Erosion is a slight hazard. In some areas, this soil is well suited to terracing and contour farming. Minimum tillage practices, for example, chisel plowing, help to control erosion. Leaving crop residue on the surface and keeping the surface rough on fall-plowed fields reduce the risk of soil blowing in winter and spring. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed in areas where water collects and flows over this soil.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. Soil blowing and water erosion can be controlled by maintaining crop residue on the surface. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

This soil has fair suitability as a site for septic tank absorption fields. It has a slow rate of absorption. Septic tank filter fields should be designed large enough for the soil to properly absorb and filter the effluent. Onsite tests are desirable to determine the absorption rate of the soil. This soil is well suited to building site development. It has low strength and is subject to frost heave. Damage to roads resulting from low strength can be reduced by building the base of roads with material that has greater strength. The damage caused by frost heave can be reduced by proper design of the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

595E—Swanlake loam, 18 to 25 percent slopes. This is a steep, well drained soil on valley side slopes adjacent to the better developed natural drainageways in the county (fig. 7). The areas are narrow and elongated

Figure 7.—Swanlake loam, 18 to 25 percent slopes, on a southwest-facing slope, in winter.

and range in size from 5 to several hundred acres. In places, a few scattered stones are on the surface.

Typically, the surface layer is very dark gray loam about 10 inches thick. The next layer is dark grayish brown loam about 4 inches thick. The underlying material to a depth of 60 inches is yellowish brown loam and clay loam. The soil generally is calcareous throughout, but in places part or all of the surface layer is leached of free lime.

Included with this soil in mapping are small areas of Calco, Storden, and Terril soils. Calco soils are poorly drained, and Terril soils are moderately well drained; both soils are in lower positions on the landscape. Storden soils have a thinner surface layer than the Swanlake soil and are on the more convex slopes. Wet, seepy spots and a few scattered perennial springs are in some places. The included soils make up less than 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Surface runoff is very rapid. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is moderate. The content of available phosphorus is very low, and the content of available potassium is medium.

In most places, this soil is used as pasture. The pasture generally has been overgrazed. As a result, the native grasses have been replaced by less productive grasses and weeds. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good grazing condition. A few potential sites for pond reservoirs are in areas of this soil.

In a few places where the slopes are less steep, this soil is used for cultivated crops. Erosion is a very severe hazard if this soil is cultivated. Because of the very rapid runoff, this soil is droughty. Gullies should be shaped and seeded to form grassed waterways. Diversion terraces can be built on some of the slopes above this soil to prevent or retard the formation of gullies.

This soil is too steep for windbreaks but is suited to other plantings. Erosion is a severe hazard if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees and shrubs. Weeds and grasses can be controlled by approved herbicides or by hand methods, such as hoeing.

This steeply sloping soil generally is not used as a site for septic tank absorption fields. The proper placement of filter fields is difficult, and effluent may seep laterally downslope and surface at a lower elevation. Erosion is a severe hazard if this soil is used for building site development. Measures to control erosion are needed both during and following construction. Mulching, sowing grass, or sodding disturbed areas can help to reduce erosion.

This soil is in capability subclass VIe.

595F—Swanlake loam, 25 to 40 percent slopes. This is a very steep, well drained soil on valley side slopes adjacent to the deeper natural drainageways in the county. The areas are narrow and elongated and range in size from 10 to several hundred acres. In some places, boulders are scattered on the surface.

Typically, the surface layer is very dark gray loam about 9 inches thick. The next layer is dark grayish brown loam about 4 inches thick. The underlying material to a depth of 60 inches is yellowish brown loam and clay loam. The soil generally is calcareous throughout, but in places part or all of the surface layer is leached of free lime.

Included with this soil in mapping and making up less than 5 percent of the map unit are small areas of Storden and Terril soils. Storden soils have a thinner surface layer than the Swanlake soil and are on the steeper, more convex slopes. Terril soils are moderately well drained and are on foot slopes. Wet, seepy spots and a few scattered perennial springs are in some mapped areas.

Permeability is moderate. The available water capacity is high. Surface runoff is very rapid. The surface layer is mildly alkaline in most places. The content of organic matter is moderate. The content of available phosphorus is very low, and the content of available potassium is medium.

This soil is mainly used as pasture. The soil is too steep for crops. In most areas, the pasture has been overgrazed. As a result, the native grasses have been replaced by less productive grasses and weeds. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good grazing condition. A few potential sites for pond reservoirs are on this soil.

This soil is too steep for windbreaks but is suited to other plantings. Erosion is a severe hazard if the surface is disturbed. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Competing weeds and grasses can be controlled by approved herbicides or by hand methods, such as hoeing.

This soil generally is not used as a site for septic tank absorption fields because of the very steep slopes. The proper placement of filter fields is difficult, and there is a hazard that effluent may seep laterally downslope and surface at a lower elevation. If buildings or roads are constructed on this soil, erosion is a severe hazard. Measures to control erosion are needed during and following construction. Mulching, sowing grasses, or sodding in disturbed areas can help to reduce erosion.

This soil is in capability subclass VIIe.

597—Tara silty clay loam. This is a very gently sloping, moderately well drained soil on the lower part of side slopes, on the upper part of drainageways, and on broad upland flats. Slopes generally are slightly concave to plane. The areas are mostly irregular in shape, but they are long and narrow where they parallel drainageways and side slopes. The areas range from 3 to 80 acres in size.

Typically, the surface soil is about 18 inches thick. It is black silty clay loam in the upper 14 inches and very dark gray silt loam below that. The subsoil is about 13 inches thick. It is dark grayish brown, friable silt loam in the upper part and light olive brown, calcareous, friable silt loam in the lower part. The underlying material to a depth of about 60 inches is light brownish gray and light olive brown, mottled, calcareous loamy glacial till. In a few places, the silty material is more than 40 inches thick. Also, in some places, carbonates are leached to a greater depth.

Included with this soil in mapping are small areas of Doland, Colvin, Seaforth, Spicer, and Quam soils. Doland soils are well drained, and Seaforth soils are moderately well drained and calcareous. Doland and Seaforth soils are on slightly convex slopes. Spicer soils are very poorly drained and are on the lower part of the landscape. Quam soils are very poorly drained and are in slight depressions. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate. The available water capacity is high or very high. Surface runoff is slow. The surface layer is neutral or slightly acid. The content of organic matter is high. The content of available phosphorus is very low, and that of available potassium is naturally high. The seasonal high water table is at a depth of 3 to 5 feet.

In most areas, this soil is used as cropland. It is well suited to all of the crops commonly grown in the county. Because it is moderately well drained, it dries out later in spring than the nearby well drained Doland soils and cannot be worked so early. Leaving crop residue on the surface of fall-plowed fields helps to control soil blowing. Green manure crops help to maintain good soil structure and tilth.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

This soil is poorly suited as a site for septic tank absorption fields because of seasonal wetness. Building the absorption field on a mound of soil material placed on the surface of this soil keeps the field above the zone of wetness. This soil is fairly suited to use as a site for low buildings and for roads. Wetness and frost action can cause construction difficulties and can result in damage to structures. This damage can be reduced by artificially draining excess water from the soil and by building above the high level of the water table.

This soil is in capability class I.

610—Calco silty clay loam, frequently flooded. This is a nearly level, poorly drained, calcareous soil in long, narrow areas next to streams and on oxbows in the flood plain. The areas are only slightly higher than the streams. The areas range in size from 5 to 40 acres, and most are in the Chippewa River Valley.

Typically, the surface layer is black silty clay loam about 13 inches thick. The subsurface layer is very dark gray silt loam about 10 inches thick. The subsoil is very dark gray silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is mottled, dark gray and very dark gray silt loam. The soil is calcareous throughout. In places, thin layers of sandy material are in the surface layer.

Included with this soil in mapping are small areas of Du Page soils. Du Page soils are moderately well drained and generally are at a higher elevation than the Calco soil. The included soils makes up 2 to 5 percent of the map unit.

Permeability is moderate. The available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high. The content of available phosphorus is low, and the content of available potassium is high. The seasonal high water table is at a depth of 1 foot to 3 feet.

In most areas, this soil is used as pasture. It is not suited to crops because it is subject to flooding and most areas are too dissected by streams or by old meander channels. In some places, leveling of stream channels can make this soil suited to crops.

This soil is well suited to use as pasture. In most places, the pasture has been overgrazed. As a result, the native grasses have been replaced by less productive grasses and by weeds. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Potential sites for excavated ponds are plentiful (fig. 8).

In most places, this soil is very poorly suited to trees and shrubs because of frequent overflow.

This soil generally is not used as sites for sanitary facilities or buildings because of wetness and the hazard

Figure 8.—Livestock watering pond on Calco silty clay loam, frequently flooded. The high water table makes this soil well suited to watering ponds.

of flooding. Damage to roads resulting from wetness can be reduced by artificially draining excess water from the soil and by building roads well above the high level of the water table. The low strength of this soil can result in damage to roads and streets. The damage resulting from low strength can be reduced by strengthening the soil or building the base of roads with material that has greater strength.

This soil is in capability subclass VIw.

847—Colvin-Spicer silty clay loams. These are nearly level soils on broad glacial lake plains. The Spicer soil is very poorly drained and is within larger areas of the poorly drained Colvin soil. The Colvin soil makes up 45 to 80 percent of the complex, and the Spicer soil makes up 10 to 45 percent. The Colvin soil is on convex rims and on rises, which are the highest points in the local relief. The Spicer soil is in swales and in small closed depressions. The areas of the two soils are so intricately mixed or so small in size that it was not practical to map the soils separately. The areas of this complex range in size from 50 to 1,000 acres.

Typically, the Colvin soil has a surface soil of black silty clay loam about 15 inches thick. The underlying material to a depth of about 60 inches is mottled, dark gray, grayish brown, and light olive brown silt loam and silty clay loam. In places, glacial till is within 40 inches of the surface.

Typically, the Spicer soil has a surface soil of black over very dark gray silty clay loam about 16 inches thick. The subsoil is olive gray silt loam and silty clay loam about 24 inches thick. The underlying material is light olive gray silty clay loam.

Included with these soils in mapping and making up 5 to 10 percent of the complex are small areas of Glyndon, Seaforth, and Tara soils. Glyndon and Tara soils generally are on the edges of the mapped areas. Glyndon soils are somewhat poorly drained and moderately well drained and are on the rim around depressions and on slightly convex rises. Seaforth and Tara soils are moderately well drained and are on glacial till knolls.

Permeability is moderate or moderately slow in the Colvin soil and moderate in the Spicer soil. The available water capacity and the content of organic matter are high. The seasonal high water table in the Colvin soil ranges from surface level to 1 foot below the surface, and the Spicer soil is subject to ponding. The surface layer is mildly alkaline to moderately alkaline.

If they are adequately drained, these soils are well suited to most of the crops commonly grown in the county. A system of subsurface tile and surface outlet ditches is needed to remove the excess water. The Colvin soil has a high content of lime in the root zone, which causes a nutrient imbalance in some crops (fig. 9). Adapted varieties should be grown, or special applications of fertilizer may be needed. Mulch tillage and the return of crop residue to the soil help to maintain tilth and to reduce soil blowing.

These soils have fair suitability for trees in windbreaks. Trees should be chosen that tolerate wetness and a high content of lime. Competing plants need to be controlled in new plantings by site preparation and post-planting weed control.

These soils generally are not used as a site for buildings or for sanitary facilities because of wetness and the hazard of ponding. If local roads are built across areas of these soils, the upper layer of both soils needs to be replaced or covered with a suitable base material to prevent damage resulting from low strength. Roads should be designed to prevent water from ponding in ditches.

Both soils are in capability subclass IIIw.

881—Glyndon-Quam silty clay loams. These are nearly level, somewhat poorly drained and very poorly drained soils on broad glacial lake plains. The areas range in size from 50 to 1,000 acres. The Glyndon soil makes up 50 to 70 percent of the complex, and the Quam soil makes up 20 to 30 percent. The Glyndon soil is somewhat poorly drained and is on the highest part of the landscape. The Quam soil is very poorly drained and is in small closed depressions. There is little difference in relief between the Quam and Glyndon soils. The areas of the two soils are so intricately mixed or so small that it was not practical to map the soils separately.

Typically, the Glyndon soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is very dark gray silt loam about 9 inches thick. The subsurface layer has many very fine particles of lime. The upper part of the underlying material is mottled, dark grayish brown silt loam, and the lower part to a depth of about 60 inches is mottled, light olive brown silt loam and silty clay loam. In some places, glacial till is within 40 inches of the surface.

Figure 9.—Soybeans on Colvin-Spicer silty clay loams. The lighter colored plants are affected by chlorosis on the highly calcareous Colvin soils.

Typically, the Quam soil has a silty clay loam surface soil about 36 inches thick. The surface soil is black in the upper 19 inches. Below that, it is very dark gray and is mottled in the lower part. The underlying material to a depth of about 60 inches is mottled, olive gray silt loam. In places, the underlying material has thin layers of sand and silt.

Included with this complex in mapping and making up 10 to 20 percent of the complex are small areas of Canisteo, Colvin, Seaforth, and Spicer soils. The included soils are at the edges of the mapped areas or are entirely within the mapped areas. Canisteo soils are poorly drained and are on glacial till convex knolls. Colvin soils are poorly drained and are on concave parts of the landscape between areas of the major soils. Seaforth soils are moderately well drained; they formed in glacial till. Spicer soils are very poorly drained and are limy throughout.

Permeability is moderate in the Glyndon soil and moderately slow in the Quam soil. The available water capacity and the content of organic matter are high. The seasonal high water table is at a depth of 2.5 to 6 feet in the Glyndon soil, and in the Quam soil it is within 1 foot of the surface. The Quam soil is occasionally ponded. The surface layer is neutral or mildly alkaline in both soils.

If these soils are adequately drained, they are well suited to all the crops commonly grown in the county. A system of subsurface tile and surface outlet ditches is necessary to remove the excess water. In the Glyndon soil, a high content of lime in the root zone causes a nutrient imbalance in some crops. Special applications of fertilizer may be needed. Mulch tillage and return of crop residue help to maintain tilth and to reduce soil blowing.

These soils are well suited to trees in windbreaks. Trees planted on these soils should be tolerant of wetness and highly tolerant of lime. Competing plants need to be controlled by the use of herbicides or by cultivation to reduce seedling mortality.

These soils generally are not used for building sites or for sanitary facilities because of wetness and the hazard of ponding on the Quam soil. If local roads are to be built across areas of these soils, a suitable base material is needed on the Quam soil to prevent damage resulting from low strength. Roads should be designed to prevent ponding of water in ditches.

The Glyndon soil is in capability class I; the Quam soil is in capability subclass IIIw.

891B2—Doland-Swanlake complex, 3 to 6 percent slopes, eroded. This complex consists of gently sloping or gently undulating, well drained soils in convex areas on uplands. The areas range in size from 10 to 50 acres. Slopes range from 50 to 1,000 feet. The Doland soil makes up 40 to 60 percent of the complex, and the Swanlake soil makes up 20 to 40 percent. The Doland soil is on the lower part of side slopes and in saddles between ridges and knolls. The Swanlake soil is in the steeper areas on the upper part of side slopes and on ridges. The areas of the two soils are so intricately mixed or so small that it was not practical to map the soils separately.

Typically, the Doland soil has a very dark gray silt loam surface layer about 8 inches thick. The subsoil is dark grayish brown silt loam about 9 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light olive brown, calcareous loam. In places, the surface layer is black. Also, in places, the silty surface layer and subsoil are thicker.

Typically, the Swanlake soil has a very dark gray loam surface layer about 7 inches thick. The layer below that is grayish brown loam about 5 inches thick. It has small masses of very dark gray material from the surface layer. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. The soil is calcareous throughout.

Included with this complex in mapping and making up 10 to 15 percent of the complex are areas of Canisteo, Seaforth, Terril, and Webster soils. Canisteo and Webster soils are poorly drained and are in swales and drainageways. Terril soils are moderately well drained and are on toe slopes and at the head of drainageways. Seaforth soils are moderately well drained and are on convex parts of the landscape.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. In most places, the surface layer of the Doland soil is neutral. The surface layer of the Swanlake soil is mildly alkaline. The content of organic matter is high in the Doland soil and medium in the Swanlake soil. The content of available phosphorus is low or very low, and the content of available potassium is medium or high. The seasonal high water table is at a depth below 6 feet.

These soils are mainly used as cropland. They are suited to all of the crops commonly grown in the county. Erosion is a moderate hazard. These soils generally are not well suited to terracing and contour farming. Minimum tillage, for example, chisel plowing, helps to control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall-plowed fields in winter and spring. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed where water collects and flows across these soils.

These soils are suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Swanlake soil have a lower survival rate because of low fertility and excessive lime. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting helps to prevent loss of moisture and kills unwanted vegetation. Maintaining crop residue on the surface while the site is being prepared helps to control erosion. In some places, windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

These soils are well suited to building site development. There is a slight hazard of erosion, and erosion control measures are needed during construction. The Doland soil has low strength, and the base of roads should be strengthened with a stronger material. These soils have fair suitability as a site for sanitary facilities. Filter fields need to be enlarged to insure adequate absorption of effluent.

Both soils are in capability subclass IIe.

891C2—Doland-Swanlake complex, 6 to 12 percent slopes, eroded. This complex consists of sloping or rolling, well drained soils on convex slopes on glaciated uplands. The areas range in size from 10 to 25 acres. The Doland soil makes up 35 to 55 percent of the complex, and the Swanlake soil makes up 25 to 45 percent. The Doland soil is on the lower part of side slopes and in saddles between ridges. The Swanlake soil is on the upper part of side slopes. The areas of the two soils are so intricately mixed or so small that it was not practical to map the soils separately.

Typically, the Doland soil has a very dark gray silt loam surface layer about 7 inches thick. The subsoil is about 9 inches thick. The upper part is dark brown silt loam, and the lower part is olive brown loamy glacial till. The underlying material to a depth of about 60 inches is calcareous, light olive brown loamy glacial till.

Typically, the Swanlake soil has a very dark gray loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. The soil is calcareous throughout.

Included with this complex in mapping and making up 15 to 20 percent of the complex are small areas of Canisteo, Storden, Terril, Ves, and Webster soils. Canisteo and Webster soils are poorly drained and are in drainageways. Terril soils are moderately well drained and are on toe slopes and at the head of drainageways. The Ves and Storden soils are well drained and are on side slopes. They are intermingled with the Doland and Swanlake soils.

Permeability is moderate. Surface runoff is medium to rapid. The available water capacity is high. The surface layer of the Doland soil is neutral, and that of the Swanlake soil is moderately alkaline. The content of organic matter is high in the Doland soil and medium in the Swanlake soil. The content of available phosphorus is low or very low, and the content of available potassium is medium or high.

If erosion is controlled and fertility maintained, these soils are well suited to the crops commonly grown in the county. The hazard of further erosion is moderate to severe. Grassed waterways are needed in some swales. In most places, slopes are too short and irregular for terracing and contouring. A crop rotation that includes a meadow crop helps to control runoff and prevent erosion. Also needed is a high level of management that includes spring plowing, heavy applications of manure, return of all crop residue to the soil, and disking instead of plowing for the small-grain crop that follows corn in the rotation.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Swanlake soil have a lower survival rate because of low fertility and a high content of lime. Planting on the contour and maintaining a mulch of crop residue help to reduce erosion. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and kill unwanted vegetation.

These soils are well suited to building site development. Erosion is a moderate hazard. Covering the surface with a mulch and then seeding grass or sodding the disturbed area after construction reduces the risk of erosion. The Doland soil has low strength, and on this soil the road base should be strengthened with coarser soil material. These soils have fair suitability for use as septic tank absorption fields. Effluent from improperly installed septic tank absorption fields, however, may seep laterally downslope and surface at a lower elevation.

Both soils are in capability subclass IIIe.

957B2—Rothsay-Zell complex, 3 to 6 percent slopes, eroded. This complex consists of gently sloping or gently undulating, well drained soils on outwash deltas. The areas range from 5 to 30 acres in size. The Rothsay soil makes up 50 to 65 percent of the complex, and the Zell soil makes up 25 to 35 percent. The Rothsay soil is on side slopes, and the Zell soil is on the steeper, more convex part of the landscape. The areas of the two soils are so intricately mixed or so small in size that it was not practical to map the soils separately.

Typically, the Rothsay soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is very dark brown and brown loam about 18 inches thick. The subsoil is mixed with the surface layer. The underlying material to a depth of about 60 inches is yellowish brown and brown very fine sandy loam. In places, the surface layer is more than 16 inches thick.

