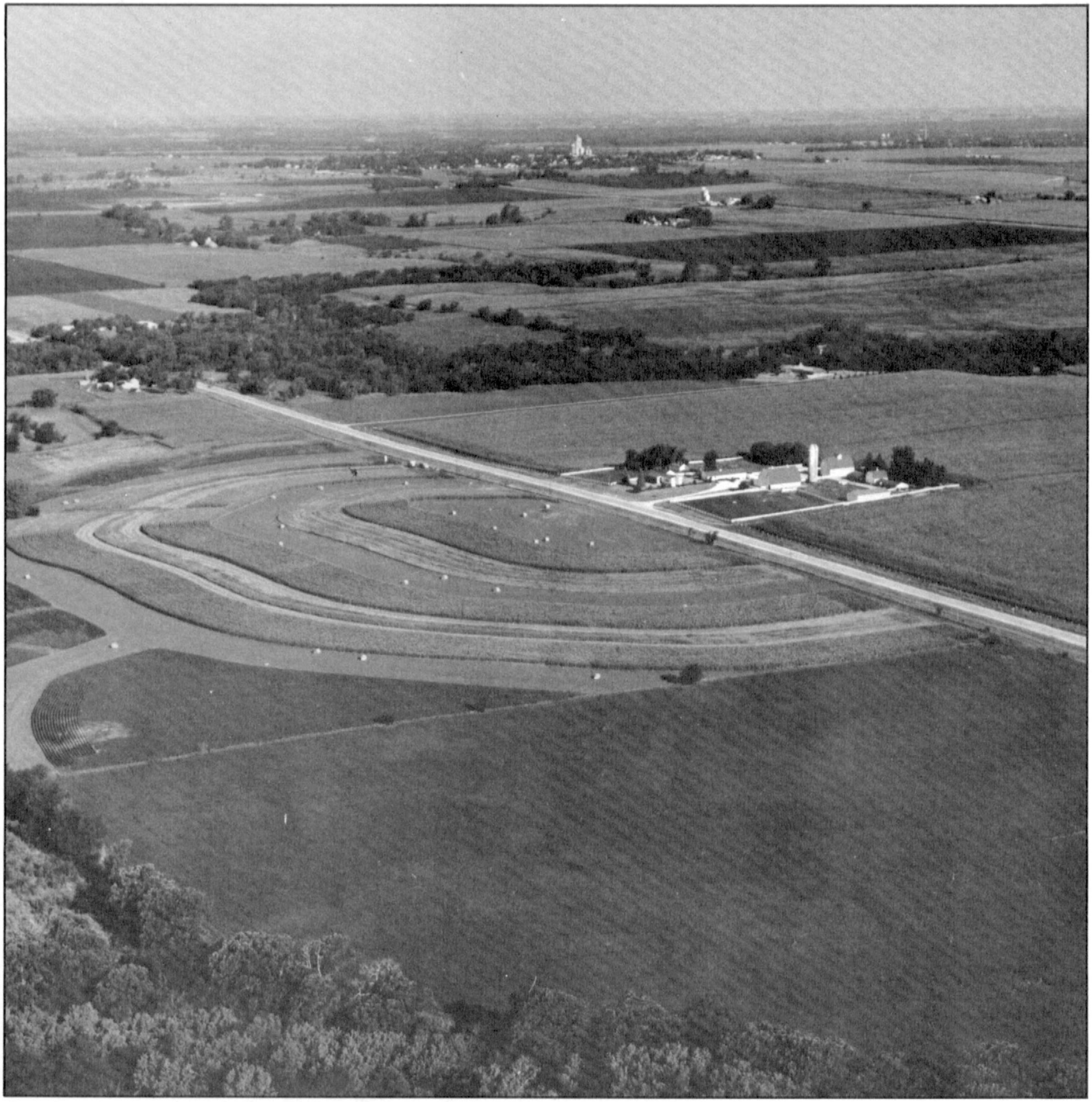
United States
Department of
Agriculture

Soil
Conservation
Service

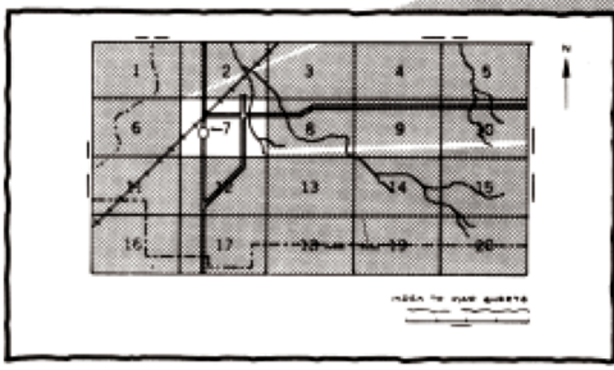
In Cooperation with the
Iowa Agriculture and
Home Economics
Experiment Station;
the Cooperative Extension
Service, Iowa State
University; and the
Department of Soil
Conservation,
State of Iowa

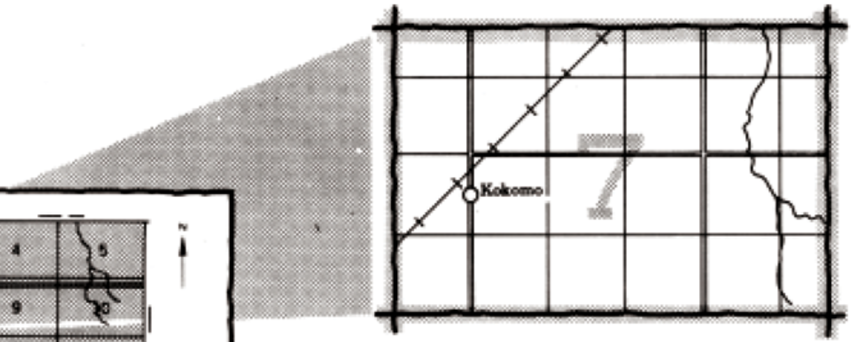
Soil Survey of Dallas County Iowa



HOW TO USE

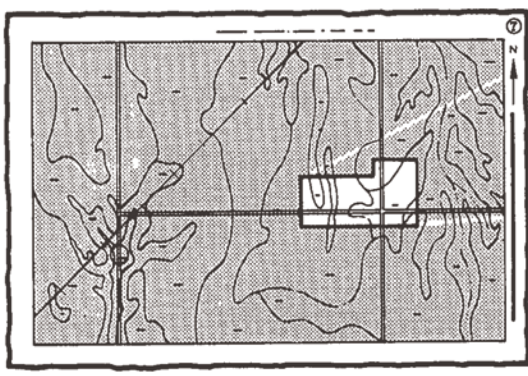
1. Locate your area of interest on the "Index to Map Sheets"

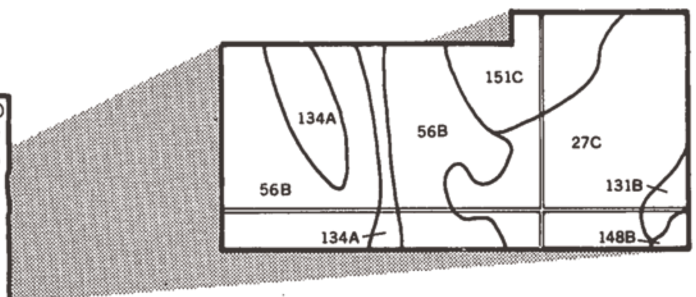




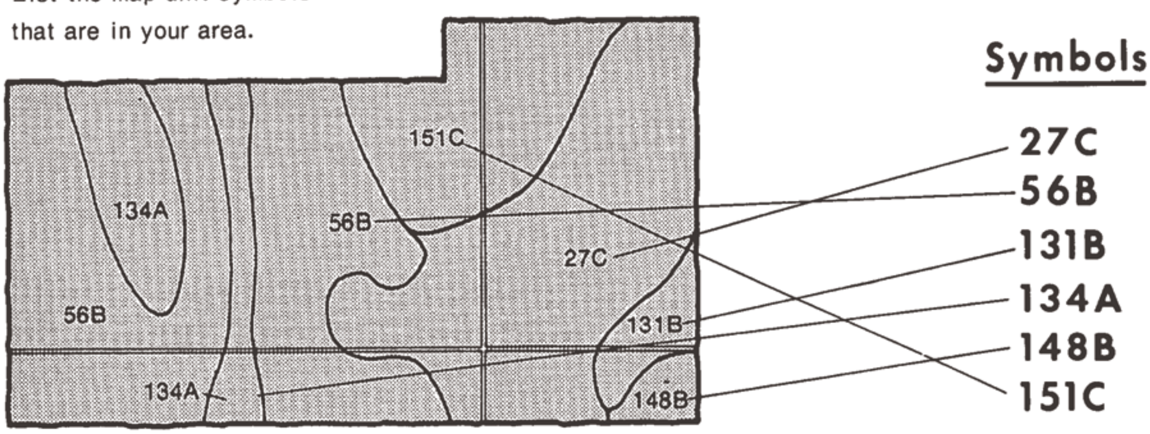
2. Note the number of the map sheet and turn to that sheet.