Typically, the Zell soil has a very dark gray silt loam surface layer about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam and silt loam. The soil is calcareous throughout. In some places, the surface layer is loam, and in a few places, it is very fine sandy loam. Also, in places, the soil is loam throughout.

Included with this complex in mapping are small areas of Egeland and Sverdrup soils. Egeland soils have more coarse sand in the subsoil. Sverdrup soils are sandy. The included soils make up 5 to 20 percent of the complex.

Permeability is moderate. Surface runoff is medium. The available water capacity is high or very high. The surface layer is neutral in the Rothsay soil and, in most places, mildly alkaline in the Zell soil. The content of organic matter is moderate or high. The content of available phosphorous is low, and the content of available potassium is medium.

In most areas, these soils are cropped. These soils are well suited to all the crops commonly grown in the county. Erosion is a moderate hazard. The long, smooth slopes generally are suited to contouring and terracing. Minimum tillage also helps to control erosion, particularly on sites that are not suited to contouring. Leaving crop residue on the surface and keeping the surface rough on fall-plowed fields reduce the risk of soil blowing in winter and spring. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed where water collects and flows over the soil.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Zell soil have a lower survival rate because of low fertility and the high content of lime. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and to reduce seedling mortality. Erosion can be controlled during site preparation by maintaining crop residue on the surface. In places, the tree rows can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

These soils are well suited as a site for septic tank absorption fields and for dwellings. Covering the surface with a mulch and then sowing grass or sodding the disturbed area following construction reduces the risk of erosion. Septic tank filter fields should be made large enough for the Zell soil to properly absorb and filter the effluent. Onsite tests need to be made to determine the absorption rate of this soil. The Zell soil has low strength, which may cause damage to roads. This damage can be reduced or prevented by building the road base with material that has greater strength and a lower shrink-swell potential. Roads should be designed so that water does not pond in ditches.

These soils are in capability subclass IIe.

957C2—Rothsay-Zell complex, 6 to 12 percent slopes, eroded. This complex consists of sloping or rolling, well drained soils on outwash deltas. The areas range in size from 5 to 20 acres. Slopes are 50 to 175 feet long. The Rothsay soil makes up 45 to 60 percent of the complex and the Zell soil 35 to 45 percent. The Rothsay soil is on side slopes, and the Zell soil is on the steeper, more convex parts of the landscape. The areas of the two soils are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Rothsay soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is very dark brown and brown loam about 18 inches thick. The subsoil is mixed with the surface layer. The underlying material to a depth of about 60 inches is yellowish brown and brown very fine sandy loam. In places, the surface layer is more than 16 inches thick.

Typically, the Zell soil has a very dark gray silt loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam and silt loam. The soil is calcareous throughout. In some places, the surface layer is loam, and in a few places, it is very fine sandy loam. Also, in places the soil is loam throughout.

Included with this complex in mapping are small areas of Egeland, Storden, and Sverdrup soils. Egeland soils have more coarse sand in the subsoil. Storden soils are calcareous throughout and are on the steeper parts of the landscape. Sverdrup soils are sandy. The included soils make up 5 to 10 percent of the complex.

Permeability is moderate. Surface runoff is medium to rapid. The available water capacity is high or very high. In most places, the surface layer is mildly alkaline in the Zell soil and neutral in the Rothsay soil. The content of organic matter is high to moderate. The content of available phosphorus is low or very low, and the content of available potassium is medium.

In most areas, these soils are cropped. If erosion is controlled and fertility maintained, these soils are well suited to the crops commonly grown in the county. The hazard of erosion is moderate to severe. Grassed waterways are needed where water collects and flows across the soil. In some places, the slopes are suited to terracing and contouring. In areas where the slopes are too irregular for terracing and contouring, a crop rotation that includes a meadow crop helps to control runoff and erosion. Also needed is a high level of management that includes spring tillage, heavy applications of manure, and return of all crop residue to the soil.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Zell soil have a lower survival rate because of low fertility and the high content of lime. Planting on the contour and maintaining a mulch of crop residue help to reduce erosion. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides. If the site for a windbreak is in sod, plowing and disking in summer or fall before planting help to prevent loss of moisture and to reduce seedling mortality.

These soils have fair suitability as a site for septic tank absorption fields and for dwellings. Covering the surface with a mulch and then seeding grass or sodding the disturbed areas after construction reduces the risk of erosion. Septic tank filter fields should be designed large enough for the Zell soil to properly absorb and filter the effluent. Onsite tests need to be made to determine the absorption rate of this soil. The Zell soil has low strength, which may cause damage to roads. This damage can be reduced by building the road base with material that has greater strength. Roads should be designed so that water does not pond in ditches.

These soils are in capability subclass IIIe.

992E—Rock outcrop-Copaston complex, 2 to 40 percent slopes. This complex consists of Rock outcrop and gently sloping to very steep, well drained Copaston soil. It is on side slopes in the Minnesota River Valley. The areas range from 6 to 100 acres in size. This complex is 40 to 50 percent Copaston soil and 40 to 50 percent Rock outcrop. Rock outcrop is grayish and reddish, rugged igneous rock that projects as much as 50 feet above the valley floor. The Copaston soil formed in loamy alluvial material that was deposited on the bedrock and among the outcrops of rock. The areas of Copaston soil are so intermingled with the Rock outcrop or are so small that it was not practical to map them separately.

The Rock outcrop is Precambrian igneous rock. It is mainly gneiss but contains dikes of basalt. The dikes are a few inches to many feet in width.

Typically, the Copaston soil has a black silt loam surface soil about 13 inches thick. Hard igneous bedrock is at a depth of about 13 inches. In places, the material over the bedrock is several feet thick, and it is sandy loam or loam.

Included with this complex in mapping are small areas of Arvilla, Calco, and Du Page soils. Arvilla soils are well drained and formed in a loamy mantle over sandy and gravelly outwash. Calco soils are poorly drained, and Du Page soils are moderately well drained. Also included in mapping are small areas consisting of marshes, intermittent waterholes, and wet flats. The soil material in these areas generally is thicker and more clayey. The included soils and wet areas make up 10 to 15 percent of the complex.

Permeability is moderate. Surface runoff is slow or medium. The available water capacity is low. Reaction of the surface layer is neutral in most places. The root zone is restricted by the shallowness to bedrock.

The soils in this complex are too rocky and shallow to bedrock to be used as cropland. They are best suited to use as pasture (fig. 10). In most areas, the pasture has been overgrazed. As a result, native grasses have largely been replaced by less productive grasses and weeds. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good condition. The included wet areas provide potential sites for stock watering pits.

The Copaston soil in this complex is too shallow and rocky for windbreaks, but in some places it is suitable for individual plantings. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Mortality of the trees and shrubs depends on their position on the slope and on the thickness of the soil mantle. Weeds and grasses can be controlled by approved herbicides or by hand methods, such as hoeing.

The Copaston soil is poorly suited to use as a site for buildings because of the shallow depth to bedrock. Blasting of bedrock is generally required. Septic tank absorption fields generally are not placed on this soil

Figure 10.—An area of Rock outcrop-Copaston complex, 2 to 40 percent slopes. Such areas are used mainly as pasture and hayland.

because of the shallowness to bedrock. There is a severe hazard that effluent may seep through fissures in the bedrock and contaminate ground water. Some areas of this complex are used as rock quarries.

The Copaston soil is in capability subclass VIIs.

1016—Udorthents, loamy. This map unit consists mainly of nearly level or gently sloping areas where the natural soil has been covered or has been removed. In places the soil has been removed and replaced with other material. Slopes are steep in some areas. Individual areas range from 3 to more than 500 acres in size.

The soil material in these areas varies considerably. Most areas are former gravel pits, dumps, and landfills that have been filled with trash, rocks, and other debris and then covered with soil material and leveled. Other areas are cut and fill places along roads, highways, and railroads.

Generally, soil characteristics vary widely. The material in most of these areas is low in fertility and in content of organic matter. Onsite investigation and borings are needed to determine the suitability of an area for a specific use.

Most of these areas are farmed with adjoining land. Some are used for grazing, wildlife habitat, or recreation uses. Those areas where the original soil was removed, stockpiled, and replaced after the fill had been obtained are suitable for use as cropland.

This map unit is not assigned to a capability subclass.

1029—Pits, gravel. This map unit consists of open excavations from which gravel has been removed. The pits vary in size, shape, and depth. There is water in some of the deeper pits. Trees, shrubs, and grasses grow in most abandoned pits. The pits generally range from 5 to 40 acres in size.

Most of the pits are within areas of Arvilla and Fordville soils. The original surface material was stripped and deposited around the edges of the pits. These mounds are a fair to good source of topsoil.

The larger gravel pits are on the steep side slopes that border the Minnesota River Valley. In these places, the slopes have a thick overburden of glacial till. Small gravel pits that are less than one-half acre in size are in pockets of sand and gravel on the upper part of side slopes and on ridges on the glaciated uplands. This gravel is suitable for use on farms.

Most of these pits have been abandoned and are used by wildlife for cover and nesting. Gravel pits that can be leveled have fair to poor potential for crops and pasture. Because soil properties vary widely, onsite investigation is needed to determine the suitability of an area for most uses.

This map unit is not assigned to a capability subclass.

1053—Aquolls and Aquents, ponded. This map unit consists of very poorly drained soils in closed depressions and ponds. In most places the soils are covered by 1 foot to 3 feet of water. A single mapped area can consist of either one or both of these soils. Cattails, reeds, sedges, and other water-tolerant plants grow in scattered areas in the open water. In prolonged dry weather, other kinds of vegetation also grow. The areas are irregular in shape and range from 5 to 160 acres in size.

In most places, the soils are deep, dark colored, and loamy.

Included with these soils in mapping are small areas of the poorly drained Webster, Canisteo, Colvin, and Perella soils along the edges of the mapped areas or on islands. In some places, in the Minnesota River Valley, there are outcrops of rock, or the soils are shallow over bedrock.

In most areas, the soils are used as wildlife habitat. Their suitability as habitat for wetland wildlife is good. The extreme wetness limits other uses.

Soils in this map unit are in capability subclass VIIIw.

1802—Spicer-Quam silty clay loams. This complex consists of nearly level, very poorly drained soils in broad, shallow depressions and in sloughs on glacial lacustrine plains. The soils formed dominantly in calcareous, silty lacustrine sediment. The Spicer soil is calcareous, and the Quam soil is leached and noncalcareous. These soils are subject to ponding.

The Spicer soil makes up 55 to 75 percent of the complex, and the Quam soil makes up 15 to 35 percent. The mapped areas range in size from 5 to 100 acres. The Spicer soil is on the edges of the mapped areas, and the Quam soil is in the center. Individual areas of the two soils are predictably mixed and are so small that it was not practical to map the soils separately.

Typically, the Spicer soil has a silty clay loam surface soil 19 inches thick. The surface soil is black in the upper 14 inches and very dark gray below that. The subsoil is olive gray, mottled silt loam and silty clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive gray silty clay loam.

Typically, the Quam soil has a silty clay loam surface soil about 38 inches thick. The surface soil is black in the upper 19 inches and very dark gray and mottled below that. The underlying material to a depth of about 60 inches is olive gray, mottled silt loam that has thin layers of sand and silt. In places, the surface layer is less than 24 inches thick.

Included with these soils in mapping and making up about 5 percent of the complex are small areas of Glyndon, Colvin, and Seaforth soils. The included soils are at the edge of the mapped areas, generally on the rim of the depressions. Glyndon soils are somewhat poorly drained and moderately well drained. Colvin soils are poorly drained. Seaforth soils are moderately well drained; they formed in glacial till.

Permeability is moderate in the Spicer soil and moderately slow in the Quam soil. The available water capacity and the content of organic matter are high. The surface layer of these soils ranges from neutral to moderately alkaline. The seasonal high water table varies from 1 foot to 2 feet above the surface to 1 foot below the surface. The content of available phosphorus is low, and that of available potassium is high.

In most areas, these soils are tile drained and are cultivated. If they are adequately drained, the soils are well suited to all the crops commonly grown in the county. The Spicer soil has a high content of lime in the root zone, which causes a nutrient imbalance in some crops. Special applications of fertilizer may be needed. Mulch tillage and return of crop residue to the soil help to maintain tilth and to reduce soil blowing.

These soils are poorly suited to trees and shrubs. The choice of trees and shrubs for windbreaks is limited to those that tolerate a high content of lime and wetness. Surface water needs to be removed, and competing plants need to be controlled for the survival and good growth of trees and shrubs.

These soils generally are not used as building sites or for sanitary facilities because of the hazard of ponding. If local roads are to be built across areas of these soils, suitable base material is needed to prevent damage that can result from the low strength of the soils. Also, drainage is needed. Roads should be designed so that water does not pond in ditches.

These soils are in capability subclass IIIw.

1849D—Storden stony loam, 6 to 25 percent slopes. This is a sloping to steep, well drained soil on side slopes of the Minnesota River Valley. The surface is plane or slightly convex. Slopes are about 150 feet long. The areas are long and narrow and range from 5 to 30 acres in size. Many stones more than 10 inches in diameter are on the surface.

Typically, the surface layer is black, calcareous stony loam about 8 inches thick. The upper part of the underlying material is dark grayish brown and yellowish brown, calcareous loam. The lower part to a depth of about 60 inches is light olive brown, calcareous loamy glacial till.

Included with this soil in mapping are areas of Canisteo, Terril, and Ves soils. Canisteo soils are poorly drained, and Terril soils are moderately drained. Canisteo and Terril soils are on the lower part of the side slopes. Canisteo soils have a seasonal high water table at a depth of 1 foot to 3 feet. Ves soils are deeper over the underlying material than the Storden stony soil. Ves soils are intermingled with the Storden soil. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate. The available water capacity is high. Surface runoff is very rapid or rapid. The content of organic matter is low. The content of available phosphorus is low, and the content of available potassium is medium. The surface is mildly alkaline or moderately alkaline.

In most places, this soil is used as pasture. Because of the stoniness and steep slopes, it generally is not suited to use as cropland. Pastures generally have been overgrazed. As a result, the native grasses have been largely replaced by less productive grasses and weeds. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good condition. A few potential sites for pond reservoirs are in areas of this soil.

In a few small areas where this soil is within fields of less sloping soils, it is used for cultivated crops. Erosion is a very severe hazard. Gullies need to be shaped and seeded to form grassed waterways. Diversion terraces can be built on some of the slopes above this soil to prevent or retard the formation of gullies.

This soil is too steep for windbreaks, but it is suited to other plantings. Erosion is a severe hazard. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Weeds and grasses can be controlled by approved herbicides or by hoeing or other hand methods.

This soil generally is not used for septic tank absorption fields because of steep slopes and stoniness. If roads or buildings are constructed on this soil, disturbed areas need seeding, mulching, or sodding to reduce erosion.

This soil is in capability subclass VIs.

1864B—Ves stony loam, 1 to 6 percent slopes. This is a gently undulating, well drained soil on a boulder-strewn erosional terrace that parallels the Minnesota River Valley in the northwest corner of the county. Numerous stones and boulders are on the surface and in the surface layer. The surface is convex, and slopes are 30 to 100 feet long. The areas range from 5 to about 100 acres in size.

Typically, the surface layer is black stony loam about 9 inches thick. The subsoil is dark yellowish brown, friable loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous loamy glacial till.

Included with this soil in mapping are small areas of Seaforth soils, Storden stony soils, and Canisteo stony soils. Seaforth soils are moderately well drained and calcareous. They are on broad flats and have a seasonal high water table within a depth of 3 feet. Storden stony soils are well drained and calcareous. They are on the steepest, most convex part of hillsides. Canisteo stony soils are poorly drained and are in drainageways. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The content of organic matter is moderate to high. The content of available phosphorus is low, and the content of available potassium is high. The surface layer is neutral or mildly alkaline.

This soil is well suited to use as cropland if the surface stones are removed. Erosion is a slight hazard if this soil is used as cropland. Minimum tillage practices that leave crop residue on the surface and tillage practices that leave the surface rough reduce the risk of soil blowing. Green manure crops help to maintain good soil structure and tilth. Grassed waterways are needed where water collects and flows across this soil.

This soil is well suited to trees in windbreaks, but planting is difficult because of the surface stoniness. Weeds and grasses need to be controlled in newly established windbreaks by shallow cultivation or approved herbicides. If the site for a windbreak is in sod, site preparation in summer or fall before planting helps to prevent loss of moisture and to control competing vegetation.

This soil is well suited to use as a site for sanitary facilities and for buildings if the stones are removed. The soil has low strength and is subject to frost heave. Damage resulting from low strength can be reduced by building the road base with material that has greater strength. Damage caused by frost heave can be reduced by designing the roadbed so that water does not pond in ditches.

This soil is in capability subclass VIs.

1866—Perella-Colvin silty clays. These are nearly level, poorly drained soils on broad wet flats and in depressions in the central part of the county in an ancient lakebed. The areas range from several hundred to 1,000 acres in size. They are 40 to 60 percent Perella soil and 35 to 50 percent Colvin soil. The two soils are in areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Perella soil has a black silty clay loam surface soil 20 inches thick. The subsoil is light olive gray and olive gray silty clay loam about 20 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is olive gray silt loam.

Typically, the Colvin soil has a black silty clay loam surface soil about 16 inches thick. The underlying material to a depth of about 60 inches is mottled, dark gray and light olive brown silt loam and silty clay loam. In places, the subsoil and the underlying material are clay.

Included with these soils in mapping are small areas of Seaforth, Tara, Spicer, and Waubay soils. Seaforth, Waubay, and Tara soils are moderately well drained and are in higher positions on the landscape. Spicer soils are very poorly drained, are in positions similar to those of the Perella soil, and have carbonates at the surface. Waubay soils are in deep silty deposits on the broad, level tops of adjacent uplands. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow in the Perella soil and moderate or moderately slow in the Colvin soil. The available water capacity is high. Surface runoff is very slow. The content of organic matter is high. The surface layer is neutral in the Perella soil and mildly alkaline or moderately alkaline in the Colvin soil. A seasonal high water table is at or on the surface in spring and during wet periods.

In most areas, these soils are farmed. If the soils are properly drained, they are well suited to all crops commonly grown in the county. Open ditches and subsurface tile lines can provide adequate drainage if there is a suitable outlet. A high content of lime in the root zone of the Colvin soil causes a nutrient imbalance in some crops. Maintaining tilth and fertility are major concerns. Also, large open areas are subject to soil blowing. A balanced fertilizer program based on soil tests, applications of manure, and the return of crop residue help to maintain fertility and tilth and to reduce soil blowing. Fall plowing permits preparation of a seedbed early in spring.

These soils have fair suitability for trees and shrubs in windbreaks. Many kinds of trees and shrubs can be grown in areas where the soils are drained. On Colvin soil, only those trees and shrubs that tolerate a high content of lime should be planted. Site preparation should be completed in the fall before planting because clods tend to form if the soil is tilled in spring when it is wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

These soils generally are not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Also, effluent from sanitary facilities can contaminate the water table. Damage to roads caused by frost heave can be reduced by draining the excess water from the soil and by building the road well above the high level of the water table. Damage to roads resulting from low strength can be reduced by strengthening the soil or building the road base with material that has greater strength.

Both soils are in capability subclass IIw.

1868—Canisteo stony loam. This is a nearly level, poorly drained, calcareous soil in upland drainageways that parallel the Minnesota River Valley. There are many stones and boulders on the surface and in the layers below. In some meandering channels there is a higher proportion of stones on the surface. The surface is plane or slightly convex. The areas are slightly elongated and range from 5 to 60 acres in size.

Typically, the surface layer is stony loam and loam about 13 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark grayish brown, mottled loam about 7 inches thick. The underlying material is yellowish brown, mottled, clayey and loamy glacial till. This soil is calcareous throughout. In some small areas, there is a layer of loamy water-worked material at the surface. In other areas, lime has been leached from the surface layer.

Included with this soil in mapping and making up to 5 to 10 percent of the map unit are small scattered areas of Marysland soils. Marysland soils formed in loamy material and underlying sandy material, and they have an accumulation of lime within 16 inches of the surface.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The surface layer is mildly alkaline or moderately alkaline. The soil has a high content of lime; in spots it also has a high content of gypsum. The content of organic matter is high. The content of available phosphorus is low or very low, and the content of available potassium is medium or high. The seasonal high water table is at a depth of 1 to 3 feet in spring and in wet periods. The surface layer and subsoil contain numerous stones and boulders, some of which are over 3 feet in diameter.

In most areas, this soil is used for grazing. It is suited to intensive cropping if the stones and boulders have been removed and if it is adequately drained and fertilized. Tile is needed to provide subsurface drainage. If crop growth is poor after adequate drainage has been provided, fertilizers that contain a liberal amount of potassium and phosphorus may be needed. These nutrients help to correct the fertility imbalance caused by the high content of lime. In some areas, the ground water contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used. Fall plowing permits rapid preparation of a seedbed in spring.