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



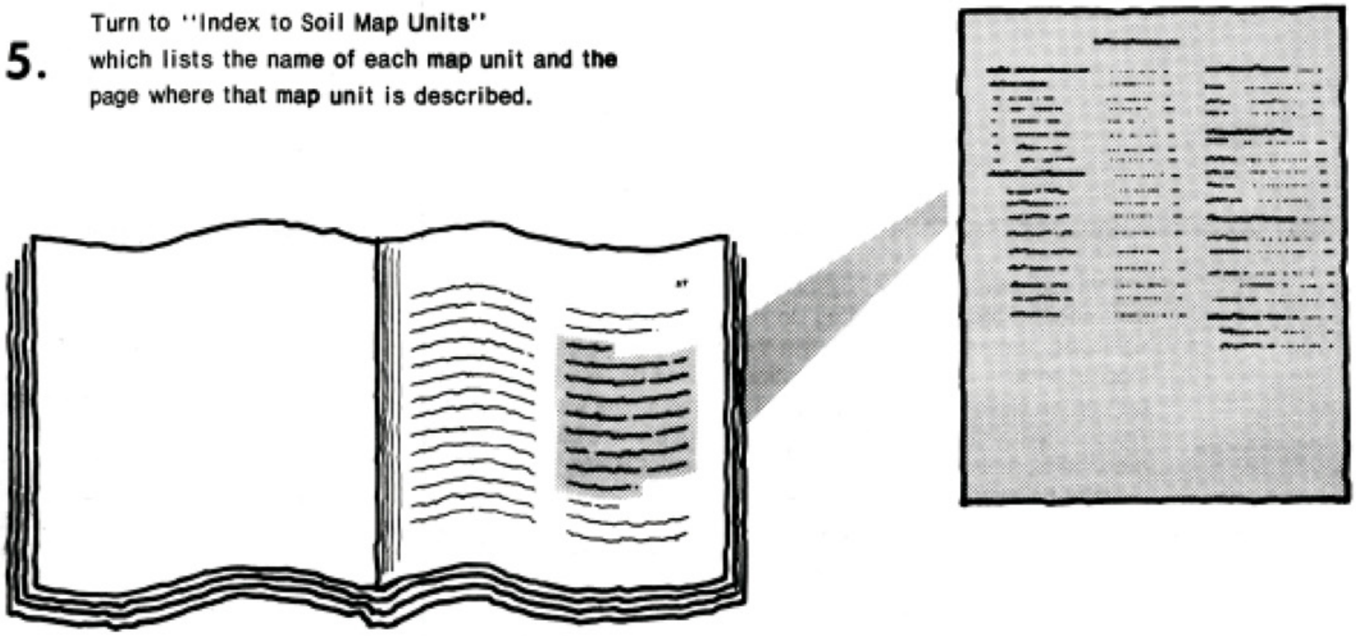


4. List the map unit symbols that are in your area.

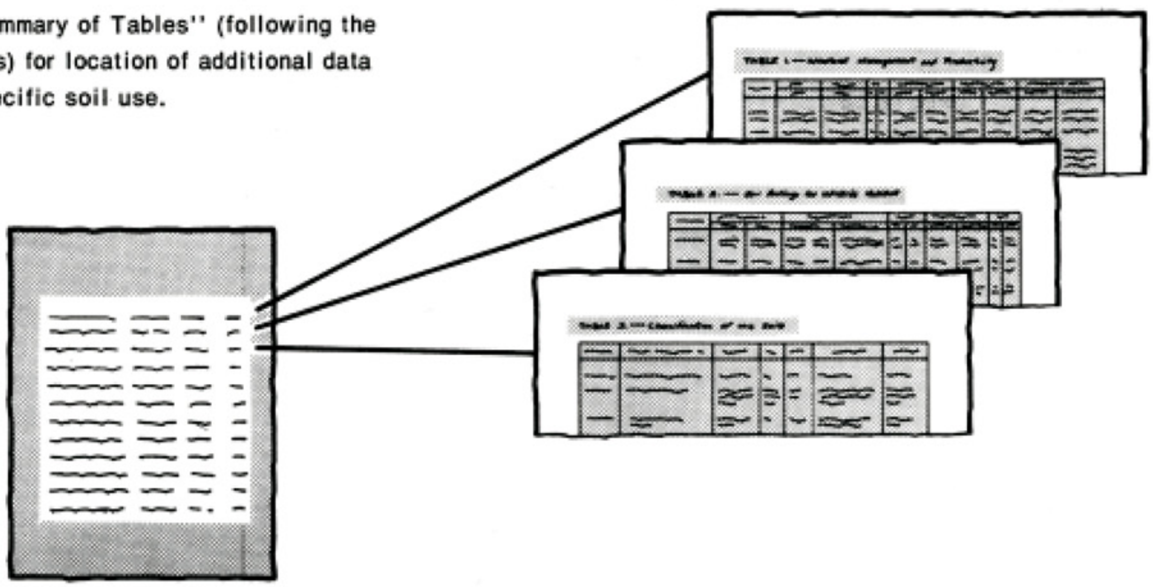


THIS SOIL SURVEY

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; to specialists in wildlife management, waste disposal, or pollution control.

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

This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Dallas County Soil Conservation District. Funds appropriated by Dallas County were used to defray part of the cost of the survey. Major fieldwork was performed in the period 1976-79. Soil names and descriptions were approved in 1980. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

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

Cover: Stripcropping on Clarion soils. Nicollet and Webster soils are in the background.

contents

soil series

Issued October 1983

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summary of tables

preface

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

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

soil survey of
Dallas County, Iowa

By Robert O. Dideriksen, Soil Conservation Service

Fieldwork by Robert O. Dideriksen, David J. Hoppe,
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United States Department of Agriculture, Soil Conservation Service,
in cooperation with the
Iowa Agriculture and Home Economics Experiment Station;
the Cooperative Extension Service, Iowa State University;
and the Department of Soil Conservation, State of Iowa

DALLAS COUNTY is in west-central Iowa (fig. 1). It has a total area of 382,080 acres, or 597 square miles. Adel, the county seat, is about 23 miles west of Des Moines. It has a population of 2,771.

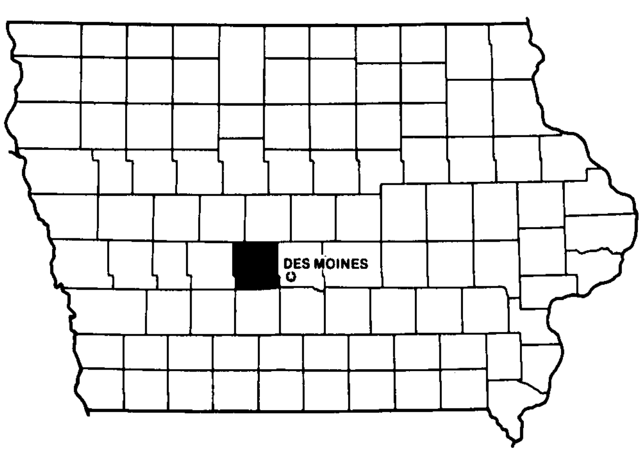

Figure 1.—Location of Dallas County in Iowa.

Most of the soils in Dallas County are nearly level to gently rolling. They formed under prairie vegetation and are dark and fertile. The soils along the larger rivers formed under trees and are lighter colored and steeper than those that formed under the prairie vegetation.

This survey updates the soil survey of Dallas County published in 1924 (*7*). It provides additional information and larger maps, which show the soils in greater detail.

general nature of the county

The following paragraphs briefly describe the history, farming, transportation facilities and industry, natural resources, and climate of the county.

history

The Sac and Fox Indians inhabited the area now known as Dallas County prior to 1845. In that year pioneers settled near the wooded areas along the larger streams. Farming was the main occupation. The county was organized in 1846. It was named after the Honorable George M. Dallas of Pennsylvania, who was then the Vice President of the United States.

In 1850, the population of the county was 854. The advent of railroads to the county about 1868 greatly increased the influx of settlers. By 1900, the population was 23,058. By 1970, it was 26,085.

In 1847, Adel became the county seat. Other towns in the county include Perry, Waukee, Dallas Center, Woodward, Redfield, Granger, Dexter, Van Meter, Minburn, DeSoto, and several other small villages.

farming

Farming is the main enterprise in Dallas County. Most of the acreage is farmland. Corn, soybeans, oats, hay, and pasture are the main crops, and corn and soybeans are the principal grain crops. Raising hogs and feeding beef cattle are the principal livestock enterprises. In 1976, about 354,500 acres was farmland. About 274,440 acres was used for field crops, and 35,000 acres was used for pasture. In 1976, about 119,000 hogs and 18,900 grain fed cattle were marketed and the number of laying hens was about 163,700.

The farms in the county have been increasing in size and decreasing in number. In 1976, the county had 1,340 farms, which averaged about 265 acres in size.

transportation facilities and industry

Three major highways serve Dallas County. U.S. Highway Number 169 transverses north and south across the county and U.S. Highway Number 6 and Interstate 80 east and west. Iowa Highways 141, 44, 293, 89, and 90 and county roads connect other areas of the county. Most farms have access to hard-surfaced or gravel roads. These roads generally follow section lines, except in the more sloping, wooded areas along the Des Moines and Raccoon Rivers. Railroad lines serve most of the towns. Two small airports serve the county. One, which has a 3,000-foot hard-surfaced runway, is located southwest of Perry. The other is north of Adel.

Although farming is the main enterprise, several industries are in the county, mainly in Perry. Farm tillage tools, iron castings, and concrete tile forms are manufactured, and pork is processed. Two seed corn companies and many grain elevators are also in the county.

natural resources

Soil is the most important natural resource in the county. It provides a growing medium for the grass grazed by livestock and for the marketable crops.

In most of the county, the water supply is adequate for domestic use and for watering livestock. Deep wells near the Raccoon River furnish most of the water for domestic use in Perry and Adel.

In some areas along the Des Moines and Raccoon Rivers and Beaver Creek, good sources of sand and gravel are on the terraces that run parallel to the drainageways. Coal was an important natural resource in the county, but at present no coal mines are in operation.

climate

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

The climate of Dallas County is subhumid and continental. Winters are cold, and summers generally are quite hot but are characterized by occasional cool spells. During the winter precipitation frequently occurs as snowstorms, and during the warm months it falls chiefly as rain, often heavy, during periods when warm moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grain. The growing season is long enough for the crops commonly grown in the county to mature.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Perry, Iowa, in the period 1951 to 1978. 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 22 degrees F, and the average daily minimum temperature is 12 degrees. The lowest temperature on record, which occurred at Perry on January 12, 1974, is -32 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred at Perry on July 22, 1974, is 104 degrees.