This soil is poorly suited to trees and shrubs. Wetness and the high content of lime limit the kinds of trees and shrubs that can grow well. Chlorosis, which generally is caused by a lack of iron, is common in trees and shrubs because of the high content of lime. This condition is best controlled by planting trees and shrubs that can tolerate the high content of lime. Site preparation in the fall before planting is desirable. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or approved herbicides.

This soil generally is not used as a site for sanitary facilities and buildings because of the numerous stones and boulders on the surface and because of seasonal wetness. The water table may be within 1 foot of the surface during wet parts of the year. Damage to roads caused by wetness and frost action can be reduced by draining excess water from the soil and by building above the high level of the water table. Roads should be designed so that water does not pond in ditches. Damage to roads resulting from low strength of the soil can be reduced by building the road base with material that has greater strength.

This soil is in capability subclass Vw.

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prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Chippewa County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have soil properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be used as cropland, pasture, or woodland, or they may be in other uses. They are either used for producing food or fiber or are available for these uses. Urban and built-up land or water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Some soils that have a high water table qualify as prime farmland soils only in areas where this limitation is overcome by drainage. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

prime farmland in Chippewa County

About 275,820 acres, or nearly 73 percent of the county, is prime farmland. The areas are scattered throughout the county. Nearly all of this prime farmland is used for crops.

A recent trend in land use in some parts of the county has resulted in 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 less productive because they are more erodible, droughty, or difficult to cultivate.

The following map units, or soils, make up prime farmland in Chippewa County. Limitations, if any, are shown in parentheses after the name of the map unit. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

35 Blue Earth mucky silt loam (where artificially drained)
60 Glyndon silt loam (where artificially drained)
85 Calco silty clay loam (where artificially drained)
89 McDonaldsville silty clay (where artificially drained)
94B Terril loam, 2 to 6 percent slopes
113 Webster silty clay loam (where artificially drained)
246 Marysland loam (where artificially drained)
290B Rothsay loam, 2 to 6 percent slopes
338 Waubay silty clay loam
339A Fordville silt loam, 0 to 2 percent slopes
339B Fordville loam, 2 to 6 percent slopes
421B Ves loam, 2 to 6 percent slopes
423 Seaforth silt loam
434 Perella silty clay loam (where artificially drained)
444 Canisteo silty clay loam (where artificially drained)
574 Du Page loam
591B Doland silt loam, 2 to 6 percent slopes
597 Tara silty clay loam
847 Colvin-Spicer silty clay loams (where artificially drained)
891B2 Doland-Swanlake complex, 3 to 6 percent slopes, eroded

957B2 Rothsay-Zell complex, 3 to 6 percent slopes, eroded

1866 Perella-Colvin silty clays (where artificially drained)

use and management of the soils

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

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

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

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

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

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

crops and pasture

Michael D. Appel, district conservationist, Soil Conservation Service, helped to prepare this section.

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

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

According to the 1971 Minnesota Soil and Water Conservation Needs Inventory, more than 320,000 acres in Chippewa County were used for crops and pasture in 1967. Of that acreage, 13,957 acres were used as pasture; 230,190 acres were in row crops, mainly corn, soybeans, and sugar beets; 58,300 acres were in close-growing crops, mainly wheat, oats, barley, and flax; 15,325 acres were used for hay, mainly alfalfa; and 6,100 acres were in conservation programs. Since 1967, the acreage of close-growing crops and of row crops has fluctuated, and that of hayland and pasture and the acreage in conservation programs have decreased. This is mainly a result of shifting market prices and a change in agricultural programs. The acreage of sunflowers, a row crop that was of little importance in 1967, has increased significantly in recent years. Market prices may make sunflowers an important crop in Chippewa County in the future.

The soils in Chippewa County have very good potential for increased crop production. Crop production could be increased on almost all the soils in the county by use of the latest varieties and technology and by proper management.

If the soils in Chippewa County are used for crops, the main concerns in management are controlling water erosion and soil blowing and providing internal drainage for the wetter soils. Soil blowing is a hazard on most of the soils in the county. This hazard is most severe on the Egeland, Maddock, Sverdrup, and Arvilla soils. Minimum tillage, stubble mulching, stripcropping, and field windbreaks help to reduce soil blowing.

Water erosion is a hazard on the undulating and steeper soils, for example, Swanlake, Ves, Storden, Doland, and Rothsay soils. Contouring, contour stripcropping, terraces, grassed waterways, and minimum tillage help control water erosion.

Droughtiness is a limitation on Maddock, Sverdrup, Egeland, and Arvilla soils. Stubble mulching, stripcropping, timely tillage, grasses and legumes in the cropping system, and fertilizer help reduce evaporation, reduce runoff, and increase fertility on these soils.

Poor internal drainage is a limitation on 80,000 acres of cropland in the county. An extensive surface ditching system that includes county, judicial, and private ditches provides outlets for tiling. With additional laterals and standpipes, the poorly drained and very poorly drained Quam, Blue Earth, Colvin, and Perella soils could be drained.

Seasonal flooding is a hazard on the Calco and Du Page soils along the Minnesota River. Shallow ditches are needed to remove surface water to ensure a sufficiently long growing season. Finding adequate outlets for tile drainage systems is difficult on these soils.

Soils that have a high content of lime are common in the eastern two-thirds of the county. Examples are Glyndon soils and Glyndon-Quam silty clay loams on the rim of shallow depressions and Colvin soils along the upper part of pothole basins. Crop selection, drainage, and applications of fertilizer are needed on these soils.

Natural fertility is medium or high for most soils in the county. Crops on most soils respond well to fertilizer applications. The soils in the county are somewhat low in phosphorus, but they have an adequate content of potassium and lime. Fertilizer needs depend on the kind of soil, past and present management, and the kind of crop to be grown. A soil test can provide the information needed for choosing the proper kind and amount of fertilizer.

Soil tilth varies throughout the county depending on soil characteristics. Tilth is important in seed germination and water infiltration. Soils that have good tilth are granular and porous. Conservation tillage, returning green manure crops to the soil, and adding other organic matter to the soil improve soil structure and water infiltration. Poor tilth can result from compaction caused by cultivating or harvesting when the surface layer is wet.

Row crops suited to the soils and climate of the county are corn, soybeans, sugar beets, and sunflowers. Grain sorghum, dry beans, and sweet corn are grown if market conditions are favorable. Wheat and oats are the most common close-grown crops. Barley, flax, rye, and buckwheat are also grown to some extent. Hayseed can be produced from alfalfa, bromegrass, big bluestem, switchgrass, sweet clover, and red clover.

About 4 percent of the county, or 13,957 acres, is used for grazing, according to the 1967 Conservation Needs Inventory. Pastureland is mainly along wooded slopes and bottoms in the valleys of the Minnesota and Chippewa Rivers and their tributaries. The dominant soils on southeast-facing slopes are Ves, Storden, Swanlake, and Doland soils. Calco, Du Page, Webster, and Marysland soils are on bottom lands.

Pasture management is needed on nearly all the pastureland. Overgrazing and high stocking rates contribute to poor pasture stands and increase the hazard of erosion. Delayed grazing, reduced stocking rates, and pasture rotation are needed to correct most management problems. Reseeding and weed and brush control are needed on some pastures. Steepness and stoniness may be limiting factors. Native prairie grasses can be encouraged in these areas by using chemicals and other control measures to eliminate weeds and brush.

Information on practices and crops mentioned in this section can be obtained from the local offices of the Cooperative Extension Service and the Soil Conservation Service.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. 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 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 insures 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 5 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.

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 grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

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

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 slight 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."

windbreaks and environmental plantings

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

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold 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 insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 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 nursery.

recreation

The soils of the survey area are rated in table 7 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 7, 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 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

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, horseback riding, and bicycling 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

Wildlife numbers have decreased since Chippewa County was settled. Changes in land use directly affected the species and populations of wildlife. Habitat has become restricted to watercourses, isolated marshes, and farmstead shelterbelts.

The most important kinds of wildlife in Chippewa County are geese and ducks. The Lac qui Parle Goose Refuge, which takes up more than 3,500 acres, is managed for waterfowl and other wildlife. During the annual fall migration, the number of geese on the refuge and in surrounding areas often is greater than 50,000. The refuge and Minnesota River bottom lands also support a large population of white-tailed deer. Ring-necked pheasant and Hungarian partridge inhabit the uplands. The pheasant population has declined over the years, and Hungarian partridge numbers have increased. Cottontail, jackrabbit, and squirrels also inhabit the county. Red fox, raccoon, mink, and muskrat are important furbearers, although they are not present in significant numbers.

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 8, 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, soybeans, wheat, and oats.

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, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, ash, chokecherry, black raspberry, wild rose, hawthorn, maple, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, honeysuckle, cherry, and crabapple.

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

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, 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 Hungarian partridge, pheasant, meadowlark, mourning dove, field sparrow, cottontail, jackrabbit, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include thrushes, woodpeckers, squirrels, 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, 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 9 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, 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 10 shows the degree and the 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 10 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 effectively filter the effluent. 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 10 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 10 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, soil reaction, and content of salts and sodium 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 11 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 11, 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 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

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

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

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

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soil properties

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

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

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

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

engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

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

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

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

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

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

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.

physical and chemical properties

Table 14 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 earth-moving operations.

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

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

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

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

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

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

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

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

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

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

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

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

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

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

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

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

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

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer 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 15 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.

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

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of 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 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

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. An *artesian* water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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

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

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are 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. In table 16, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

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

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

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

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

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

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

soil series and their morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*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."

Arvilla series

The Arvilla series consists of somewhat excessively drained soils on glacial outwash plains. The soils formed in a loamy mantle overlying sandy outwash material. Permeability is moderately rapid in the surface soil and subsoil and rapid in the underlying material. Slopes range from 0 to 12 percent.

Arvilla soils are similar to Sverdrup soils and are adjacent to Clontarf and Fordville soils. Sverdrup soils have less than 5 percent coarse fragments in the underlying sand and gravel. Clontarf soils are well drained, and Fordville soils are moderately well drained. Clontarf and Fordville soils have a thicker mollic epipedon and are in higher positions on the landscape than Arvilla soils.

Typical pedon of Arvilla sandy loam, 1 to 6 percent slopes, 175 feet west and 1,300 feet north of the center of sec. 33, T 117 N., R. 39 W.

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

A3—8 to 14 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium platy structure parting to weak medium subangular blocky; friable; neutral; clear smooth boundary.

B2—14 to 18 inches; dark brown (7.5YR 3/2) sandy loam, brown (7.5YR 5/3) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

IIC1—18 to 21 inches; brown (10YR 4/3) loamy sand; weak medium subangular blocky structure parting to single grain; loose; 6 percent coarse fragments 2 to 3 mm in size; strong effervescence; moderately alkaline; clear smooth boundary.

IIC2—21 to 38 inches; brown (10YR 4/3) gravelly sand; single grain; loose; 25 percent coarse fragments 3 mm to 7.5 cm in size; slight effervescence; mildly alkaline; gradual smooth boundary.

IIC3—38 to 60 inches; dark brown (7.5YR 4/4) sand; single grain; loose; 15 percent coarse fragments 2 to 8 mm in size; slight effervescence; mildly alkaline.

The solum is 14 to 25 inches thick. Depth to sand and gravel ranges from 14 to 25 inches. Typically, the solum is sandy loam, but the range includes loam to coarse sandy loam. Coarse fragments 2 mm in size or larger make up as much as 5 percent of the volume. The mollic epipedon is 7 to 20 inches thick.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1. The B2 horizon has hue of 2.5Y to 7.5YR, value of 2 through 4, and chroma of 1 through 3. In some pedons, a calcic horizon is at a depth of more than 16 inches. The IIC horizon is more than 5 percent gravel and has lime accumulations in the upper part.

Blue Earth series

The Blue Earth series consists of very poorly drained, moderately permeable, calcareous soils. The soils formed in a mantle of organic material overlying silty lake sediment. They are on former glacial lakes and ponds. Slopes are 0 to 2 percent.

Soils of the Blue Earth series in Chippewa County have 18 to 30 inches of limnic sediment, which is less than that prescribed in the defined range for the Blue Earth series. This difference, however, does not alter the use or behavior of the soils.

Blue Earth soils are commonly adjacent to Calco, Canisteo, and Seaforth soils. Calco soils are poorly drained and formed in recently deposited silty alluvium on flood plains. Canisteo soils are poorly drained, and Seaforth soils are moderately well drained. Canisteo and Seaforth soils are in higher positions on the landscape than Blue Earth soils; they formed in loamy glacial till.

Typical pedon of Blue Earth mucky silt loam, 200 feet east and 120 feet south of the northwest corner of NE1/4 sec. 4, T. 117 N., R. 38 W.

Lcop—0 to 9 inches; black (10YR 2/1) mucky silt loam, dark gray (5Y 4/1) dry; weak medium subangular blocky structure; very friable; common shell fragments; slight to strong effervescence; mildly alkaline; abrupt smooth boundary.

Lco2—9 to 20 inches; black (10YR 2/1) mucky silt loam, dark gray (5Y 4/1) dry; weak medium prismatic structure parting to weak medium platy; friable; common shell fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

IIC1—20 to 32 inches; very dark gray (5Y 3/1) silty clay loam; few medium distinct olive brown (2.5Y 4/4) mottles; weak coarse prismatic structure parting to weak fine and medium subangular blocky; friable; common shell fragments; slight to strong effervescence; mildly alkaline; gradual smooth boundary.

IIC2—32 to 60 inches; very dark gray (5Y 3/1) silty clay loam; few fine distinct olive (5Y 4/3) mottles; weak coarse prismatic structure; firm; few shell fragments; strong effervescence; moderately alkaline.

The coprogenous earth is 18 to 30 inches thick. Depth to glacial till or glacial lacustrine sediment ranges from 18 to 30 inches. There are free carbonates throughout the profile. The coprogenous earth has few to many fragments of snail shells and clamshells, and the content of organic matter is 10 to 20 percent.

The coprogenous earth has hue of 10YR or 5Y, value of 2 through 4, and chroma of 1 or 2. The IIC horizon has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam.

Calco series

The Calco series consists of poorly drained, moderately permeable soils on flood plains. The soils formed dominantly in silty, stream-deposited alluvium. Slope ranges from 0 to 2 percent.

Calco soils are similar to Quam soils, and they are near Du Page and Terril soils on the landscape. Quam soils are very poorly drained and are in closed depressions on glacial uplands. Du Page soils are moderately well drained and are at a higher elevation on flood plains. Terril soils are moderately well drained; they are at the base of adjacent upland slopes and are not subject to flooding.

Typical pedon of Calco silty clay loam, 1,000 feet south and 25 feet west of the northeast corner of SE1/4 sec. 13, T. 116 N., R. 40 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; strong medium subangular blocky structure; firm; many fine roots; fine fragments of snail shells; slight effervescence; neutral; abrupt smooth boundary.

A12—10 to 26 inches; black (2.5Y 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to strong fine granular; firm; many fine roots; common fine fragments of snail shells; strong effervescence; mildly alkaline; gradual smooth boundary.

A13—26 to 37 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak moderate subangular blocky structure parting to moderate fine subangular blocky; friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg—37 to 46 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; few medium distinct olive gray (5Y 5/2) mottles; weak fine prismatic structure; friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; dark olive gray (5Y 3/2) silty clay loam; common medium distinct olive gray (5Y 5/2) mottles; massive; friable; mildly alkaline; strong effervescence.

The silty part of the solum typically is more than 36 inches thick. In most pedons, horizon boundaries are gradual or diffuse, and there are fragments of snail shells throughout. In some pedons, the A horizon is mottled in the lower part. The Bg horizon has hue of 10YR or 2.5Y, chroma of 3 or 4, and value of 1. The C horizon has hue of 10YR, value of 3 or 4, and chroma of 1 through 4.

In map unit 610, Calco silty clay loam, frequently flooded, the soil is more stratified than is defined for the Calco series. This difference does not alter the use or behavior of the soil.

Canisteo series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils on glacial moraines. These soils formed in glacial till or in a mantle of silty lacustrine sediment and the underlying till. Many stones are on the surface or in the profile of this soil in the northwest corner of the county. Slopes range from 0 to 2 percent.

Canisteo soils are similar to Colvin and Webster soils and are commonly adjacent to Seaforth, Quam, and Tara soils. Colvin and Quam soils have a fine-silty control section, and Quam soils are very poorly drained. Webster soils do not have carbonates in the upper part of the subsoil. Seaforth and Tara soils are moderately well drained and generally are in higher positions on the landscape than Canisteo soils.

Typical pedon of Canisteo silty clay loam, 330 feet north and 110 feet west of the southeast corner of NE1/4 sec. 22, T. 119 N., R. 37 W.

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

A12—8 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

B2g—15 to 24 inches; dark gray (5Y 4/1) silty clay loam; few fine faint olive (5Y 5/4) mottles; weak fine subangular blocky structure; friable; 2 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C1g—24 to 43 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; firm; 8 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2g—43 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; firm; 10 percent coarse fragments; slight effervescence; mildly alkaline.

The mollic epipedon is 14 to 24 inches thick. The content of coarse fragments typically is 2 to 8 percent, but there may be no coarse fragments in the upper 20 inches. In many pedons, few to common nests of gypsum crystals are in the underlying material.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or less. It is stony loam or silty clay loam, but the range includes clay loam, loam, and silt loam. The C horizon has hue of 2.5Y or 5Y, value of 4 through 7, and chroma of 1 through 3. It is loam, silty clay loam, or clay loam.

Clontarf series

The Clontarf series consists of moderately well drained soils on outwash plains, glacial lake plains, or deltas. The soils formed in a loamy mantle and in the underlying sandy water-deposited sediment. Permeability is moderately rapid in the solum and rapid in the underlying material. Slopes range from 1 to 3 percent.

Clontarf soils are commonly adjacent to Maddock, Sverdrup, and Torning soils. Maddock soils are well drained, and Sverdrup soils are somewhat excessively drained. Maddock and Sverdrup soils have a sandy control section. Torning soils are well drained and calcareous and are on adjacent steeper slopes.

Typical pedon of Clontarf fine sandy loam, 600 feet east and 1,200 feet south of the northwest corner of sec. 5, T. 118 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.
A12—8 to 19 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; slightly acid; clear wavy boundary.
B1—19 to 24 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; clear wavy boundary.
IIB2—24 to 29 inches; dark brown (10YR 3/3) loamy sand; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; neutral; clear wavy boundary.
IIC2—29 to 60 inches; olive brown (2.5Y 4/4) loamy sand; few fine prominent reddish yellow (7.5YR 6/6) and common medium distinct yellowish brown (10YR 5/4) mottles; single grain; loose; neutral.

The solum is 20 to 32 inches thick. The mollic epipedon is 16 to 30 inches thick.

The A horizon is sandy loam, fine sandy loam, or loam. It has value of 2 or 3 (4 or 5 dry) and chroma of 1. The B horizon is sandy loam or loam in the upper part and loamy sand or sand in the lower part. It is mottled and has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. The IIC horizon has hue of 2.5Y and value and chroma of 4 through 6.

Colvin series

The Colvin series consists of poorly drained soils on lacustrine-influenced glacial till plains. Permeability is moderate or moderately slow. The soils formed in calcareous, silty lacustrine sediment. Slopes range from 0 to 2 percent.

Colvin soils commonly are adjacent to Glyndon, Doland, Seaforth, and Tara soils. Glyndon soils are moderately well drained or somewhat poorly drained and are in higher positions on the landscape. Doland soils are well drained, and Tara soils are moderately well drained; Doland and Tara soils are on higher slopes and formed in a silty mantle over glacial till. Seaforth soils are moderately well drained and are on convex surfaces on low knolls.

Typical pedon of Colvin silty clay loam, in an area of Colvin-Spicer silty clay loams, 645 feet west and 700 feet north of the southeast corner of NE1/4 sec. 13, T. 118 N., R. 40 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.
A12—8 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.
C1ca—15 to 21 inches; dark gray (10YR 4/1) silt loam; weak fine and medium subangular blocky structure; friable; violent effervescence; moderately alkaline; clear wavy boundary.
C2g—21 to 43 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct light olive brown (2.5Y 5.4) mottles; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.
C3g—43 to 60 inches; light olive brown (2.5Y 5.4) silty clay loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; slight effervescence; mildly alkaline.

The mollic epipedon is 7 to 16 inches thick. In some pedons the lower part of the mollic epipedon is part of the calcic horizon.