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

The total annual precipitation is about 31 inches. Of this, 23 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 4.83 inches at Perry on August 6, 1963. Thunderstorms occur on about 40 days each year, and most occur in summer.

The average seasonal snowfall is about 28 inches. The greatest snow depth at any one time during the period of record was 24 inches. On an average of 9 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 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally. They are usually of local extent and of short duration, and the resulting damage is sparse and in narrow belts. Hail falls at times during the warmer part of the year in scattered small areas.

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, woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

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

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

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

soil descriptions

1. Canisteo-Clarion-Nicollet association

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

This association consists of nearly level to undulating soils on swells and in swales. The natural drainage pattern is poorly defined. Slopes range from 0 to 5 percent.

This association makes up about 38 percent of the county. It is about 35 percent Canisteo soils, 30 percent Clarion soils, 20 percent Nicollet soils, and 15 percent minor soils (fig. 2).

The nearly level, poorly drained Canisteo soils are on broad upland flats characterized by many scattered potholes. The gently sloping, well drained Clarion soils and the very gently sloping, somewhat poorly drained Nicollet soils are on rises, knolls, and ridges.

Typically, the surface layer of Canisteo soils is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is about 11 inches of dark gray, friable clay loam and olive gray, friable loam. The substratum to a depth of about 60 inches is olive gray, mottled loam. The soils are calcareous throughout.

Typically, the surface layer of Clarion soils is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 11 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 19 inches thick. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous loam.

Typically, the surface layer of Nicollet soils is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 13 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable loam about 27 inches thick. The substratum to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

Minor in this association are Webster, Okoboji, Harps, and Storden soils. Webster soils are in drainageways. Okoboji soils are in closed depressions surrounded by Harps soils. Storden soils are on the more sloping knolls and side slopes.

In this association growing cash grain crops, principally corn and soybeans, is the major enterprise. Most areas are drained by tile and surface outlets. Large drainage ditches provide outlets for the tile drains. The main management concern is maintaining the tile and surface drainage systems. Maintaining tilth and fertility is also important because most areas are intensively row cropped. Measures that control erosion are needed on the well drained soils.

2. Coland-Hanlon-Wadena association

Nearly level to gently sloping, poorly drained, moderately well drained, and well drained, loamy soils that formed in alluvium on bottom land and stream terraces

This association consists of nearly level to undulating soils on rises on the broad alluvial plains. It is on bottom land and on stream terraces along the major rivers. Slopes range from 0 to 5 percent.

This association makes up about 7 percent of the county. It is about 25 percent Coland soils, 20 percent Hanlon soils, 15 percent Wadena soils, and 40 percent minor soils.

The nearly level Coland and Hanlon soils are on first bottoms. Coland soils are poorly drained and Hanlon soils moderately well drained. Wadena soils are on stream terraces. They are nearly level to gently sloping and are well drained.

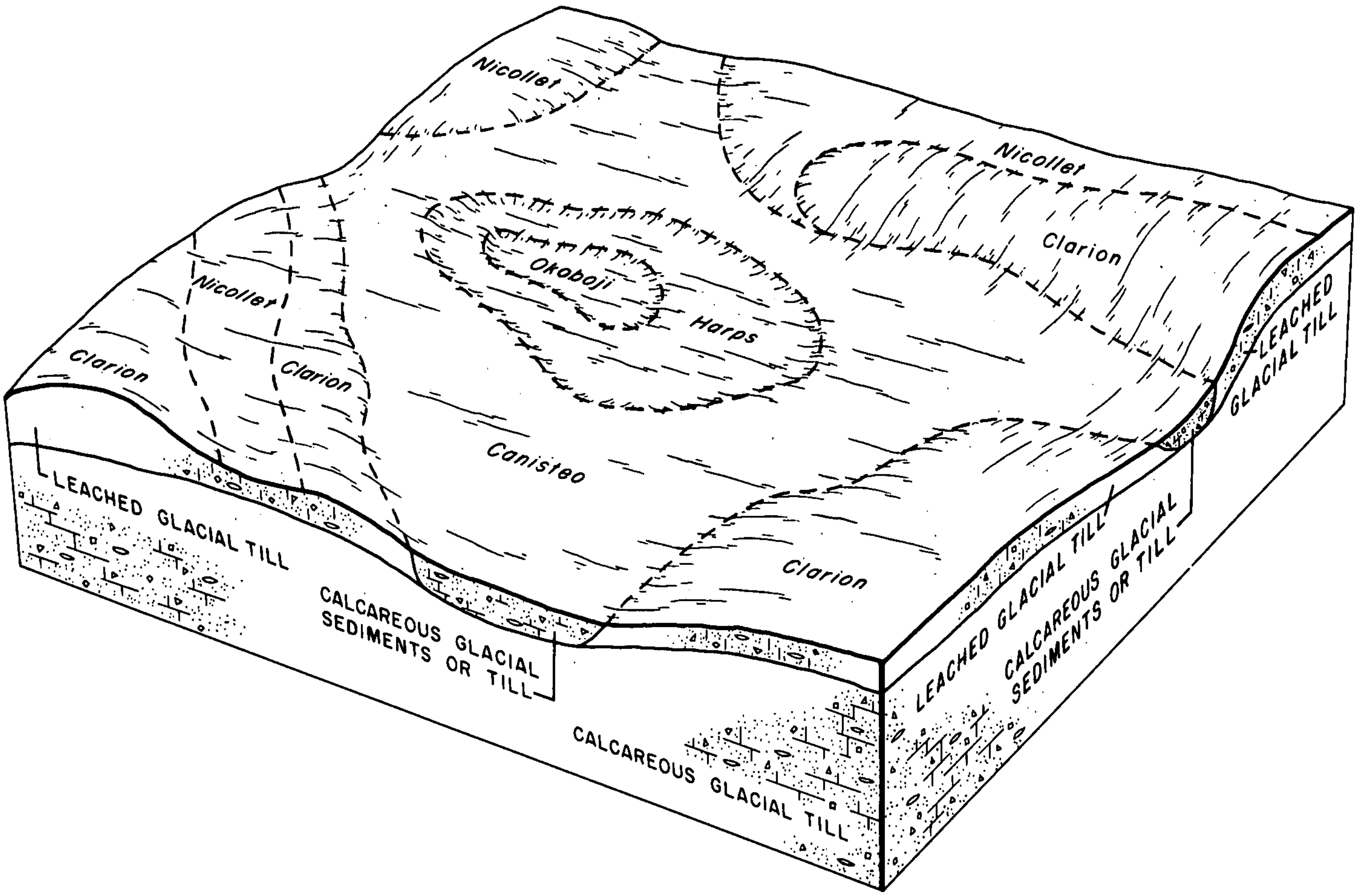

Figure 2.—Pattern of soils and parent material in the Canisteo-Clarion-Nicollet association.

Typically, the surface layer of Coland soils is black clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 28 inches thick. The subsoil is dark gray, mottled, friable clay loam about 8 inches thick. The substratum to a depth of about 60 inches is grayish brown, olive gray, and light olive gray, calcareous sandy clay loam.

Typically, the surface layer of Hanlon soils is very dark brown fine sandy loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown fine sandy loam about 21 inches thick. The subsoil is very dark grayish brown, very friable sandy loam about 15 inches thick. The substratum to a depth of about 60 inches is dark grayish brown sandy loam.

Typically, the surface layer of Wadena soils is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 10 inches thick. The subsoil is about 18 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable sandy loam. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, calcareous loamy sand and sand.

Minor in this association are the nearly level Cylinder, Biscay, and Spillville soils. The somewhat poorly drained Cylinder and poorly drained Biscay soils are on stream terraces. The somewhat poorly drained Spillville soils are on bottom land.

In this association growing cash grain crops is the major enterprise. Also, some small enterprises raise livestock. Corn, soybeans, and hay are the main crops. Some inaccessible areas that are cut up by old stream channels and areas that are frequently flooded are used for pasture. The main management needs are measures that control the flooding and wetness.

3. Clarion-Webster-Storden association

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

This association consists of nearly level to hilly soils in slightly concave drainageways and on knolls and side slopes. The steeper soils are along the major drainageways. Slopes range from 0 to 18 percent.

This association makes up about 9 percent of the county. It is about 50 percent Clarion soils, 15 percent Webster soils, 10 percent Storden soils, and 25 percent minor soils.

The gently sloping to strongly sloping, well drained Clarion soils are on side slopes. The nearly level, poorly drained Webster soils are in drainageways and on upland flats. The moderately sloping to moderately steep, well drained Storden soils are on side slopes.

Typically, the surface layer of Clarion soils is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 11 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 19 inches thick. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown, calcareous loam.

Typically, the surface layer of Webster soils is black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 9 inches thick. The subsoil is dark gray, friable clay loam about 12 inches thick. The substratum to a depth of about 60 inches is grayish brown and olive, calcareous loam. It has yellowish brown mottles.

Typically, the surface layer of Storden soils is mixed brown and yellowish brown, calcareous loam about 7 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Minor in this association are Nicollet, Canisteo, Okoboji, and Zenor soils. The very gently sloping Nicollet soils are on rises. Canisteo soils are in upland drainageways. Okoboji soils are in closed depressions. Zenor soils are on side slopes and upland knolls.

In this association the main enterprises are growing cash grain crops and raising livestock. Corn and soybeans are grown in the less sloping areas. The steeper areas are used for hay and pasture. The well drained soils are subject to erosion. Because of irregular slopes, the application of conservation practices, such as terracing, is somewhat difficult. A drainage system is needed in areas of the poorly drained soils.