The A horizon has hue of 10YR or 2.5Y, value of 2 through 4 (3 through 6 dry), and chroma of less than 1 moist or dry. It typically is silt loam or silty clay loam. The Cca horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 through 6, and chroma of 2 or less. The Cg horizon has hue of 2.5Y or 5Y, value of 4 through 6 (5 through 7 dry), and chroma of 1 through 3. The texture of this horizon is similar to that of the control section (silt loam or silty clay loam).

Copaston series

The Copaston series consists of shallow, well drained, moderately permeable soils. The soils formed in a thin mantle of loamy alluvium over bedrock. They are dominantly on rock-cored terraces or benches on flood plains in the Minnesota River Valley. Slope ranges from 2 to 40 percent.

Copaston soils commonly are adjacent to Calco and Du Page soils. Calco soils are poorly drained and are in depressions on flood plains. Du Page soils are moderately well drained and are on stream levees and high terraces of flood plains. Calco and Du Page soils formed in thick, calcareous alluvial deposits.

Typical pedon of Copaston silt loam, in an area of Rock outcrop-Copaston complex, 2 to 40 percent slopes, 2,275 feet west and 1,475 feet north of the southeast corner of sec. 11, T. 115 N., R. 39 W.

A1—0 to 3 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine crumb structure; friable; many roots; 1 percent coarse fragments of alluvial origin; slightly acid; clear smooth boundary.
A12—3 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate fine

subangular blocky; friable; many roots; 1 percent coarse fragments of alluvial origin; neutral; clear smooth boundary.

A13—7 to 13 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; common roots; root mat at soil/rock interface; 4 percent coarse fragments of alluvial origin; neutral; abrupt smooth boundary.

IIR—13 inches; granite bedrock.

The solum is 12 to 20 inches thick. Depth to bedrock ranges from 12 to 20 inches. The solum typically is neutral, but it ranges to mildly alkaline in the lower part. The solum typically is silty loam, but the range includes loam.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Bedrock is Precambrian igneous rock. Typically, the boundary between the solum and bedrock is abrupt. However, a thin weathered layer that has many fragments of rock is at the interface in some pedons.

Doland series

The Doland series consists of well drained, moderately permeable soils on uplands. The soils formed in silty or loamy, water- and wind-deposited sediment and in the underlying loamy glacial till. Slopes range from 2 to 12 percent.

Doland soils are similar to Ves and Rothsay soils and are associated on the landscape with Tara, Perella, and Quam soils. Ves soils formed entirely in loamy glacial till. Rothsay soils have more silt in the solum than Doland soils. Tara soils are moderately well drained and are on lower, plane to concave parts of the landscape. Perella soils are poorly drained and are in drainageways and on nearly level flats. Quam soils are very poorly drained and are in depressions on the lowest part of the landscape.

Typical pedon of Doland silt loam, 2 to 6 percent slopes, 360 feet north and 300 feet west of the southeast corner of NE1/4 sec. 17, T. 118 N., R. 37 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

B2—10 to 20 inches; dark grayish brown (10YR 4/2) silt loam; moderate coarse prismatic structure parting to weak medium subangular blocky; friable; neutral; clear wavy boundary.

IIC1ca—20 to 26 inches; brown (10YR 5/3) loam; weak coarse prismatic structure parting to weak fine and medium subangular blocky; friable; 4 percent coarse fragments; many white powdery carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC2ca—26 to 41 inches; light olive brown (2.5Y 5/4) loam; massive; friable; 6 percent coarse fragments; few iron concretions and many white powdery carbonate accumulations; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC3—41 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; 8 percent coarse fragments that include many pieces of shale; few iron concretions; strong effervescence; moderately alkaline.

The solum is 15 to 28 inches thick. Depth to carbonates ranges from 15 to 28 inches. The sediment over the glacial till typically is 16 to 24 inches thick; the range, however, is 12 to 30 inches. The mollic epipedon is 9 to 16 inches thick. Coarse fragments of mixed lithology typically are not present in the overlying sediment.

The A horizon is silt loam or loam that has value of 2 or 3 and chroma of 1. The B horizon is loam or silt loam. The B horizon has hue of 10YR or 2.5Y, value of 2 through 5, and chroma of 2 through 4. The IIC horizon is loam or clay loam. It has value of 4 through 6 and chroma of 2 through 4.

Du Page series

The Du Page series consists of moderately well drained, moderately permeable soils on low stream terraces and flood plains. The soils formed in loamy stream-deposited sediment. These soils are subject to occasional flooding. Slope ranges from 0 to 2 percent.

Soils of the Du Page series in Chippewa County have a thicker mollic epipedon, a thinner A horizon, a thinner solum, and a slightly cooler soil temperature than is defined for the Du Page series. Also, the average annual precipitation is somewhat less. These differences do not affect the use or behavior of the soils.

Du Page soils are similar to Terril soils and are near Calco soils. Terril soils formed in local colluvium and are not subject to flooding. Calco soils are poorly drained and are in lower positions on the landscape.

Typical pedon of Du Page loam, 750 feet east and 100 feet north of the southwest corner of sec. 11, T. 115 N., R. 39 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12—7 to 11 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry in upper part and grayish brown (10YR 5/2) dry in lower part; massive; friable; strong effervescence; mildly alkaline; clear smooth boundary.

C1—11 to 36 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; massive; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—36 to 60 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; massive; friable; few white concretions of calcium carbonate; strong effervescence; mildly alkaline.

The mollic epipedon commonly is more than 60 inches thick. The soil is calcareous throughout. The 10- to 40-inch control section, on the average, is between 18 and 27 percent clay and more than 50 percent fine and coarse sand.

The A horizon is silt loam or loam. It has value of 2 or 3 (3 to 5 dry) and chroma of 1 or 2. The C horizon has value of 3 or 4 moist and chroma of 1 through 4.

Egeland series

The Egeland series consists of well drained, moderately rapidly permeable soils on glacio-lacustrine plains and outwash delta plains. The soils formed in a mantle of moderately coarse textured outwash overlying coarse textured glacial outwash. Slopes range from 0 to 6 percent.

Egeland soils are similar to Clontarf and Rothsay soils and are commonly adjacent to Arvilla, Fordville, and Torning soils. Clontarf soils have a thicker dark-colored surface soil. Rothsay soils are less than 15 percent fine and coarse sand in the control section. Arvilla soils are sandy. Fordville soils have less sand in the solum. Torning soils do not have a mollic epipedon.

Typical pedon of Egeland sandy loam, 2 to 6 percent slopes, 750 feet west and 200 feet north of the southeast corner of sec. 3, T. 119 N., R. 41 W.

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

A12—9 to 14 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; very friable; neutral; clear smooth boundary.

B21—14 to 24 inches; brown (10YR 4/3) sandy loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; neutral; clear smooth boundary.

B22—24 to 37 inches; dark grayish brown (10YR 4/2) sandy loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; neutral; abrupt smooth boundary.

C1—37 to 48 inches; light olive brown (2.5Y 5/4) fine sandy loam; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loamy fine sand; common medium distinct light brownish gray (2.5Y 6/2) mottles; single grain; loose; slight effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. The depth to carbonates ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 16 inches in thickness. Some pedons have accumulations of lime in the upper part of the C horizon.

The A horizon has value of 2 or 3 moist (3 or 4 dry) and chroma of 1.5 or less. It is sandy loam or fine sandy loam. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4. It is sandy loam or fine sandy loam, and in some pedons, it extends to a depth of 40 inches. The C horizon is loamy sand, loamy fine sand, sandy loam, or fine sandy loam.

Fordville series

The Fordville series consists of well drained soils on glacial outwash plains. The soils formed in a loamy mantle overlying sand and gravel. Permeability is moderate in the solum and rapid in the underlying material. Slopes range from 0 to 6 percent.

Fordville soils are adjacent to Colvin, Doland, and Sverdrup soils. Colvin soils are poorly drained and calcareous and are on nearby broad flats. Doland soils are underlain by glacial till. Sverdrup soils are sandy.

Typical pedon of Fordville silt loam, 0 to 2 percent slopes, 610 feet north and 1,340 feet east of the southwest corner of sec. 20, T. 117 N., R. 39 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A12—7 to 14 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; clear wavy boundary.

B21—14 to 20 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak medium subangular blocky; friable; neutral; gradual wavy boundary.

B22—20 to 28 inches; dark yellowish brown (10YR 4/4) loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; neutral; clear wavy boundary.

B3—28 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; moderate medium prismatic structure parting to weak medium subangular blocky; firm; neutral; clear wavy boundary.

IIC1—36 to 42 inches; grayish brown (2.5Y 5/2) sand; single grain; medium to very coarse sand; 10 percent coarse fraction 2 to 5 mm in size; loose; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC2—42 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; medium to very coarse sand; 10 percent coarse fraction 2 to 5 mm in size; loose; slight effervescence; mildly alkaline.

The mollic epipedon is 16 to 26 inches thick and typically includes the B2 horizon. The depth to sand and gravel and to carbonates ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 (3 or 4 dry) and chroma of 1 or 2. It is silt loam or loam. The B2 horizon has value of 2 through 4 and chroma of 1 through 4. It is loam, silt loam, or clay loam. There is no B3 horizon in some pedons. The IIC horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is stratified sand or gravel or loamy sand.

Glyndon series

The Glyndon series consists of moderately well drained and somewhat poorly drained calcareous soils that are moderately permeable. The soils formed in wind- and water-deposited silty sediment on a lacustrine-influenced glacial till plain. Slopes range from 0 to 2 percent.

Glyndon soils are similar to Seaforth soils and are adjacent on the landscape to Quam, Spicer, and Tara soils. Seaforth soils are in similar positions on the landscape and formed in glacial till. Quam and Spicer soils are more poorly drained than Glyndon soils and are in slight depressions or swales. Tara soils are moderately well drained and are on more sloping parts of the landscape.

Typical pedon of Glyndon silt loam, 660 feet west and 100 feet north of the southeast corner of NE1/4 sec. 36, T. 118 N., R. 40 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1ca—10 to 19 inches; light olive brown (2.5Y 5/4) silt loam; few fine faint light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

C2—19 to 47 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct grayish brown (2.5Y 5/2) mottles; laminated; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C3—47 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam; common medium faint light brownish gray (2.5Y 6/2) and light olive brown (2.5Y 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The mollic epipedon is 7 to 16 inches thick.

The Ap or A1 horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It typically is silt loam or silty clay loam, but the range also includes loam. The Cca horizon has hue of 10YR, value of 4 through 7, and chroma of 1 through 4, or it has hue of 2.5Y or 5Y, value of 4 through 7, and chroma of 2 or 3. It is silt loam or silty clay loam. The C horizon below the Cca horizon has hue of 2.5Y or 5Y, value of 4, 5 or 6, and chroma of 2 through 4. It has mottles in some or all parts and has the same textural range as the Cca horizon.

Maddock series

The Maddock series consists of well drained, rapidly permeable soils. The soils formed in wind- and water-sorted sandy material on glacio-lacustrine plains and delta plains. Slopes range from 1 to 12 percent.

Maddock soils are similar to Sverdrup soils, and commonly are adjacent to Egeland, Marysland, and Torning soils. Sverdrup soils are excessively drained. Egeland and Torning soils are coarse-loamy. In addition, Torning soils do not have a mollic epipedon. Marysland soils are poorly drained and are in lower positions on the landscape.

Typical pedon of Maddock loamy fine sand, 1 to 6 percent slopes, 550 feet south and 250 feet east of the northwest corner of the NW1/4 sec. 7, T. 119 N., R. 41 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; very friable; many roots; mildly alkaline; abrupt smooth boundary.

B2—10 to 18 inches; dark grayish brown (10YR 4/2) fine sand; single grain; loose; many roots; mildly alkaline; clear smooth boundary.

C—18 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; slight effervescence; moderately alkaline.

The depth to free carbonates is 10 inches or more. The mollic epipedon is 10 to 16 inches thick.

The A horizon has value of 2 or 3 moist (3 through 5 dry) and chroma of less than 1.5. It is loamy fine sand, fine sandy loam, sandy loam, or loamy sand. The B horizon has value of 2 or 3 moist (4 through 6 dry) and chroma of 2 or 3. Typically, the control section is fine sand or loamy fine sand and is less than 50 percent medium sand and less than 25 percent coarse sand and coarser material. The C horizon has value of 2 or 3 moist and chroma of 2 through 4.

Marysland series

The Marysland series consists of poorly drained, calcareous soils that are moderately permeable in the upper part and rapidly permeable in the lower part. The soils formed in a mantle of loamy outwash sediment over sandy material. They are in channels on outwash plains and outwash stream deltas. Slope ranges from 0 to 2 percent.

The Marysland soils in Chippewa County have subhorizons that have higher chroma than is defined for the series. This difference, however, does not alter the use or behavior of these soils.

Marysland soils are adjacent to Colvin, Canisteo, and Rothsay soils. Colvin soils formed entirely in deep silty material. Canisteo soils are in positions on the landscape similar to those of Marysland soils and formed in glacial till. Rothsay soils are well drained, have a coarse-silty control section, and are on adjacent steeper slopes.

Typical pedon of Marysland loam, 1,120 feet south and 1,300 feet east of the northwest corner of NE1/4 sec. 2, T. 119 N., R. 42 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A12—9 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

C1ca—16 to 23 inches; very dark gray (2.5Y 3/1) loam, dark grayish brown (2.5Y 4/2) dry; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C2—23 to 27 inches; grayish brown (2.5Y 5/2) sandy loam; massive; friable; slight effervescence; mildly alkaline; clear smooth boundary.

IIC3—27 to 51 inches; light olive brown (2.5Y 5/4) sand; single grain; loose; 14 percent coarse fragments; slight effervescence; moderately alkaline; gradual smooth boundary.

IIC4—51 to 60 inches; olive brown (2.5Y 4/4) sand; single grain; loose; 14 percent coarse fragments; slight effervescence; moderately alkaline.

The mollic epipedon typically is 12 to 25 inches thick. The mantle of loamy outwash ranges from 20 to 40 inches in thickness.

The A horizon has hue of 10YR through 5Y, value of 2 or 3 (4 or 5 dry), and chroma of 1 or less. It is loam, clay loam, or sandy clay loam. The Cca horizon has hue of 2.5Y or 5Y, value of 3 through 6, and chroma of 1 or 2. It typically is mottled. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The IIC horizon is fine sand, sand, or coarse sand, or it is stratified sand and gravel.

McDonaldsville series

The McDonaldsville series consists of poorly drained soils that are slowly permeable in the upper part and rapidly permeable in the lower part. These soils formed in fine textured lacustrine material overlying calcareous sandy outwash. The soils are in a former lakebed in northern Chippewa County. Slopes range from 0 to 2 percent.

McDonaldsville soils are similar to Perella soils and are adjacent to Arvilla, Calco, and Rothsay soils. Perella soils have a fine-silty solum. Arvilla soils are well drained and formed entirely in coarser material. Calco soils are poorly drained and subject to flooding. Rothsay soils are upslope and well drained and have a coarse-silty solum.

Typical pedon of McDonaldsville silty clay, 900 feet south and 100 feet east of the northwest corner of SW1/4 sec. 15, T. 119 N., R. 41 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak coarse subangular blocky structure; very firm; neutral; abrupt smooth boundary.

A12—7 to 23 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; firm; many thin clay films on faces of peds; neutral; gradual smooth boundary.

B2—23 to 32 inches; dark grayish brown (2.5Y 4/2) silty clay; few medium faint very dark gray (N3/0) mottles; moderate medium prismatic structure parting to moderate very fine and fine subangular blocky; firm; continuous moderately thick clay films lining tubular and interstitial pores and on faces of peds; mildly alkaline; abrupt wavy boundary.

IIC1—32 to 36 inches; olive brown (2.5Y 4/4) sandy loam; single grain; loose; slight effervescence; mildly alkaline; clear smooth boundary.

IIC2—36 to 60 inches; olive brown (2.5Y 4/4) and dark yellowish brown (10YR 4/4) sand; single grain; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand typically are 28 to 36 inches but range from 20 to 40 inches. The mollic epipedon ranges from 15 to 24 inches in thickness.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 2 or 3 (3 or 4 dry), and chroma of 2. It is silty clay, clay, or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 through 3. It typically is clay or silty clay but ranges to light clay or clay loam. The B horizon typically does not contain free carbonates, but in some places free carbonates are at a depth as shallow as 10 inches. The IIC horizon has hue of 5Y or 2.5Y, value of 3 through 5, and chroma of 1 through 4. It is loamy fine sand, sandy loam, or sand.

Perella series

The Perella series consists of poorly drained, moderately slowly permeable soils. The soils are in drainageways and swales on ground moraines and lacustrine plains. They formed in silty water-deposited material. Slopes range from 0 to 2 percent.

Perella soils are similar to Quam soils and are commonly adjacent to Tara and Waubay soils. Quam soils are very poorly drained and have a thicker mollic epipedon than Perella soils have. Tara and Waubay soils are moderately well drained and are on upland flats and the upper end of drainageways.

Typical pedon of Perella silty clay loam, 108 feet west and 50 feet south of the center of the east side of SE1/4 sec. 4, T. 118 N., R. 40 W.

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

A12—8 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 4/1) dry; moderate medium and coarse prismatic structure parting to weak medium subangular blocky and moderate very fine subangular blocky; friable; few thin clay films on faces of peds; neutral; clear smooth boundary.

B1g—16 to 20 inches; 60 percent very dark gray (2.5Y 3/1) and 40 percent dark grayish brown (2.5Y 4/2) silty clay loam; moderate medium and coarse prismatic structure parting to weak medium subangular blocky and moderate fine and very fine subangular blocky; friable; few thin clay films on ped faces; neutral; clear smooth boundary.

B2g—20 to 25 inches; olive (5Y 4/3) silty clay loam; common medium distinct dark olive gray (5Y 3/2) mottles; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky and weak very fine subangular blocky; friable; neutral; clear smooth boundary.

C1g—25 to 38 inches; light olive gray (5Y 6/2) silt loam; weak coarse prismatic structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C2g—38 to 60 inches; olive gray (5Y 5/2) silt loam; common medium light gray (5Y 6/1) and distinct light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum is 18 to 36 inches thick. The mollic epipedon is 14 to 24 inches thick. Depth to free carbonates ranges from 18 to 30 inches.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3 moist and 3 or 4 dry, and chroma of 0 or 1 moist or dry. It is silty clay loam, silt loam, or silty clay. The B horizon has hue of 2.5Y or 5Y, value of 2 through 4, and chroma of 1 through 3. It is mottled silty clay loam, silt loam, or silty clay. The C horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 1 through 4. It is silt loam, silty clay loam, or silt.

Quam series

The Quam series consists of very poorly drained soils that have moderately slow permeability. The soils formed in dominantly silty lacustrine sediment. They are in closed depressions on glacial lacustrine plains. Slopes range from 0 to 2 percent.

Quam soils are similar to Calco and Spicer soils and are adjacent to Colvin, Seaforth, Spicer, and Tara soils. Calco and Spicer soils are calcareous throughout. Calco soils are subject to annual flooding. Colvin soils are on the rim of depressions and are calcareous throughout. Seaforth and Tara soils are moderately well drained and are on knolls.

Typical pedon of Quam silty clay loam, in an area of Spicer-Quam silty clay loams, 820 feet west and 550 feet south of the northeast corner of NW1/4 sec. 8, T. 117 N., R. 37 W.

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

A12—10 to 19 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

A13—19 to 25 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak medium subangular blocky; friable; neutral; gradual smooth boundary.

A14—25 to 36 inches; very dark gray (2.5Y 3/1) silty clay loam, gray (2.5Y 5/1) dry; common medium distinct olive (5Y 5/4) mottles; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—36 to 60 inches; olive gray (5Y 5/2) silt loam; common medium distinct pale olive (5Y 6/4) mottles; massive; friable; common yellowish brown (10YR 5/8) iron oxide stains; sand and silt laminations; neutral.

The mollic epipedon is 24 to 60 inches thick. Depth to free carbonates is 20 to 60 inches.

The A horizon has hue of 10YR, 2.5Y or 5Y, value of 2 or 3 (4 or 5 dry), and chroma of 1 or less. Typically, it is silty clay loam, but the range includes subhorizons of loam to silty clay. In some places, there is a B horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, silt loam, silty clay loam, or clay loam. In some places, there is a IIC horizon.

Rothsay series

The Rothsay series consists of well drained, moderately permeable soils on glacial lake plains or moraines. The soils formed in lacustrine or eolian deposits. Slopes range from 2 to 12 percent.

Rothsay soils are similar to Doland soils. They are adjacent to Perella and Waubay soils and are mapped in complex with Zell soils. Doland soils formed in part in loamy glacial till. Zell soils are calcareous throughout the solum and generally are on more convex parts of the landscape. Perella soils are poorly drained and are in swales and drainageways. Waubay soils are moderately well drained and are on concave parts of the landscape.

Typical pedon of Rothsay loam, 2 to 6 percent slopes, 205 feet west and 135 feet north of the southeast corner of SW1/4 sec. 21, T. 119 N., R. 42 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
B1—10 to 13 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; clear smooth boundary.
B2—13 to 19 inches; brown (10YR 4/3) loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; neutral; clear smooth boundary.
B3—19 to 30 inches; yellowish brown (10YR 5/4) very fine sandy loam; massive; very friable; neutral; clear wavy boundary.
C1—30 to 48 inches; yellowish brown (10YR 5/4) very fine sandy loam; massive; very friable; strong effervescence; mildly alkaline; gradual smooth boundary.
C2—48 to 60 inches; brown (10YR 5/3) very fine sandy loam; common medium distinct yellowish brown (10YR 5/6) and light gray (10YR 7/1) mottles; massive; very friable; strong effervescence; mildly alkaline.

The solum is 15 to 30 inches thick. Depth to free carbonates ranges from 15 to 30 inches. The mollic epipedon is 10 to 16 inches thick. The solum is neutral or mildly alkaline. Typically, the control section is loam or very fine sandy loam, but in some pedons it is silt loam.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The B1 horizon has hue of 10YR, value of 3 through 5, and chroma of 2 through 4. The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 2 through 4. The C horizon has hue of 2.5Y or 10YR, value of 5 or 6, and chroma of 2 through 5. There are free carbonates in the C horizon but not enough for it to qualify as a calcic horizon.

Seaforth series

The Seaforth series consists of moderately well drained, moderately permeable, calcareous soils. The soils formed in silty and loamy glacial till on upland glacial till plains. Slopes range from 1 to 3 percent.

Seaforth soils are similar to Ves soils and are adjacent to Canisteo, Colvin, and Spicer soils. Ves soils are well drained. Canisteo, Colvin, and Spicer soils are in lower positions on the landscape and are more poorly drained than Seaforth soils.

Typical pedon of Seaforth silt loam, 2,300 feet south and 900 feet east of the northwest corner of sec. 26, T. 119 N., R. 37 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.
A3—7 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; 3 percent coarse fragments; slight effervescence; mildly alkaline; clear wavy boundary.
B2ca—11 to 19 inches; brown (10YR 5/3) silt loam; weak medium subangular blocky structure; friable; 8 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.
C1—19 to 35 inches; light olive brown (2.5Y 5.4) loam; few fine faint grayish brown (10YR 5/2) mottles; massive; friable; 10 percent coarse fragments; strong effervescence; moderately alkaline; gradual irregular boundary.
C2—35 to 60 inches; light olive brown (2.5Y 5.4) loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; 10 percent coarse fragments; few reddish iron stains; common soft white lime accumulations; strong effervescence; moderately alkaline.

The solum is 16 to 28 inches thick. The mollic epipedon is 10 to 20 inches thick. In some places, subhorizons are clay loam, sandy clay loam, or sandy loam. Fragments of shale are common.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon typically has hue of 2.5Y, value of 4 or 5, and chroma of 2 through 4. Less commonly, it has hue of 10YR. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 through 4.

Spicer series

The Spicer series consists of very poorly drained, moderately permeable soils. The soils formed in silty, calcareous lacustrine sediment. They are in closed depressions, potholes, and sloughs on a lacustrine-influenced glacial till plain. Slopes range from 0 to 2 percent.

Spicer soils are commonly adjacent to Glyndon, Quam, and Seaforth soils. Glyndon soils are moderately well drained and somewhat poorly drained and are in slightly convex areas on low knolls. Quam soils are in positions on the landscape similar to those of Spicer soils and do not have free carbonates in the solum. Seaforth soils are moderately well drained and formed in glacial till in convex areas on low knolls.

Typical pedon of Spicer silty clay loam, in an area of Spicer-Quam silty clay loams, 620 feet north and 670 feet east of the southwest corner of sec. 4, T. 117 N., R. 38 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium granular structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A12—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A3—14 to 19 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; slight effervescence; mildly alkaline; clear smooth boundary.

B21g—19 to 29 inches; olive gray (5Y 5/2) silt loam; few fine faint gray (2.5Y 5/1) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium prismatic structure parting to weak medium subangular blocky; friable; 35 percent, by volume, is very dark gray (10YR 3/1) krotovina filling; common fine distinct white lime accumulations; slight effervescence; mildly alkaline; clear smooth boundary.

B22g—29 to 39 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C1g—39 to 45 inches; light olive gray (5Y 6/2) silty clay loam; common medium distinct strong brown (7.5YR 5/6) effervescence; mildly alkaline; clear smooth boundary.

C2g—45 to 60 inches; light olive gray (5Y 6/2) silty clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; slight effervescence; mildly alkaline.

The solum is 22 to 48 inches thick. The mollic epipedon is 12 to 24 inches thick. Free carbonates are in all parts of the solum.

The A horizon has value of 2 or 3 and chroma of 1. It typically is silty clay loam or silt loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The B horizon is mottled silty clay loam or silt loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is silty clay loam or silt loam and commonly has dark concretions or stains.

Storden series

The Storden series consists of well drained, moderately permeable soils. The soils formed in loamy glacial till. They generally are adjacent to major drainageways. Slope ranges from 6 to 25 percent.

Storden soils are similar to Swanlake soils and are near Ves and Terril soils. Swanlake soils have a mollic epipedon. Ves soils have a darker surface layer and a thicker solum than Storden soils. Terril soils are moderately well drained; they are on foot slopes and formed in colluvium.

Typical pedon of Storden loam, 12 to 18 percent slopes, 100 feet west and 140 feet north of the southeast corner of SW1/4 sec. 23, T. 119 N., R. 40 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, gray (10YR 6/1) dry; weak medium granular structure; friable; about 8 percent coarse fragments; mildly alkaline; strong effervescence; abrupt smooth boundary.

C1—7 to 20 inches; grayish brown (2.5Y 5/3) loam; moderate very fine prismatic structure parting to weak subangular blocky; friable; about 5 percent coarse fragments; mildly alkaline; strong effervescence; gradual wavy boundary.

C2—20 to 33 inches; light olive brown (2.5Y 5.4) loam; few fine distinct brownish yellow (10YR 6/6) mottles; massive; very hard; about 5 percent coarse fragments; mildly alkaline; strong effervescence; clear wavy boundary.

C3—33 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/6) mottles; massive; very hard; about 5 percent coarse fragments; mildly alkaline; strong effervescence.

The Ap horizon is 6 to 10 inches thick. The thickness of the solum commonly is the same as that of the A horizon. The texture of the solum typically is loam, but in some places, the subhorizons are clay loam. All horizons are mildly or moderately alkaline and have strong or violent effervescence.

The Ap horizon has value of 4 or 5 (2 or 3 in a few masses) and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 6.

Sverdrup series

The Sverdrup series consists of somewhat excessively drained soils that have moderately rapid permeability over rapid permeability. The soils formed in loamy and sandy glacial outwash on lake plains and delta plains. Slopes range from 0 to 12 percent.

Sverdrup soils are similar to Maddock soils and are commonly adjacent to Doland, Rothsay, and Waubay soils. Maddock soils are well drained. Doland soils are well drained and have glacial till underlying material within 40 inches of the surface. Rothsay soils are coarse-silty. Waubay soils are fine-silty and are moderately well drained.

Typical pedon of Sverdrup fine sandy loam, 2 to 6 percent slopes, 500 feet north and 100 feet west of the southeast corner of SW1/4 sec. 2, T. 116 N., R. 39 W.

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

B2—10 to 20 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

B3—20 to 24 inches; brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; 4 percent coarse fragments; very friable; neutral; gradual smooth boundary.

C1—24 to 33 inches; brown (10YR 4/3) sand, variegated; single grain; 10 percent coarse fragments; loose; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—33 to 40 inches; dark yellowish brown (10YR 4/4) sand, variegated; single grain; 8 percent coarse fragments; loose; slight effervescence; mildly alkaline; gradual smooth boundary.

C3—40 to 60 inches; dark yellowish brown (10YR 4/4) sand, variegated; single grain; 5 percent coarse fragments; loose; slight effervescence; mildly alkaline.

The solum is 15 to 40 inches thick. Depth to free lime ranges from 15 to 40 inches.

The A horizon is sandy loam or fine sandy loam and is 10 to 15 inches thick. The A horizon has chroma of 2 or 3 and value of 1 or 2. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. The B horizon ranges from fine sandy loam to loamy sand and, in some places, to fine sand in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4.

Swanlake series

The Swanlake series consists of well drained, moderately permeable soils on uplands. The soils formed in loamy glacial till. Slopes range from 3 to 40 percent.

Swanlake soils are similar to Storden soils and are near Arvilla, Canisteo, Seaforth, Sverdrup, Terril, and Webster soils. Storden soils do not have a mollic epipedon. Arvilla and Sverdrup soils have sandy underlying material. Canisteo and Webster soils are poorly drained, and Seaforth and Terril soils are moderately well drained; these soils generally are in lower positions on the landscape.

Typical pedon of Swanlake loam, 25 to 40 percent slopes, 605 feet west and 1,420 feet south of the northeast corner of sec. 13, T. 116 N., R. 40 W.

A1—0 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderately fine granular structure; friable; 5 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

AC—9 to 13 inches; mixed, dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) loam, pale brown (10YR 6/3) and grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; 5 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C1ca—13 to 24 inches; yellowish brown (10YR 5/4) loam; weak coarse subangular blocky structure; friable; many coarse distinct white (10YR 8/2) lime accumulations; 2 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—24 to 36 inches; yellowish brown (10YR 5/4) loam; massive; firm; 10 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—36 to 60 inches; yellowish brown (10YR 5/4) clay loam; massive; firm; 15 percent coarse fragments; slight effervescence; mildly alkaline.

The mollic epipedon is 7 to 14 inches thick. Carbonates typically are at the surface, but in some places, they are leached to a depth of 10 inches. The solum and the C horizon typically are loam, but in some places, there are subhorizons of sandy loam or clay loam.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The AC horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 3 through 5. It is 4 to 25 percent carbonates. The C horizon has hue of 2.5Y, value of 5, and chroma of 4 through 6. It is 10 to 20 percent carbonates.

Tara series

The Tara series consists of moderately well drained, moderately permeable soils on glacial till uplands. The soils formed in a mantle of silty water- and wind-deposited sediment over loamy glacial till. Slope ranges from 1 to 3 percent.

Tara soils are similar to Waubay soils and are near Colvin, Spicer, and Doland soils. Waubay soils formed entirely in silty wind- and water-deposited sediment. Colvin and Spicer soils are more poorly drained and are in lower positions on the landscape than Tara soils. Doland soils are well drained.

Typical pedon of Tara silty clay loam, 1,335 feet north and 200 feet west of the southeast corner of sec. 29, T. 118 N., R. 37 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.

A3—14 to 18 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual wavy boundary.

B2—18 to 25 inches; dark grayish brown (2.5Y 4.2) silt loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual wavy boundary.

B3—25 to 31 inches; light olive brown (2.5Y 5/3) silt loam; weak fine subangular blocky structure; friable; 1 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

IIC1ca—31 to 40 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; many soft lime accumulations; 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

IIC2—40 to 60 inches; light olive brown (2.5Y 5/4) loam; many medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; common soft lime accumulations; common fine dark iron and manganese concretions; 5 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 20 to 36 inches thick. Depth to free carbonates ranges from 20 to 36 inches. The thickness of the silty mantle typically is the same as that of the solum, but the full range is 25 to 40 inches. In some places, the B horizon extends into the underlying material. The mollic epipedon is 16 to 30 inches thick.

In some places, the A horizon is silt loam. The B horizon has hue of 10YR or 2.5Y in the upper part and hue of 2.5Y in the lower part. It has value of 3 through 5 and chroma of 2 or 3. The IIC horizon has value of 5 or 6 and chroma of 2 through 4. The amount and intensity of mottling are variable. The IIC horizon is loamy or clayey and loamy glacial till.

Terril series

The Terril series consists of moderately well drained, moderately permeable soils. The soils formed in loamy colluvial or alluvial sediment. They are on foot slopes and alluvial fans. Slope ranges from 2 to 6 percent.

These soils are more alkaline and have free carbonates higher in the profile than is defined in the range for the Terril series. This difference, however, does not alter the use or behavior of the soils to any great extent.

Terril soils are near Storden and Swanlake soils. They are similar to Du Page soils. Storden and Swanlake soils are well drained and generally are on steeper slopes than Terril soils. Du Page soils are on bottom lands.

Typical pedon of Terril loam, 2 to 6 percent slopes, 900 feet north and 550 feet west of the southeast corner of NE1/4 sec. 21, T. 118 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.

A12—8 to 18 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak fine subangular blocky; friable; common roots; neutral; gradual smooth boundary.

A13—18 to 28 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium prismatic structure parting to moderate medium subangular blocky; friable; common roots; neutral; gradual smooth boundary.

B2—28 to 40 inches; dark brown (10YR 4/3) loam; nearly continuous very dark grayish brown (10YR 3/2) coatings on ped faces; moderate fine subangular blocky structure; friable; few roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C—40 to 60 inches; yellowish brown (10YR 5/4) loam; massive; friable; 8 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is about 36 to 60 inches thick. In most places, loamy material similar to that of the solum extends to a depth of 6 feet or more.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The A horizon typically is loam, but in some places it is silt loam that has a high percentage of sand, or it is clay loam. The B horizon has value of 3 or 4 and chroma of 2 through 4. It is loam or clay loam. The C horizon has value of 3, 4, or 5 and chroma of 2 through 4.

Tonka series

The Tonka series consists of poorly drained, slowly permeable soils on uplands. The soils formed in wind- and water-deposited local alluvium over glacial till. They are in closed depressions. Slopes range from 0 to 2 percent.

Tonka soils are commonly adjacent to Glyndon, Quam, Rothsay, and Waubay soils. Glyndon soils are somewhat poorly drained, and Quam soils are very poorly drained. Rothsay and Waubay soils are better drained than Tonka soils and are on surrounding higher parts of the landscape.

Typical pedon of Tonka silty clay loam, 60 feet south and 50 feet east of the northwest corner of sec. 27, T. 119 N., R. 42 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; slightly acid; abrupt smooth boundary.

A12—9 to 20 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak medium platy structure; firm; slightly acid; gradual irregular boundary.

A2—20 to 30 inches; dark gray (10YR 4/1) silt loam, light gray (10YR 6/1) dry; moderate medium platy structure; friable; medium acid; clear wavy boundary.

B2t—30 to 47 inches; dark gray (5Y 4/1) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; strong fine and medium prismatic structure parting to strong medium subangular blocky; very firm; medium acid; clear wavy boundary.

B3—47 to 54 inches; dark gray (5Y 4/1) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure; very firm; neutral; gradual smooth boundary.

C—54 to 60 inches; olive gray (5Y 4/2) silty clay loam; massive; firm; many white lime segregations; strong effervescence; mildly alkaline.

Depth to carbonates ranges from 20 to more than 60 inches. These soils range from medium acid to strongly alkaline.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of less than 1.5. The solum is silt loam, loam, clay loam, clay, or silty clay loam. The A2 horizon has hue of 10YR or 2.5Y, value of 3 through 6, and chroma of 0 through 2. The B and C horizons have hue of 2.5Y or 5Y, value of 2 through 4, and chroma of 1 or 2.

Torning series

The Torning series consists of well drained soils that have moderately rapid permeability. The soils are on glacial outwash plains and delta plains. Torning soils formed in wind- or water-deposited, loamy and sandy sediment. Slopes range from 2 to 6 percent.

Torning soils are similar to Zell soils and are commonly adjacent to Maddock and Marysland soils. Zell, Maddock, and Marysland soils have a mollic epipedon. Also, Maddock soils are sandy, and Marysland soils are poorly drained and are in depressions.

Typical pedon of Torning very fine sandy loam, 2 to 6 percent slopes, 1,650 feet north and 1,475 feet west of the southeast corner of SW1/4 sec. 27, T. 119 N., R. 42 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) very fine sandy loam, light brownish gray (10YR 6/2) dry; weak fine and medium subangular blocky structure; very friable; many roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1ca—10 to 20 inches; brown (10YR 5/3) very fine sandy loam; massive; very friable; common roots; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—20 to 42 inches; brown (10YR 5/3) loamy fine sand; massive; very friable; few roots; slight effervescence; moderately alkaline; gradual smooth boundary.

C3—42 to 60 inches; yellowish brown (10YR 5/4) silt loam; massive; very friable; few roots; slight effervescence; moderately alkaline.

The A horizon and the solum are 9 to 16 inches thick. These soils are calcareous throughout the upper 40 inches.

The A horizon has hue of 10YR, value of 3 or 4 (6 or 7 dry), and chroma of 2. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 (6 to 8 dry), and chroma of 1 to 3, moist or dry.

Ves series

The Ves series consists of well drained, moderately permeable soils. The soils formed in loamy glacial till on uplands. Slope ranges from 2 to 6 percent.

Ves soils are similar to Doland soils and are near Canisteo, Seaforth, and Storden soils. Doland soils are silty in the upper part. Canisteo and Seaforth soils are calcareous and are more poorly drained than Ves soils. Storden soils have a lighter colored surface horizon and a thinner solum.

Typical pedon of Ves loam, 2 to 6 percent slopes, 340 feet east and 1,220 feet north of the southwest corner of NE1/4 sec. 21, T. 116 N., R. 39 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; 4 percent coarse fragments; neutral; abrupt smooth boundary.

B2—10 to 18 inches; brown (10YR 4/3) clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; 5 percent coarse fragments; neutral; clear smooth boundary.

C1—18 to 27 inches; light olive brown (2.5Y 5/4) loam; weak medium subangular blocky; friable; 8 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—27 to 42 inches; light olive brown (2.5Y 5/4) loam; massive; friable; 10 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—42 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; 10 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 18 to 30 inches thick. Depth to free carbonates typically ranges from 18 to 25 inches. The mollic epipedon is 10 to 20 inches thick. Shale fragments are a common component. The solum typically is loam or clay loam, but in a few places there are subhorizons of silt loam, sandy clay loam, or sandy loam.

The Ap or A1 horizon is typically black (10YR 2/1) or very dark gray (10YR 3/1). The B2 horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 3 or 4. In some places, a Cca horizon has few to many soft masses, seams, or filaments of lime. The C horizon typically is mottled.

Waubay series

The Waubay series consists of moderately well drained, moderately permeable soils on silt-mantled glacial till uplands. The soils formed in silty water- and wind-deposited sediment. Slopes range from 0 to 3 percent.

Waubay soils are similar to Tara soils and are near Rothsay, Colvin, and Spicer soils. Tara soils formed in silt-mantled loamy or clayey and loamy glacial till. Rothsay soils are well drained and are on higher, more convex parts of the landscape. Colvin and Spicer soils are more poorly drained and are calcareous. They are in lower positions on the landscape.

Typical pedon of Waubay silty clay loam, 700 feet north and 100 feet east of the southwest corner of SW1/4 sec. 9, T. 118 N., R. 40 W.

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

A12—8 to 17 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; clear smooth boundary.

B2—17 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay loam; moderate fine and medium prismatic structure parting to moderate medium subangular blocky; friable; neutral; clear smooth boundary.

C1ca—27 to 38 inches; light olive brown (2.5Y 5/4) silt loam; few fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—38 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum is 20 to 36 inches thick. The depth to free lime ranges from 20 to 36 inches. The mollic epipedon is 16 to 25 inches thick and extends into the upper part of the B2 horizon in some places. The solum and the C horizon are silty clay loam or silt loam.

The A horizon has value of 2 or 3 and chroma of 1.5 or less. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. In some places, there is a B3ca horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4. Loam or clay loam glacial till typically is at a depth of 48 inches or more, but the depth is as little as 40 inches in some places.

Webster series

The Webster series consists of poorly drained, moderately permeable soils on upland flats. The soils formed in silty and loamy glacial material on glaciated uplands. Slope ranges from 0 to 2 percent.

Webster soils are similar to Canisteo soils and are near Ves, Spicer, and Quam soils. Canisteo soils are calcareous. Ves soils are moderately well drained and are in higher positions on the landscape. Spicer and Quam soils are in shallow depressions.

Typical pedon of Webster silty clay loam, 1,400 feet north and 1,750 feet west of the southeast corner of SE1/4 sec. 16, T. 116 N., R. 39 W.