4. Hayden-Storden-Lester association

Gently sloping to very steep, well drained, loamy soils that formed in glacial till on uplands

This association consists of soils on side slopes and ridgetops along the major streams and rivers. It is characterized by a distinct contrast in relief between the river valleys and the adjacent uplands. Many drainageways and ravines that cut back into the uplands are in the very steep areas on the sides of valleys. Slopes range from 2 to 50 percent.

This association makes up about 7 percent of the county. It is 45 percent Hayden and Storden soils, 25 percent Lester soils, and 30 percent minor soils.

The very steep Hayden and Storden soils are on the sides of valleys. The gently sloping and moderately sloping Lester soils are on ridgetops and side slopes.

Typically, the surface layer of Hayden soils is dark grayish brown loam about 8 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is dark yellowish brown and yellowish brown, firm and friable clay loam about 27 inches thick. The substratum to a depth of about 60 inches is yellowish brown, calcareous loam.

Typically, the surface layer of Storden soils is mixed brown and yellowish brown, calcareous loam about 7 inches thick. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Typically, the surface layer of Lester soils is very dark gray loam about 8 inches thick. The subsoil is about 23 inches of brown and light olive brown, friable clay loam and loam. The substratum to a depth of about 60 inches is light olive brown, calcareous loam.

Minor in this association are Le Sueur, Hanlon, and Moingona soils. Le Sueur soils are on slightly convex upland rises. Hanlon soils are on first bottoms. Moingona soils are on foot slopes.

The steepest areas in this association are generally wooded. Most of these areas are used for wooded pasture, but some small areas are managed for timber. Many areas are used for permanent bluegrass pasture. The less sloping areas are cultivated. They tend to be smaller and more irregular in shape than the other cultivated areas in the county. The main crops are corn, hay, and soybeans. The main management needs are measures that control sheet and gully erosion in the steeply sloping areas and measures that control the flooding on the bottom land.

5. Ladoga-Lindley association

Gently sloping to very steep, moderately well drained and well drained, silty soils that formed in loess and glacial till on uplands

This association consists of gently sloping to very steep soils on ridgetops and the sides of valleys. The gently sloping to strongly sloping soils formed in loess. The steep and very steep soils formed in glacial till. Many hillside drainageways and gullies are in the steeper areas. Slopes range from 2 to 40 percent.

This association makes up about 9 percent of the county. It is about 35 percent Ladoga soils, 25 percent Lindley soils, and 40 percent minor soils.

The gently sloping to strongly sloping Ladoga soils are on ridgetops and side slopes. They are moderately well drained. The steep and very steep Lindley soils are on side slopes. They are well drained.

Typically, the surface layer of Ladoga soils is very dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil to a depth of about 60 inches is firm and friable silty clay loam. The upper part is brown and dark yellowish brown, and the lower part is mottled grayish brown and yellowish brown.

Typically, the surface layer of Lindley soils is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is brown and dark yellowish brown silt loam about 7 inches thick. The subsoil is about 40 inches thick. The upper part is yellowish brown, friable loam. The next part is dark yellowish brown, firm and very firm clay loam. The lower part is yellowish brown, mottled, firm and very firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

Minor is this association are Clinton, Gara, Armstrong, and Vanmeter soils. Clinton soils are on ridgetops and side slopes. Gara, Armstrong, and Vanmeter soils are on side slopes.

A large part of this association is used for pasture or woodland because slopes are too steep for cultivation. Many of the areas on ridgetops and some of the areas on side slopes are cultivated. Corn and soybeans are the main row crops. Alfalfa, red clover, and bromegrass are the main forage crops. The soils are subject to sheet erosion and gullying (fig. 3). Uncrossable gullies are common in areas where waterways slope more than 3 percent. The main management needs are measures that control water erosion.

Figure 3.—A pond in an area of the Ladoga-Lindley association. The pond helps to control gullying.