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

A12—8 to 20 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; neutral; clear smooth boundary.

A13—20 to 23 inches; dark gray (5Y 4/1) silty clay loam; moderate fine and medium prismatic structure parting to moderate fine and medium subangular blocky; friable; neutral; clear smooth boundary.

C1g—23 to 42 inches; grayish brown (2.5Y 5/2) loam; few fine faint light olive brown (2.5Y 5/4) mottles; massive; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C2g—42 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; strong effervescence; moderately alkaline.

The solum generally is 20 to 30 inches thick. The thickness typically is the same as the depth to free lime, but in some pedons, free carbonates are in a B3 horizon.

The Ap and A12 horizons are black (N 2/0 or 10YR 2/1). They are clay loam or silty clay loam and have a moderate content of sand. The A13 horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It has a texture range similar to that of the upper part of the A horizon. The C horizon has a color range similar to that of the A13 horizon, but in some places, the C horizon has chroma of 3 and value as high as 6. It is commonly loam, but in some places it is sandy loam or clay loam.

Zell series

The Zell series consists of well drained, moderately permeable soils on outwash deltas. The soils formed dominantly in silty, calcareous sediment that was deposited by water and wind. Slope ranges from 3 to 12 percent.

The Zell soils in Chippewa County have more sand and less silt than is defined in the range for the Zell series. This difference, however, does not alter the use or behavior of these soils.

Zell soils are similar to Maddock soils and are near Rothsay and Quam soils. Maddock soils are sandy.

Rothsay soils have a thicker mollic epipedon and do not have free carbonates in the A horizon. The very poorly drained Quam soils are in depressions.

Typical pedon of Zell silt loam, in an area of Rothsay-Zell complex, 3 to 6 percent slopes, eroded, 300 feet west and 200 feet north of the southeast corner of sec. 17, T. 119 N., R. 42 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak coarse subangular blocky structure; very friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cca—9 to 16 inches; yellowish brown (10YR 5/4) silt loam, light yellowish brown (10YR 6/4) dry; weak medium prismatic structure parting to weak medium subangular blocky; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—16 to 40 inches; yellowish brown (10YR 5/4) silt loam; massive; very friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—40 to 60 inches; yellowish brown (10YR 5/4) silt loam; massive; very friable; slight effervescence; mildly alkaline.

The solum is 6 to 16 inches thick. The mollic epipedon is of the same thickness as the solum. The solum and the C horizon commonly are silt loam, but the range includes very fine sandy loam and loam.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1.5 or less. The AC horizon has hue of 2.5Y or 10YR, value of 3 through 5, and chroma of 2 through 4. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. In some places, there are thin lenses of finer or coarser material in the lower part of the C horizon.

formation of the soils

Soil is a natural, three-dimensional body on the earth's surface that is capable of supporting the growth of plants. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and weathered, the plant and animal life on and in the soil, the relief, or lay of the land, and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed. Finally, time is needed for changing the parent material into soil. In general, a long time is required for distinct horizons to develop.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

parent material

The soils in Chippewa County formed in the glacial drift and the modified glacial drift of late Wisconsin Glaciation (*4, 8*). The last advance of the ice, the Des Moines Lobe, buried deposits of earlier ice advances. The earlier deposits are occasionally exposed in borrow pits and stock watering ponds in the Minnesota River Valley and in major drainageways.

The material deposited by the Des Moines Lobe is calcareous and contains many shale fragments. It is mainly loam or clay loam. Most of the deposits are mantled by silt and clay material that ranges in thickness from 4 to 6 inches in the northeast corner to more than 60 inches in the Benson Lacustrine Plain. As the ice receded, melt water flowed over much of the county, depositing lacustrine, deltaic, and outwash sediment. Many areas in the county are glacial outwash.

About 20 percent of the soils in Chippewa County formed entirely in the loamy glacial till. Storden and Swanlake soils, which are on steeper slopes, and Ves and Seaforth soils, which are on nearly level and undulating parts of the landscape, all formed in glacial till. About 25 percent of the soils in the county formed in a mantle of silt or clay material 6 to 40 inches thick overlying the till. Tara and Doland soils are examples. About 50 percent of the soils in the county formed in silt or clay material more than 50 inches thick. Colvin, Spicer, Glyndon, and Quam soils are the most common of this type. About 5 percent of the soils formed in sandy outwash material. Sverdrup and Torning soils are examples.

relief

Relief influences the formation of soils through its effects on drainage, runoff, and erosion. Maximum profile development takes place in well drained, level to gently sloping soils, for example, Tara, Waubay, and Rothsay soils. Profile development is slower on steep slopes, because runoff is rapid and less water is available for plants and for leaching. Storden, Swanlake, and Torning soils developed under these conditions. Excess water that collects where drainage is poor also affects soil formation. Colvin, Tonka, and Marysland soils, for example, are affected by poor drainage.

time

Soils develop with time. The soils in Chippewa County are all young. The processes of soil formation began about 10,000 years ago when the glaciers receded.

The time required for soil formation depends on the other soil-forming factors. Mature soils have developed where relief and drainage have been favorable. Soils on steep slopes have a thin profile because most water runs off and the soil-forming processes have been less effective. Soils on bottom lands along rivers and creeks are immature because the soil material is very young.

climate

Chippewa County has a continental climate that is characterized by cold winters and hot summers. The climate is favorable for prairie grasses. The prairie vegetation has produced soils that have a dark-colored surface layer.

Climate directly affects soil formation through temperature and precipitation. Temperature influences the rate of physical and chemical reactions in the soil and the level of biological activity. Freezing in winter slows the soil forming processes. Alternate freezing and thawing hasten weathering and mix the soil. Water supports biological activity, dissolves minerals, and transports minerals and organic matter through the soil profile. The amount of water moving through the profile depends on the amount of precipitation, the position on the landscape, the permeability of the soil, and other factors.

The climate is essentially uniform over the county. The eastern part receives 1 to 2 inches more precipitation each year on the average than the northwest corner. Slight variations in microclimate are caused by differences in relief, soil material, slope aspect, and vegetation. South- and west-facing slopes tend to be drier and warmer than north- and east-facing slopes. More information about the climate of Chippewa County is given in the section "General nature of the county."

plants and animals

Soil formation started in Chippewa County when plants began to grow in the unconsolidated material deposited by the glaciers. Plant roots loosen the soil and bring minerals up from the parent material. The plants die and decay, returning organic matter and plant nutrients to the soil. Bacteria, fungi, and other micro-organisms help to decompose the vegetative matter and build soil structure. Earthworms and burrowing animals mix the soil material from different horizons and bring parent material to the surface.

The typical native vegetation in this county consisted of tall and medium prairie grasses. Nutrient cycling and the grass vegetation produced the dark-colored surface layer characteristic of prairie soils, or Mollisols.

Man is influencing the rate and direction of soil formation by altering drainage and the water table, by farming, which mixes the surface layer, changes the vegetation, and accelerates erosion if the surface is left bare, and by other means.

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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.

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

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

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.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

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.

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. The Lco horizon is a limnic layer that contains many fecal pellets.

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 arresting grazing 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.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

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.

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 melt water.

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 melt water. Many deposits are interbedded or laminated.

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 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

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 upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

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, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A 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) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

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 A or B 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, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B 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.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 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

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. The water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability or an impermeable layer near the surface, the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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.

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.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in 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 mm 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 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.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind 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.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

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. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt water streams, in a glacial lake or other body of still water in front of a glacier.

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tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-75 at Milan, 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[1]	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----	19.9	-1.1	9.4	46	-30	0	.69	.21	1.06	3	7.8
February---	26.3	4.5	15.4	50	-28	0	.83	.27	1.28	3	8.7
March------	37.2	16.8	27.1	67	-18	18	1.25	.62	1.76	5	8.8
April------	54.9	32.5	43.7	86	11	36	2.66	1.61	3.58	7	3.2
May--------	69.3	44.6	57.0	92	24	237	3.33	1.81	4.57	8	.1
June-------	78.6	55.1	66.9	96	37	507	4.15	2.15	5.77	8	.0
July-------	83.5	59.6	71.5	98	43	667	3.51	1.83	4.87	6	.0
August-----	81.4	57.7	69.6	97	41	608	3.60	1.60	5.22	6	.0
September--	70.9	46.9	58.9	93	28	274	2.13	.90	3.11	5	.0
October----	60.6	37.0	48.8	87	15	102	1.79	.55	2.77	4	.8
November---	40.8	21.7	31.3	68	-8	0	1.20	.48	1.77	3	4.0
December---	26.2	7.5	16.8	50	-25	0	.81	.23	1.27	3	6.1
Year-----	54.1	31.9	43.0	99	-31	2,449	25.95	21.52	30.15	61	39.5

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-75 at Milan, Minnesota]

Probability	Temperature: 24° F or lower	Temperature: 28° F or lower	Temperature: 32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 5	May 18	May 23
2 years in 10 later than--	April 30	May 13	May 19
5 years in 10 later than--	April 19	May 3	May 10
First freezing temperature in fall:			
1 year in 10 earlier than--	October 1	September 23	September 13
2 years in 10 earlier than--	October 6	September 28	September 18
5 years in 10 earlier than--	October 16	October 8	September 28

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-75 at Milan, Minnesota]

Probability	Length of growing season if daily minimum temperature is-: Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	158	139	120
8 years in 10	165	145	127
5 years in 10	179	157	140
2 years in 10	193	169	153
1 year in 10	201	175	160

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
31D	Storden loam, 12 to 18 percent slopes	1,490	0.4
35	Blue Earth mucky silt loam	4,500	1.2
45B	Maddock loamy fine sand, 1 to 6 percent slopes	385	0.1
45C	Maddock loamy fine sand, 6 to 12 percent slopes	250	0.1
60	Glyndon silt loam	12,660	3.4
85	Calco silty clay loam	2,605	0.7
89	McDonaldsville silty clay	1,410	0.4
94B	Terril loam, 2 to 6 percent slopes	1,550	0.4
113	Webster silty clay loam	2,875	0.8
127A	Sverdrup fine sandy loam, 0 to 2 percent slopes	1,100	0.3
127B	Sverdrup fine sandy loam, 2 to 6 percent slopes	5,210	1.4
127C	Sverdrup fine sandy loam, 6 to 12 percent slopes	950	0.3
141A	Egeland sandy loam, 0 to 2 percent slopes	1,540	0.4
141B	Egeland sandy loam, 2 to 6 percent slopes	1,910	0.5
234	Tonka silty clay loam	910	0.2
246	Marysland loam	1,670	0.4
290B	Rothsay loam, 2 to 6 percent slopes	9,665	2.6
324B	Torning very fine sandy loam, 2 to 6 percent slopes	1,010	0.3
338	Waubay silty clay loam	14,575	3.9
339A	Fordville silt loam, 0 to 2 percent slopes	745	0.2
339B	Fordville loam, 2 to 6 percent slopes	500	0.1
341B	Arvilla sandy loam, 1 to 6 percent slopes	915	0.2
341C	Arvilla sandy loam, 6 to 12 percent slopes	620	0.2
344	Quam silty clay loam	1,385	0.4
371	Clontarf fine sandy loam	1,180	0.3
421B	Ves loam, 2 to 6 percent slopes	14,150	3.8
423	Seaforth silt loam	10,800	2.9
434	Perella silty clay loam	3,725	1.0
444	Canisteo silty clay loam	19,250	5.2
574	Du Page loam	1,125	0.3
591B	Doland silt loam, 2 to 6 percent slopes	24,480	6.5
595E	Swanlake loam, 18 to 25 percent slopes	1,115	0.3
595F	Swanlake loam, 25 to 40 percent slopes	1,490	0.4
597	Tara silty clay loam	39,530	10.6
610	Calco silty clay loam, frequently flooded	1,020	0.3
847	Colvin-Spicer silty clay loams	93,480	24.8
881	Glyndon-Quam silty clay loams	12,605	3.4
891B2	Doland-Swanlake complex, 3 to 6 percent slopes, eroded	19,350	5.2
891C2	Doland-Swanlake complex, 6 to 12 percent slopes, eroded	5,960	1.6
957B2	Rothsay-Zell complex, 3 to 6 percent slopes, eroded	1,860	0.5
957C2	Rothsay-Zell complex, 6 to 12 percent slopes, eroded	750	0.2
992E	Rock outcrop-Copaston complex, 2 to 40 percent slopes	450	0.1
1016	Udorthents, loamy	370	0.1
1029	Pits, gravel	285	0.1
1053	Aquolls and Aquents, ponded	2,600	0.7
1802	Spicer-Quam silty clay loams	33,025	8.7
1849D	Storden stony loam, 6 to 25 percent slopes	365	0.1
1864B	Ves stony loam, 1 to 6 percent slopes	3,095	0.8
1866	Perella-Colvin silty clays	8,765	2.4
1868	Canisteo stony loam	1,225	0.3
	Water	1,920	0.5
	Total	374,400	100.0

TABLE 5.--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	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa	Grass-legume hay
	Bu	Bu	Bu	Bu	AUM*	Ton
31D----------------------- Storden	40	---	40	20	4.2	3.0
35------------------------ Blue Earth	75	35	70	35	---	3.5
45B----------------------- Maddock	35	15	35	20	3.2	2.3
45C----------------------- Maddock	25	10	30	10	1.8	1.3
60------------------------ Glyndon	80	30	75	40	5.8	4.0
85------------------------ Calco	80	30	75	38	5.6	3.8
89------------------------ McDonaldsville	70	30	70	33	4.7	3.4
94B----------------------- Terril	80	30	80	40	5.6	4.0
113----------------------- Webster	90	34	80	40	5.7	4.0
127A---------------------- Sverdrup	40	18	50	22	3.8	2.7
127B---------------------- Sverdrup	35	15	40	18	3.5	2.5
127C---------------------- Sverdrup	25	10	30	10	1.9	1.3
141A---------------------- Egeland	53	24	53	30	4.2	3.0
141B---------------------- Egeland	45	20	48	25	3.3	2.5
234----------------------- Tonka	85	32	77	35	5.2	3.5
246----------------------- Marysland	60	25	70	35	5.2	3.5
290B---------------------- Rothsay	70	30	75	35	5.6	4.0
324B---------------------- Torning	35	15	40	18	3.6	2.5
338----------------------- Waubay	80	30	80	43	5.7	3.8
339A---------------------- Fordville	60	24	65	30	4.5	3.0
339B---------------------- Fordville	55	20	60	25	3.9	2.6
341B---------------------- Arvilla	30	14	35	17	2.9	2.0

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa	Grass-legume hay
	Bu	Bu	Bu	Bu	AUM*	Ton
341C---------------------- Arvilla	20	10	25	10	2.2	1.5
344---------------------- Quam	85	30	75	40	5.0	3.5
371---------------------- Clontarf	60	25	55	30	4.2	3.0
421B--------------------- Ves	85	30	75	35	5.9	4.2
423---------------------- Seaforth	80	30	80	40	6.0	4.0
434---------------------- Perella	90	34	80	40	6.0	4.0
444---------------------- Canisteo	85	32	75	38	6.0	4.0
574---------------------- Du Page	75	32	75	40	5.9	4.0
591B--------------------- Doland	85	32	80	38	5.9	4.0
595E, 595F--------------- Swanlake	---	---	---	---	2.0	---
597---------------------- Tara	90	35	75	45	5.9	4.0
610---------------------- Calco	---	---	---	---	5.0	3.6
847---------------------- Colvin-Spicer	80	30	74	---	5.2	3.5
881---------------------- Glyndon-Quam	85	30	75	36	5.9	4.0
891B2-------------------- Doland-Swanlake	75	28	75	35	5.7	3.9
891C2-------------------- Doland-Swanlake	60	22	58	30	5.0	3.5
957B2-------------------- Rothsay-Zell	70	27	67	33	5.3	3.8
957C2-------------------- Rothsay-Zell	55	21	55	27	4.1	3.0
992E--------------------- Rock outcrop-Copaston	---	---	---	---	1.6	---
1016. Udorthents						
1029. Pits						
1053--------------------- Aquolls and Aquents	---	---	---	---	---	---
1802--------------------- Spicer-Quam	85	32	76	38	5.4	3.8

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Bromegrass-alfalfa	Grass-legume hay
	Bu	Bu	Bu	Bu	AUM*	Ton
1849D------Storden	---	---	---	---	3.2	2.2
1864B------Ves	---	---	---	---	5.8	4.0
1866------Perella-Colvin	80	30	76	35	5.0	3.5
1868------Canisteo	---	---	---	---	5.9	4.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, five sheep, or five goats) for a period of 30 days.

TABLE 6.--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
31D. Storden					
35. Blue Earth	---	Redosier dogwood, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash	Eastern cottonwood, golden willow, Siberian elm.
45B. Maddock	---	Silver buffaloberry, common chokecherry, Siberian peashrub, eastern redcedar, Tatarian honeysuckle, American plum, Siberian crabapple, lilac.	Bur oak, green ash, ponderosa pine, Russian-olive.	---	---
45C. Maddock	---	Rocky Mountain juniper, eastern redcedar, ponderosa pine.	---	---	---
60. Glyndon	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
85. Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, eastern white pine, green ash.	Eastern cottonwood.
89. McDonaldsville	---	Tatarian honeysuckle, American plum, lilac, eastern redcedar, redosier dogwood, common chokecherry, Siberian peashrub.	Siberian crabapple, green ash, Black Hills spruce.	Golden willow	Eastern cottonwood.
94B. Terril	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Common hackberry, bur oak, eastern white pine, ponderosa pine, green ash.	Silver maple.
113. Webster	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, green ash, eastern white pine, white spruce.	Silver maple, golden willow.	Eastern cottonwood.

TABLE 6.--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
127A, 127B, 127C-- Sverdrup	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, American plum, lilac.	Siberian crabapple, common hackberry, Russian-olive, ponderosa pine, green ash.	Siberian elm, honeylocust.	---
141A, 141B-------- Egeland	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, common hackberry, ponderosa pine, Russian-olive, Siberian crabapple.	Siberian elm, honeylocust.	---
234--------------- Tonka	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
246--------------- Marysland	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Siberian crabapple, common hackberry, eastern redcedar, Black Hills spruce.	Golden willow, green ash.	Eastern cottonwood.
290B-------------- Rothsay	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, bur oak, Siberian crabapple.	Green ash, honeylocust.	Siberian elm.
324B-------------- Torning	American plum, silver buffaloberry.	Russian-olive, common hackberry, Rocky Mountain juniper, eastern redcedar, Siberian peashrub, Tatarian honeysuckle.	Siberian elm, ponderosa pine, green ash, honeylocust.	---	---
338--------------- Waubay	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
339A, 339B-------- Fordville	Lilac-------------	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry, Tatarian honeysuckle.	Honeylocust, green ash, ponderosa pine.	Siberian elm------	---
341B, 341C-------- Arvilla	Lilac-------------	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle, common chokecherry.	Honeylocust, green ash, ponderosa pine.	Siberian elm------	---

TABLE 6.--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
344--------------- Quam	Lilac, silver buffaloberry.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
371--------------- Clontarf	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, common hackberry, ponderosa pine, Russian-olive, Siberian crabapple.	Siberian elm, honeylocust.	---
421B-------------- Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
423--------------- Seaforth	---	Northern white-cedar, Tatarian honeysuckle, lilac.	Eastern redcedar, blue spruce, American plum.	Ponderosa pine, laurel willow, green ash, Russian-olive.	Eastern cottonwood, Siberian elm.
434--------------- Perella	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
444--------------- Canisteo	---	Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Russian-olive, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
574--------------- Du Page	---	Lilac, Tatarian honeysuckle.	Amur maple, white spruce, northern white-cedar, Siberian crabapple.	Green ash, common hackberry, bur oak, eastern white pine, ponderosa pine.	Silver maple.
591B-------------- Doland	---	Lilac, eastern redcedar, Siberian peashrub, American plum.	Blue spruce, bur oak, Siberian crabapple, ponderosa pine, Russian-olive.	Honeylocust, green ash.	Siberian elm.
595E, 595F. Swanlake					
597--------------- Tara	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
610--------------- Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, eastern white pine, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 6.--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
847*:					
Colvin	---	Tatarian honeysuckle, Siberian peashrub, common chokecherry, lilac.	Siberian crabapple, Black Hills spruce, eastern redcedar, blue spruce.	Green ash, golden willow.	Eastern cottonwood, Siberian elm.
Spicer	---	Tatarian honey-suckle, redosier dogwood, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash	Eastern cottonwood, golden willow, Siberian elm.
881*:					
Glyndon	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, Siberian crabapple, ponderosa pine.	Green ash, golden willow, common hackberry.	Eastern cottonwood, Siberian elm.
Quam	Lilac, silver buffaloberry.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
891B2*, 891C2*:					
Doland	---	Lilac, eastern redcedar, Siberian peashrub, American plum.	Blue spruce, bur oak, Siberian crabapple, ponderosa pine, Russian-olive.	Honeylocust, green ash.	Siberian elm.
Swanlake	---	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	White spruce, ponderosa pine, common hackberry, Russian-olive, Siberian crabapple, eastern redcedar.	Green ash	Siberian elm.
957B2*, 957C2*:					
Rothsay	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, bur oak, Siberian crabapple.	Green ash, honeylocust.	Siberian elm.
Zell	American plum, silver buffaloberry.	Russian-olive, common hackberry, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle.	Siberian elm, honeylocust, green ash, ponderosa pine.	---	---
992E*:					
Rock outcrop.					
Copaston.					
1016*. Udorthents					
1029*. Pits					

See footnote at end of table.

TABLE 6.--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
1053*: Aquolls.					
Aquents.					
1802*: Spicer	---	Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash	Eastern cottonwood, golden willow, Siberian elm.
Quam	Lilac, silver buffaloberry.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
1849D. Storden					
1864B Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern whitecedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
1866*: Perella	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
Colvin	---	Tatarian honeysuckle, Siberian peashrub, common chokecherry, lilac.	Siberian crabapple, Black Hills spruce, eastern redcedar, blue spruce.	Green ash, golden willow.	Eastern cottonwood, Siberian elm.
1868 Canisteo	---	Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Russian-olive, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--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
31D Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
35 Blue Earth	Severe: floods, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
45B Maddock	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
45C Maddock	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
60 Glyndon	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Slight.
85 Calco	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: floods, wetness.
89 McDonaldsville	Severe: wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
94B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
113 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
127A Sverdrup	Slight	Slight	Slight	Slight	Moderate: droughty.
127B Sverdrup	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
127C Sverdrup	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
141A Egeland	Slight	Slight	Slight	Slight	Moderate: droughty.
141B Egeland	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
234 Tonka	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
246 Marysland	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
290B Rothsay	Slight	Slight	Moderate: slope.	Slight	Slight.
324B Torning	Slight	Slight	Moderate: slope.	Slight	Slight.
338 Waubay	Slight	Slight	Slight	Slight	Slight.
339A Fordville	Slight	Slight	Slight	Slight	Slight.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
339B------------------ Fordville	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
341B------------------ Arvilla	Slight----------	Slight----------	Moderate: slope.	Slight------------	Moderate: droughty.
341C------------------ Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: droughty, slope.
344------------------- Quam	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
371------------------- Clontarf	Slight----------	Slight----------	Slight----------	Slight------------	Moderate: droughty.
421B------------------ Ves	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
423------------------- Seaforth	Slight----------	Slight----------	Slight----------	Slight------------	Slight.
434------------------- Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
444------------------- Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
574------------------- Du Page	Severe: floods.	Slight----------	Moderate: floods.	Slight------------	Moderate: floods.
591B------------------ Doland	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
595E------------------ Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
595F------------------ Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
597------------------- Tara	Slight----------	Slight----------	Slight----------	Slight------------	Slight.
610------------------- Calco	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
847*:					
Colvin---------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Spicer---------------	Severe: ponding.	Severe: ponding.	Severe: wetness, ponding.	Severe: ponding.	Severe: ponding.
881*:					
Glyndon--------------	Slight----------	Slight----------	Slight----------	Slight------------	Slight.
Quam-----------------	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
891B2*:					
Doland---------------	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
891B2*:					
Swanlake	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
891C2*:					
Doland	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Swanlake	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
957B2*:					
Rothsay	Slight	Slight	Moderate: slope.	Slight	Slight.
Zell	Slight	Slight	Moderate: slope.	Slight	Slight.
957C2*:					
Rothsay	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Zell	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
992E*:					
Rock outcrop.					
Copaston	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.	Severe: slope, thin layer.
1016*. Udorthents					
1029*. Pits					
1053*:					
Aquolls.					
Aquents.					
1802*:					
Spicer	Severe: ponding.	Severe: ponding.	Severe: wetness, ponding.	Severe: ponding.	Severe: ponding.
Quam	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
1849D Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: large stones, slope.	Severe: large stones, slope.
1864B Ves	Slight	Slight	Moderate: slope, large stones.	Moderate: large stones.	Severe: large stones.
1866*:					
Perella	Severe: ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding.	Severe: ponding, too clayey.	Severe: ponding, too clayey.
Colvin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1868------------------ Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--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
31D: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
35: Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
45B: Maddock	Fair	Good	Good	Fair	Fair	Poor	Very poor.	Fair	Fair	Very poor.
45C: Maddock	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
60: Glyndon	Good	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Poor.
85: Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
89: McDonaldsville	Good	Good	Fair	Fair	Fair	Good	Very poor.	Good	Fair	Poor.
94B: Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
113: Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
127A, 127B: Sverdrup	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Poor.
127C: Sverdrup	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
141A, 141B: Egeland	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Poor	Very poor.
234: Tonka	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
246: Marysland	Good	Good	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
290B: Rothsay	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
324B: Torning	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
338: Waubay	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
339A: Fordville	Good	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
339B: Fordville	Fair	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
341B: Arvilla	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
341C: Arvilla	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
344. Quam	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
371. Clontarf	Fair	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
421B. Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
423. Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
434. Perella	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
444. Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
574. Du Page	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
591B. Doland	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
595E, 595F. Swanlake	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
597. Tara	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
610. Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
847*:										
Colvin	Good	Good	---	Fair	Fair	Good	Good	Good	Fair	Good.
Spicer	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
881*:										
Glyndon	Good	Good	Good	Fair	Poor	Poor	Poor	Good	Fair	Poor.
Quam	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
891B2*:										
Doland	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.
891C2*:										
Doland	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Swanlake	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
957B2*:										
Rothsay	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
Zell	Fair	Fair	Fair	Poor	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.

See footnote at end of table.

TABLE 8.--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
957C2*:										
Rothsay-----------	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
Zell--------------	Poor	Fair	Fair	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
992E*:										
Rock outcrop.										
Copaston----------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
1016*. Udorthents										
1029*. Pits										
1053*:										
Aquolls.										
Aquents.										
1802*:										
Spicer------------	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
Quam--------------	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
1849D-------------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
1864B-------------- Ves	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
1866*:										
Perella-----------	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
Colvin------------	Good	Good	---	Fair	Fair	Good	Good	Good	Fair	Good.
1868--------------- Canisteo	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--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]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
31D-----Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35-----Blue Earth	Severe: excess humus, ponding.	Severe: floods, ponding, low strength.	Severe: floods, ponding.	Severe: floods, ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
45B-----Maddock	Severe: cutbanks cave.	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.
45C-----Maddock	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
60-----Glyndon	Moderate: wetness.	Slight-----	Moderate: wetness.	Slight-----	Severe: frost action.	Slight.
85-----Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Moderate: floods, wetness.
89-----McDonaldsville	Severe: cutbanks cave, wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness, too clayey.
94B-----Terril	Slight-----	Slight-----	Slight-----	Moderate: slope.	Severe: low strength.	Slight.
113-----Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
127A-----Sverdrup	Severe: cutbanks cave.	Slight-----	Slight-----	Slight-----	Slight-----	Moderate: droughty.
127B-----Sverdrup	Severe: cutbanks cave.	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.
127C-----Sverdrup	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
141A-----Egeland	Severe: cutbanks cave.	Slight-----	Slight-----	Slight-----	Slight-----	Moderate: droughty.
141B-----Egeland	Severe: cutbanks cave.	Slight-----	Slight-----	Moderate: slope.	Slight-----	Moderate: droughty.
234-----Tonka	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
246-----Marysland	Severe: cutbanks cave, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.
290B-----Rothsay	Slight-----	Slight-----	Slight-----	Moderate: slope.	Severe: frost action.	Slight.
324B-----Torning	Severe: cutbanks cave.	Slight-----	Slight-----	Moderate: slope.	Moderate: frost action.	Slight.
338-----Waubay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.

TABLE 9.--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
339A-------------- Fordville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
339B-------------- Fordville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Slight.
341B-------------- Arvilla	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
341C-------------- Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
344--------------- Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
371--------------- Clontarf	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
421B-------------- Ves	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
423--------------- Seaforth	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
434--------------- Perella	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
444--------------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
574--------------- Du Page	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
591B-------------- Doland	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
595E, 595F-------- Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
597--------------- Tara	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
610--------------- Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Severe: floods.
847*:						
Colvin-----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
Spicer-----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.

See footnote at end of table.

TABLE 9.--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
881*:						
Glyndon	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
Quam	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
891B2*:						
Doland	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Swanlake	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
891C2*:						
Doland	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Swanlake	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
957B2*:						
Rothsay	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.	Slight.
957C2*:						
Rothsay	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
Zell	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
992E*:						
Rock outcrop.						
Copaston	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, thin layer.
1016*. Udorthents						
1029*. Pits						
1053*:						
Aquolls.						
Aquents.						

See footnote at end of table.

TABLE 9.--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
1802*:						
Spicer-----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
Quam-------------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
1849D------------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: large stones, slope.
1864B------------- Ves	Moderate: large stones.	Moderate: large stones.	Moderate: large stones.	Moderate: large stones.	Moderate: low strength, frost action.	Severe: large stones.
1866*:						
Perella----------	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding, too clayey.
Colvin-----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
1868-------------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: large stones, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
31D Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
35 Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
45B Maddock	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
45C Maddock	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
60 Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
85 Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
89 McDonaldsville	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
94B Terril	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
113 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
127A, 127B Sverdrup	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
127C Sverdrup	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
141A, 141B Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
234 Tonka	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
246 Marysland	Severe: wetness, poor filter.	Severe: seepage, floods, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
290B Rothsay	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
324B Torning	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy.

TABLE 10.--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
338 Waubay	Moderate: wetness, percs slowly.	Moderate: seepage, wetness.	Moderate: too clayey.	Slight	Fair: too clayey.
339A, 339B Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
341B Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
341C Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
344 Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
371 Clontarf	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
421B Ves	Slight	Moderate: seepage, slope, excess humus.	Slight	Slight	Good.
423 Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
434 Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
444 Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
574 Du Page	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage, wetness.	Severe: floods.	Good.
591B Doland	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Slight	Slight	Good.
595E, 595F Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
597 Tara	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Slight	Fair: wetness.
610 Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
847*:					
Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

TABLE 10.--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
847*:					
Spicer	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
881*:					
Glyndon	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: too clayey, wetness.
Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
891B2*:					
Doland	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Slight	Slight	Good.
Swanlake	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
891C2*:					
Doland	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Swanlake	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
957B2*:					
Rothsay	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
957C2*:					
Rothsay	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Zell	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
992E*:					
Rock outcrop.					
Copaston	Severe: depth to rock, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: area reclaim, slope.
1016*. Udorthents					
1029*. Pits					
1053*:					
Aquolls.					
Aquents.					

See footnote at end of table.

TABLE 10.--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
1802*:					
Spicer	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
Quam	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
1849D Storden	Severe: slope.	Severe: slope, large stones.	Severe: slope.	Severe: slope.	Poor: slope.
1864B Ves	Moderate: percs slowly, large stones.	Severe: large stones.	Moderate: large stones.	Slight	Fair: large stones.
1866*:					
Perella	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
Colvin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1868 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
31D Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
45B, 45C Maddock	Good	Probable	Improbable: too sandy.	Poor: thin layer.
60 Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
85 Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
89 McDonaldsville	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too clayey, wetness.
94B Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
113 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
127A, 127B Sverdrup	Good	Probable	Improbable: too sandy.	Fair: thin layer.
127C Sverdrup	Good	Probable	Improbable: too sandy.	Fair: slope, thin layer.
141A, 141B Egeland	Good	Probable	Improbable: too sandy.	Good.
234 Tonka	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
246 Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
290B Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
324B Torning	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
338 Waubay	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
339A, 339B Fordville	Good	Probable	Probable	Fair: thin layer.
341B, 341C Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
344: Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
371: Clontarf	Good	Probable	Improbable: too sandy.	Fair: thin layer.
421B: Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
423: Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
434: Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
444: Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
574: Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
591B: Doland	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
595E: Swanlake	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
595F: Swanlake	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
597: Tara	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
610: Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
847*:				
Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Spicer	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
881*:				
Glyndon	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
891B2*:				
Doland	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Swanlake	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
891C2*:				
Doland	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, thin layer.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
891C2*:				
Swanlake	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim, slope.
957B2*:				
Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
957C2*:				
Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
992E*:				
Rock outcrop.				
Copaston	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	
1016*. Udorthents				
1029*. Pits				
1053*:				
Aquolls.				
Aquents.				
1802*:				
Spicer	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Quam	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1849D Storden	Fair: large stones, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim, slope.
1864B Ves	Fair: low strength, large stones.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim.
1866*:				
Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Colvin	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1868 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--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]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
31D Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
35 Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
45B Maddock	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
45C Maddock	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Slope, too sandy, soil blowing.	Slope, droughty.
60 Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
85 Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
89 McDonaldsville	Severe: seepage.	Severe: seepage, piping, wetness.	Percs slowly, cutbanks cave.	Wetness, slow intake, percs slowly.	Wetness, too sandy.	Wetness, percs slowly.
94B Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
113 Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
127A Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
127B Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Too sandy, soil blowing.	Droughty.
127C Sverdrup	Severe: seepage, slope.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
141A Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, droughty.	Soil blowing, too sandy.	Droughty.
141B Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Soil blowing, too sandy.	Droughty.
234 Tonka	Slight	Severe: ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
246 Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
290B Rothsay	Severe: seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
324B Torning	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing	Soil blowing	Favorable.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
338: Waubay	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
339A: Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
339B: Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
341B: Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
341C: Arvilla	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
344: Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
371: Clontarf	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
421B: Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
423: Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Favorable	Favorable.
434: Perella	Moderate: seepage.	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding	Wetness, percs slowly.
444: Canisteo	Severe: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
574: Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Floods	Favorable	Favorable.
591B: Doland	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
595E, 595F: Swanlake	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
597: Tara	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
610: Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
847*:						
Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Spicer	Moderate: seepage.	Severe: ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
881*:						
Glyndon	Severe: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
891B2*:						
Doland	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Favorable	Favorable.
Swanlake	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
891C2*:						
Doland	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope	Slope.
Swanlake	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
957B2*:						
Rothsay	Severe: seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
957C2*:						
Rothsay	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Zell	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
992E*:						
Rock outcrop.						
Copaston	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
1016*. Udorthents						
1029*. Pits						
1053*:						
Aquolls.						
Aquents.						
1802*:						
Spicer	Moderate: seepage.	Severe: ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
Quam	Slight	Severe: piping, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness, erodes easily.
1849D Storden	Severe: slope.	Severe: piping.	Deep to water	Large stones, slope.	Slope, large stones, erodes easily.	Large stones, slope, erodes easily.
1864B Ves	Moderate: seepage, slope.	Severe: piping, large stones.	Deep to water	Large stones, slope.	Large stones	Large stones.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1866*:						
Perella	Moderate: seepage.	Severe: piping, ponding.	Ponding, percs slowly, frost action.	Ponding, slow intake, percs slowly.	Ponding	Wetness, percs slowly.
Colvin	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
1868 Canisteo	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Large stones, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
31D----------- Storden	0-7	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam----------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
35----------- Blue Earth	0-20	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	20-60	Silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
45B, 45C--------- Maddock	0-10	Loamy fine sand	SM	A-2	0	100	100	50-80	15-35	---	NP
	10-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	60-95	5-35	---	NP
60----------- Glyndon	0-10	Silt loam--------	OL, ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	10-19	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	19-47	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	47-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-95	20-40	5-20
85----------- Calco	0-37	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	37-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
89----------- McDonaldsville	0-23	Silty clay-------	CH, CL	A-7	0	100	95-100	90-100	75-95	45-75	20-45
	23-32	Clay, silty clay, clay loam.	CL, CH	A-7	0	100	95-100	90-100	70-95	40-75	20-45
	32-60	Loamy sand, sand, sandy loam.	SM, SW-SM, SP-SM	A-2	0-5	85-100	80-100	50-75	10-35	<20	NP
94B----------- Terril	0-28	Loam----------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	28-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
113----------- Webster	0-20	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	20-23	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
	23-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
127A, 127B, 127C- Sverdrup	0-10	Sandy loam, fine sandy loam.	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	10-24	Loam, sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	24-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
141A, 141B------- Egeland	0-14	Sandy loam-------	SM, SM-SC	A-2, A-4	0	100	95-100	75-100	30-50	<30	NP-7
	14-37	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-95	15-50	<30	NP-7
	37-60	Loamy sand, loamy fine sand, fine sandy loam.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-90	10-45	<25	NP-5
234----------- Tonka	0-30	Silty clay loam, silt loam.	CL, CL-ML	A-4, A-6	0-2	100	95-100	90-100	70-90	20-40	5-25
	30-54	Silty clay loam, clay loam, clay.	CH, CL	A-6, A-7	0-2	100	95-100	90-100	75-95	35-55	15-35
	54-60	Silty clay loam, clay loam.	CL	A-6, A-7	0-3	100	95-100	90-100	70-90	30-50	10-30
246----------- Marysland	0-16	Loam----------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	16-27	Loam, clay loam, sandy loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	27-60	Stratified fine sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP

TABLE 13.--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	
290B----------- Rothsay	0-10	Loam-------------	ML	A-4	0	95-100	95-100	90-100	85-100	20-40	NP-10
	10-30	Silt loam, very fine sandy loam, loam.	ML	A-4	0	95-100	95-100	90-100	80-100	20-40	NP-10
	30-60	Silt loam, loam, very fine sandy loam.	ML	A-4	0	95-100	95-100	90-100	80-90	20-40	NP-10
324B----------- Torning	0-10	Very fine sandy loam.	ML, CL-ML	A-4	0	100	100	85-95	50-65	<20	1-5
	10-42	Very fine sand, very fine sandy loam, loamy fine sand.	SM, ML	A-4	0	100	100	70-100	36-90	<20	NP-4
	42-60	Silt loam--------	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-15
338------------ Waubay	0-17	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	17-27	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	27-38	Silt loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	95-100	85-100	30-45	5-20
	38-60	Silt loam, loam	ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	30-45	5-20
339A, 339B------- Fordville	0-14	Loam, silt loam	ML, CL	A-4, A-6, A-7	0	100	95-100	70-95	60-90	30-50	5-25
	14-36	Loam, clay loam, silt loam.	CL, ML, SM, SC	A-4, A-6	0	95-100	90-100	65-90	40-55	25-40	3-15
	36-60	Gravelly loamy sand, sand, gravelly coarse sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-40	0-15	<25	NP-5
341B, 341C------- Arvilla	0-18	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	18-60	Gravelly sand, sand, loamy sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
344------------ Quam	0-10	Silty clay loam	CL, ML, OL	A-7	0	100	100	90-100	85-95	40-50	15-25
	10-36	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	36-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
371------------ Clontarf	0-19	Fine sandy loam	SM	A-2, A-4	0	100	95-100	60-85	25-50	<30	NP-7
	19-24	Sandy loam, loam, fine sandy loam.	SM, ML	A-2, A-4	0	100	95-100	60-95	20-60	<30	NP-7
	24-60	Sand, fine sand, loamy sand.	SP-SM, SM	A-2, A-3	0	100	95-100	50-80	5-35	<20	NP
421B----------- Ves	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-18	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	18-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
423------------ Seaforth	0-11	Silt loam--------	ML, OL	A-7, A-6, A-4	0-5	95-100	90-100	80-100	60-80	35-45	8-15
	11-19	Loam, silt loam	CL, ML	A-6, A-4	0-5	90-100	85-100	80-95	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

TABLE 13.--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	
434-------------- Perella	0-16	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	25-50	10-30
	16-25	Silt loam, silty clay loam, silty clay.	CL, CL-ML, CH	A-4, A-7, A-6	0	100	100	95-100	80-95	25-60	5-40
	25-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-95	25-50	3-28
444-------------- Canisteo	0-15	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	15-24	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	24-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
574-------------- Du Page	0-11	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	11-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20
591B------------- Doland	0-10	Silt loam--------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	10-20	Silt loam--------	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	20-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0	90-100	85-98	80-90	55-80	20-40	6-20
595E, 595F------- Swanlake	0-9	Loam-------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-60	Loam, clay loam.	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
597-------------- Tara	0-14	Silty clay loam	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	14-31	Silt loam, loam	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	31-60	Loam-------------	CL, CL-ML	A-6, A-4	0-2	95-100	85-100	80-90	55-80	20-40	6-20
610-------------- Calco	0-23	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	23-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
847*:											
Colvin----------	0-15	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	80-95	35-50	15-30
	15-21	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	21-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
Spicer----------	0-16	Silty clay loam	OL, ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	16-40	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	40-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
881*:											
Glyndon---------	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-95	30-45	10-25
	8-17	Silt loam, very fine sandy loam, loam.	ML, CL-ML, CL	A-4	0	100	100	90-100	60-95	20-30	NP-10
	17-47	Very fine sandy loam, silt loam.	ML, CL, CL-ML	A-4	0	100	100	90-100	60-95	20-30	NP-10
	47-60	Silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	80-95	20-40	5-20
Quam------------	0-10	Silty clay loam	CL, ML, OL	A-7	0	100	100	90-100	85-95	40-50	15-25
	10-36	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	36-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
891B2*, 891C2*:											
Doland----------	0-7	Silt loam--------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	7-18	Silt loam--------	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	18-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0	90-100	85-98	80-90	55-80	20-40	6-20

See footnote at end of table.

TABLE 13.--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	
891B2*, 891C2*:											
Swanlake	0-7	Loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	7-60	Loam	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
957B2*, 957C2*:											
Rothsay	0-8	Loam	ML	A-4	0	95-100	95-100	90-100	85-100	20-40	NP-10
	8-16	Silt loam, very fine sandy loam, loam.	ML	A-4	0	95-100	95-100	90-100	80-100	20-40	NP-10
	16-60	Silt loam, loam, very fine sandy loam.	ML	A-4	0	95-100	95-100	90-100	80-90	20-40	NP-10
Zell	0-9	Silt loam	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	9-60	Silt loam, very fine sandy loam, loam.	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
992E*:											
Rock outcrop.											
Copaston	0-13	Silt loam	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	13	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
1016*. Udorthents											
1029*. Pits											
1053*:											
Aquolls.											
Aquents.											
1802*:											
Spicer	0-19	Silty clay loam	OL, ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	19-36	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	36-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
Quam	0-8	Silty clay loam	CL, ML, OL	A-7	0	100	100	90-100	85-95	40-50	15-25
	8-38	Silty clay loam, silt loam, loam.	CL, ML	A-7, A-6, A-4	0	100	100	80-100	70-95	30-50	5-25
	38-60	Clay loam, silty clay loam, silt loam.	CL, ML, CL-ML	A-4, A-6, A-7	0	100	90-100	85-95	70-90	20-50	5-20
1849D Storden	0-8	Stony loam	ML, CL	A-4, A-6	10-50	90-100	85-95	70-85	55-70	30-40	5-15
	8-60	Loam, stony loam	CL-ML, CL	A-4, A-6	5-30	90-100	85-95	70-85	55-70	20-40	5-15
1864B Ves	0-9	Stony loam	CL	A-6, A-4	10-50	95-100	85-100	80-90	60-80	30-40	7-15
	9-19	Loam, clay loam, stony loam.	CL	A-6	5-30	95-100	90-100	80-95	55-75	30-40	10-20
	19-60	Loam, stony loam	CL, ML	A-6, A-4	0-30	90-100	90-95	80-90	55-80	30-40	7-15
1866*:											
Perella	0-20	Silty clay	CL, CH	A-7	0	100	100	95-100	90-95	40-60	20-40
	20-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-95	25-50	3-28

See footnote at end of table.

TABLE 13.--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	
1866*:											
Colvin----------	0-10	Silty clay-------	CL, CH	A-7	0	100	100	95-100	90-95	45-60	20-35
	10-30	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	80-95	25-50	10-30
	30-60	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	70-95	25-50	10-25
1868------------- Canisteo	0-13	Stony loam-------	OL, CL	A-7	5-25	98-100	95-100	85-95	60-90	40-50	15-20
	13-20	Clay loam, loam	CL	A-6, A-7	0-20	98-100	90-100	85-95	65-85	35-50	15-25
	20-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	60-75	30-40	10-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol > 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/cm^3	In/hr	In/in	pH					Pct
31D	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
Storden	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
35	0-20	18-32	0.20-0.80	0.6-6.0	0.18-0.24	7.4-8.4	Moderate	0.28	5	5	10-25
Blue Earth	20-60	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low	0.28			
45B, 45C	0-10	5-10	1.35-1.45	6.0-20	0.08-0.12	6.6-7.8	Low	0.17	5	2	1-3
Maddock	10-60	3-8	1.35-1.45	6.0-20	0.05-0.13	6.6-8.4	Low	0.17			
60	0-10	15-27	1.20-1.40	0.6-2.0	0.20-0.23	7.4-9.0	Low	0.28	4	4L	3-7
Glyndon	10-19	10-18	1.30-1.50	0.6-6.0	0.17-0.20	7.9-9.0	Low	0.28			
	19-47	10-18	1.35-1.55	0.6-6.0	0.15-0.22	7.4-8.4	Low	0.28			
	47-60	15-35	1.40-1.60	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.28			
85	0-37	28-33	1.25-1.30	0.6-2.0	0.21-0.23	6.6-8.4	High	0.28	5	7	5-7
Calco	37-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
89	0-23	40-60	1.20-1.30	0.06-0.2	0.15-0.18	6.1-7.3	High	0.28	5	4	4-8
McDonaldsville	23-32	35-60	1.20-1.30	0.06-0.2	0.14-0.19	6.1-8.4	High	0.28			
	32-60	0-10	1.40-1.70	6.0-20	0.07-0.12	7.9-8.4	Low	0.17			
94B	0-28	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	28-60	27-32	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low	0.32			
113	0-20	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate	0.24	5	6	6-7
Webster	20-23	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate	0.32			
	23-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
127A, 127B, 127C	0-10	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	Low	0.20	3	3	2-4
Sverdrup	10-24	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	Low	0.20			
	24-60	0-10	1.50-1.65	6.0-20	0.02-0.12	7.4-8.4	Low	0.15			
141A, 141B	0-14	10-18	1.25-1.35	2.0-6.0	0.11-0.17	5.6-7.3	Low	0.20	5	3	1-4
Egeland	14-37	10-18	1.30-1.45	2.0-6.0	0.09-0.15	6.1-7.8	Low	0.20			
	37-60	5-10	1.40-1.65	2.0-6.0	0.08-0.10	6.6-8.4	Low	0.20			
234	0-30	18-39	1.00-1.50	0.6-2.0	0.18-0.23	5.6-7.3	Low	0.32	5	6	5-10
Tonka	30-54	35-45	1.40-1.70	0.06-0.2	0.14-0.19	5.6-7.3	High	0.43			
	54-60	27-39	1.40-1.70	0.2-0.6	0.14-0.19	6.6-9.0	Moderate	0.43			
246	0-16	18-30	1.20-1.30	0.6-2.0	0.17-0.22	7.9-8.4	Moderate	0.28	4	4L	5-8
Marysland	16-27	18-30	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	Moderate	0.28			
	27-60	1-5	1.55-1.65	>6.0	0.02-0.07	7.9-8.4	Low	0.15			
290B	0-10	10-18	1.20-1.40	0.6-2.0	0.22-0.24	6.6-7.3	Low	0.32	5	5	3-6
Rothsay	10-30	10-18	1.20-1.40	0.6-2.0	0.17-0.22	6.6-7.8	Low	0.43			
	30-60	10-18	1.20-1.40	0.6-6.0	0.20-0.22	7.4-8.4	Low	0.43			
324B	0-10	10-18	1.45-1.55	2.0-6.0	0.18-0.22	7.4-7.8	Low	0.32	5	3	.5-2
Torning	10-42	5-18	1.45-1.65	2.0-6.0	0.09-0.19	7.4-8.4	Low	0.32			
	42-60	12-18	1.45-1.65	2.0-6.0	0.12-0.20	7.4-8.4	Low	0.32			
338	0-17	27-35	1.35-1.45	0.6-2.0	0.19-0.22	6.1-7.3	Moderate	0.28	5	7	4-8
Waubay	17-27	20-30	1.35-1.45	0.6-2.0	0.18-0.21	6.6-7.8	Moderate	0.43			
	27-38	20-30	1.35-1.45	0.6-2.0	0.17-0.20	7.4-8.4	Moderate	0.43			
	38-60	20-30	1.40-1.50	0.6-2.0	0.16-0.18	7.4-8.4	Moderate	0.43			
339A, 339B	0-14	18-25	1.10-1.25	0.6-2.0	0.19-0.22	6.1-7.3	Low	0.24	4	6	3-7
Fordville	14-36	15-30	1.25-1.45	0.6-6.0	0.12-0.18	6.1-7.8	Low	0.24			
	36-60	0-5	1.60-1.80	6.0-20	0.03-0.06	7.4-8.4	Low	0.10			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
341B, 341C: Arvilla	0-18	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-7.8	Low	0.20	3	3	1-4
	18-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	Low	0.10			
344: Quam	0-10	28-35	1.00-1.35	0.2-0.6	0.18-0.22	6.6-7.8	Moderate	0.28	5	7	6-15
	10-36	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	Moderate	0.28			
	36-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate	0.37			
371: Clontarf	0-19	10-18	1.35-1.55	2.0-6.0	0.13-0.18	6.1-7.3	Low	0.20	4	3	3-6
	19-24	10-18	1.45-1.60	2.0-6.0	0.12-0.19	6.1-7.8	Low	0.20			
	24-60	5-10	1.55-1.70	6.0-20	0.05-0.09	6.6-7.8	Low	0.15			
421B: 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
	10-18	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.24			
	18-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
423: Seaforth	0-11	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.28	5	4L	3-6
	11-19	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			
434: Perella	0-16	27-39	1.20-1.40	0.2-2.0	0.18-0.23	6.6-7.8	Moderate	0.28	5	7	4-8
	16-25	18-45	1.30-1.50	0.06-2.0	0.15-0.22	6.6-7.8	Moderate	0.28			
	25-60	18-34	1.30-1.60	0.2-0.6	0.16-0.22	7.4-8.4	Moderate	0.28			
444: Canisteo	0-15	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.32	5	4L	4-8
	15-24	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	24-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
574: Du Page	0-11	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	Moderate	0.28	5	6	3-5
	11-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	Low	0.28			
591B: Doland	0-10	18-27	1.30-1.45	0.6-2.0	0.24-0.28	6.1-7.3	Low	0.32	5	6	4-6
	10-20	18-27	1.35-1.50	0.6-2.0	0.17-0.22	6.1-7.3	Low	0.32			
	20-60	18-30	1.45-1.70	0.6-2.0	0.14-0.19	6.6-8.4	Low	0.32			
595E, 595F: Swanlake	0-9	18-27	1.25-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	9-60	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
597: Tara	0-14	18-30	1.40-1.50	0.6-2.0	0.20-0.24	6.1-7.3	Low	0.28	5	6	4-8
	14-31	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-7.8	Low	0.28			
	31-60	18-27	1.35-1.60	0.6-2.0	0.15-0.19	7.4-8.4	Low	0.37			
610: Calco	0-23	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High	0.28	5	7	5-7
	23-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
847*:											
Colvin	0-15	27-34	1.20-1.50	0.2-0.6	0.20-0.22	7.4-9.0	Moderate	0.32	5	4L	4-7
	15-21	18-34	1.20-1.50	0.06-2.0	0.16-0.20	7.4-9.0	Moderate	0.32			
	21-60	18-34	1.30-1.50	0.06-2.0	0.15-0.20	7.4-9.0	Moderate	0.32			
Spicer	0-16	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate	0.28	5	4L	6-8
	16-40	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate	0.28			
	40-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.28			
881*:											
Glyndon	0-8	27-35	1.25-1.40	0.6-2.0	0.18-0.22	7.4-9.0	Moderate	0.28	4	4L	4-8
	8-17	10-18	1.30-1.50	0.6-6.0	0.17-0.20	7.9-9.0	Low	0.28			
	17-47	10-18	1.35-1.55	0.6-6.0	0.15-0.22	7.4-8.4	Low	0.28			
	47-60	15-35	1.40-1.60	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.28			
Quam	0-10	28-35	1.00-1.35	0.2-0.6	0.18-0.22	6.6-7.8	Moderate	0.28	5	7	6-8
	10-36	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	Moderate	0.28			
	36-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate	0.37			
891B2*, 891C2*:											
Doland	0-7	18-27	1.30-1.45	0.6-2.0	0.24-0.28	6.1-7.3	Low	0.32	5	6	4-6
	7-18	18-27	1.35-1.50	0.6-2.0	0.17-0.22	6.1-7.3	Low	0.32			
	18-60	18-30	1.45-1.70	0.6-2.0	0.14-0.19	6.6-8.4	Low	0.32			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
891B2*, 891C2*:											
Swanlake--------	0-7	18-27	1.25-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low-----------	0.28	5	4L	2-4
	7-60	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
957B2*, 957C2*:											
Rothsay---------	0-8	10-18	1.20-1.40	0.6-2.0	0.22-0.24	6.6-7.3	Low-----------	0.32	5	5	3-6
	8-16	10-18	1.20-1.40	0.6-2.0	0.17-0.22	6.6-7.8	Low-----------	0.43			
	16-60	10-18	1.20-1.40	0.6-6.0	0.20-0.22	7.4-8.4	Low-----------	0.43			
Zell------------	0-9	10-18	1.15-1.30	0.6-2.0	0.17-0.22	6.6-8.4	Low-----------	0.32	5	4L	2-5
	9-60	10-18	1.25-1.40	0.6-2.0	0.15-0.20	7.4-8.4	Low-----------	0.43			
992E*: Rock outcrop.											
Copaston--------	0-13	10-20	1.40-1.60	0.6-2.0	0.18-0.20	6.1-7.3	Low-----------	0.28	2	5	2-5
	13	---	---	---	---	---	--------------	----			
1016*. Udorthents											
1029*. Pits											
1053*: Aquolls.											
Aquents.											
1802*:											
Spicer----------	0-19	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L	6-8
	19-36	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.28			
	36-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low-----------	0.28			
Quam------------	0-8	28-35	1.00-1.35	0.2-0.6	0.18-0.22	6.6-7.8	Moderate-----	0.28	5	7	6-8
	8-38	22-35	1.25-1.45	0.2-0.6	0.16-0.22	6.6-7.8	Moderate-----	0.28			
	38-60	20-35	1.40-1.65	0.2-0.6	0.14-0.19	7.4-8.4	Moderate-----	0.37			
1849D------------ Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.11-0.18	7.4-8.4	Low-----------	0.28	5	8	1-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.13-0.18	7.4-8.4	Low-----------	0.37			
1864B------------ Ves	0-9	20-28	1.35-1.60	0.6-2.0	0.10-0.18	6.1-7.8	Low-----------	0.17	5	8	2-6
	9-19	20-32	1.30-1.60	0.6-2.0	0.12-0.18	6.6-7.8	Moderate-----	0.24			
	19-60	20-28	1.30-1.60	0.6-2.0	0.12-0.18	7.4-8.4	Low-----------	0.24			
1866*:											
Perella---------	0-20	40-59	1.20-1.40	0.06-0.2	0.15-0.18	6.6-7.3	Moderate-----	0.28	5	4	4-8
	20-60	18-34	1.30-1.60	0.2-0.6	0.16-0.22	7.4-8.4	Moderate-----	0.28			
Colvin----------	0-10	40-45	1.20-1.40	0.06-0.2	0.15-0.18	7.4-9.0	High----------	0.32	5	4	4-7
	10-30	18-34	1.20-1.50	0.06-2.0	0.16-0.20	7.4-9.0	Moderate-----	0.32			
	30-60	18-34	1.30-1.50	0.06-2.0	0.15-0.20	7.4-9.0	Moderate-----	0.32			
1868------------- Canisteo	0-13	18-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	8	4-8
	13-20	18-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32			
	20-60	18-35	1.45-1.65	0.6-2.0	0.14-0.16	7.4-8.4	Low-----------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
31D----- Storden	B	None-----	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
35*----- Blue Earth	B/D	Rare-----	---	---	+2-1.0	Apparent	Jan-Dec	>60	High--------	High-----	Low.
45B, 45C----- Maddock	A	None-----	---	---	>6.0	---	---	>60	Low---------	Moderate	Low.
60----- Glyndon	B	None-----	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High--------	High-----	Low.
85----- Calco	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
89----- McDonaldsville	C/D	None-----	---	---	0-3.0	Apparent	Apr-Jun	>60	Moderate----	High-----	Low.
94B----- Terril	B	None-----	---	---	>6.0	---	---	>60	Moderate----	Moderate	Low.
113----- Webster	B/D	None-----	---	---	1.0-2.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
127A, 127B, 127C-- Sverdrup	B	None-----	---	---	>6.0	---	---	>60	Low---------	Low------	Low.
141A, 141B----- Egeland	B	None-----	---	---	>6.0	---	---	>60	Low---------	Moderate	Low.
234*----- Tonka	C/D	None-----	---	---	+.5-1.0	Apparent	Apr-Jun	>60	High--------	High-----	Low.
246----- Marysland	B/D	Rare-----	---	---	1.0-2.5	Apparent	Nov-Jul	>60	High--------	High-----	Low.
290B----- Rothsay	B	None-----	---	---	>6.0	---	---	>60	High--------	Low------	Low.
324B----- Torning	B	None-----	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
338----- Waubay	B	None-----	---	---	4.0-6.0	Perched	Oct-Jun	>60	High--------	High-----	Low.
339A, 339B----- Fordville	B	None-----	---	---	>6.0	---	---	>60	Low---------	Moderate	Low.
341B, 341C----- Arvilla	A	None-----	---	---	>6.0	---	---	>60	Low---------	Moderate	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
344*: Quam	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	>60	High	High	Low.
371: Clontarf	B	None	---	---	3.0-5.0	Apparent	Nov-Jun	>60	Moderate	Low	Low.
421B: Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
423: Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	>60	High	High	Low.
434*: Perella	B/D	None	---	---	+1-1.0	Apparent	Apr-Jul	>60	High	High	Low.
444: Canisteo	C/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High	High	Low.
574: Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	Moderate	Low	Low.
591B: Doland	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
595E, 595F: Swanlake	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
597: Tara	B	None	---	---	3.0-5.0	Perched	Mar-Jun	>60	High	Moderate	Low.
610: Calco	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High	High	Low.
847:											
Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	>60	High	High	Low.
Spicer*	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	>60	High	High	Low.
881:											
Glyndon	B	None	---	---	2.5-6.0	Apparent	Apr-Jul	>60	High	High	Low.
Quam*	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	>60	High	High	Low.
891B2, 891C2:											
Doland	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Swanlake	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
957B2, 957C2:											
Rothsay	B	None	---	---	>6.0	---	---	>60	High	Low	Low.
Zell	B	None	---	---	>6.0	---	---	>60	High	High	Moderate.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
992E:											
Rock outcrop.											
Copaston	D	None	---	---	>6.0	---	---	12-20	Moderate	Low	Low.
1016. Udorthents											
1029. Pits											
1053:											
Aquolls.											
Aquents.											
1802*:											
Spicer	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	>60	High	High	Low.
Quam	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	>60	High	High	Low.
1849D Storden	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
1864B Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
1866:											
Perella*	B/D	None	---	---	+1-1.0	Apparent	Apr-Jul	>60	High	High	Low.
Colvin	C/D	None	---	---	0-1.0	Apparent	Apr-Jul	>60	High	High	Low.
1868 Canisteo	D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High	High	Low.

* In the "High water table--Depth" column, 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.

TABLE 16.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquent	Loamy, mixed, nonacid, mesic Aquents
Aquolls	Loamy, mixed, mesic Haplaquolls
Arvilla	Sandy, mixed Udic Haploborolls
*Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clontarf	Coarse-loamy, mixed Pachic Udic Haploborolls
Colvin	Fine-silty, frigid Typic Calciaquolls
Copaston	Loamy, mixed, mesic Lithic Hapludolls
Doland	Fine-loamy, mixed Udic Haploborolls
*Du Page	Fine-loamy, mixed, mesic Cumulic Hapludolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
Glyndon	Coarse-silty, frigid Aeric Calciaquolls
Maddock	Sandy, mixed Udorthentic Haploborolls
*Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
McDonaldsville	Clayey over sandy or sandy-skeletal, montmorillonitic, frigid Typic Haplaquolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Quam	Fine-silty, mixed, frigid Cumulic Haplaquolls
Rothsay	Coarse-silty, mixed Udic Haploborolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Sverdrup	Sandy, mixed Udic Haploborolls
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Tara	Fine-silty, mixed Pachic Udic Haploborolls
*Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Torning	Coarse-loamy, mixed (calcareous), frigid Typic Udorthents
Udorthents	Loamy, mixed, nonacid, mesic Udorthents
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Waubay	Fine-silty, mixed Pachic Udic Haploborolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
*Zell	Coarse-silty, mixed Udorthentic Haploborolls

* The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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