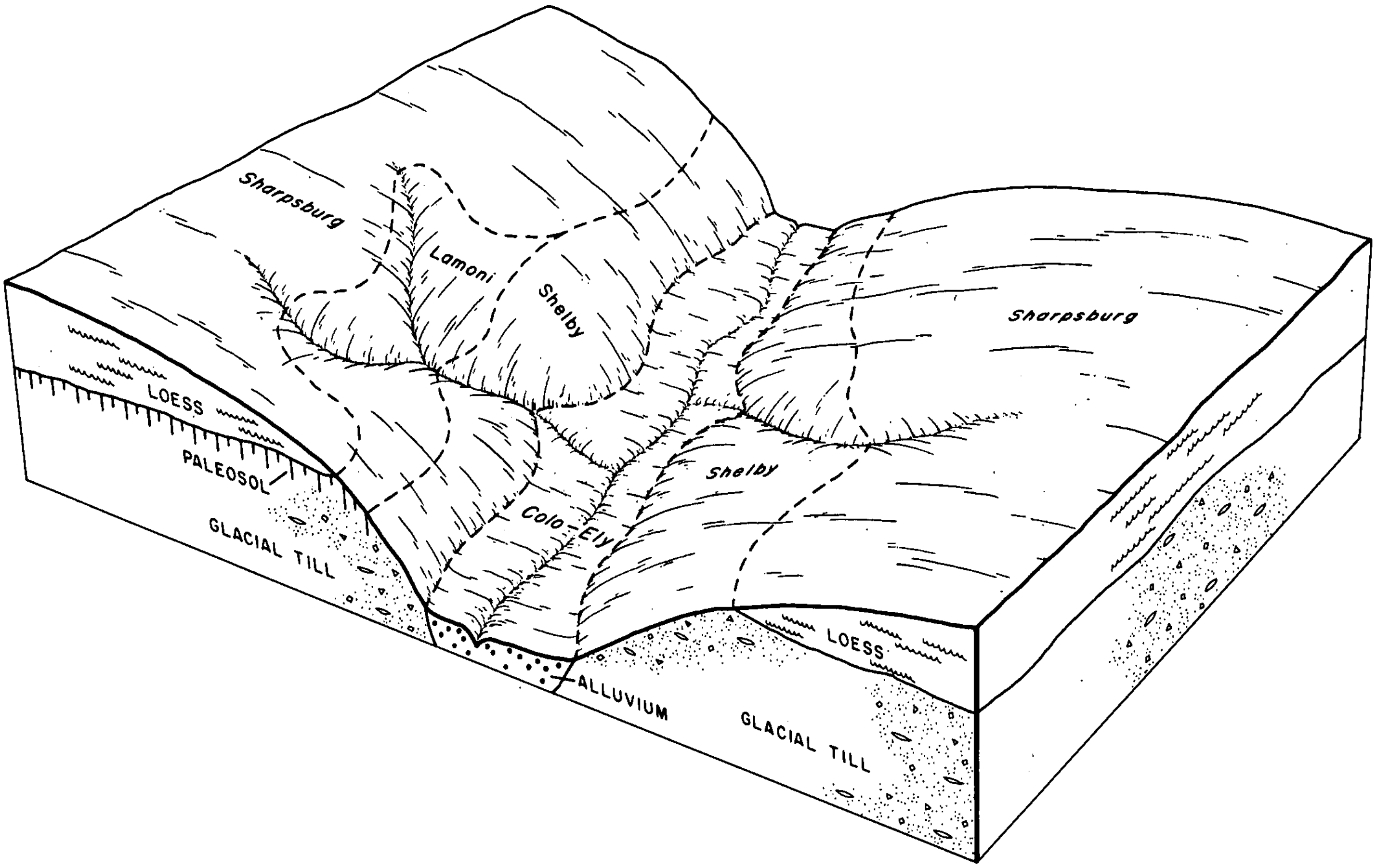

Figure 4.—Pattern of soils and parent material in the Sharpsburg-Shelby association.

6. Sharpsburg-Shelby association

Gently sloping to moderately steep, moderately well drained, silty and loamy soils that formed in loess and glacial till on uplands

This association consists of undulating to hilly soils on wide ridgetops and short side slopes. Slopes range from 2 to 18 percent.

This association makes up about 8 percent of the county. It is about 55 percent Sharpsburg soils, 15 percent Shelby soils, and 30 percent minor soils (fig. 4).

The gently sloping to strongly sloping Sharpsburg soils are on ridgetops and side slopes. The strongly sloping and moderately steep Shelby soils are on side slopes.

Typically, the surface layer of Sharpsburg soils is very dark grayish brown and dark brown silty clay loam about 8 inches thick. The subsoil is yellowish brown, mottled, friable silty clay loam about 30 inches thick. The substratum to a depth of about 60 inches is mottled grayish brown and yellowish brown silty clay loam.

Typically, the surface layer of Shelby soils is very dark brown loam about 7 inches thick. The subsurface layer is dark brown clay loam about 4 inches thick. The subsoil is yellowish brown, mottled, friable clay loam about 30 inches thick. The substratum to a depth of about 60 inches is light olive gray, mottled, calcareous clay loam.

Minor in this association are Macksburg, Lamoni, Adair, Colo, and Ely soils. The nearly level Macksburg soils are on wide ridgetops. Lamoni soils are on side slopes around the head of drainageways. Adair soils are on shoulder slopes. Colo soils are on bottom land and in upland drainageways. Ely soils are on foot slopes.

Corn and soybeans are grown on the less sloping soils in this association. The steeper soils generally are used for hay and pasture (fig. 5). The soils are subject to sheet and gully erosion. Uncrossable gullies are common in areas where waterways slope more than 3 percent. The main management needs are measures that control erosion. Because of long, uniform slopes, the soils can be easily terraced.

Figure 5.—An area of the Sharpsburg-Shelby association used for cultivated crops and hay.

7. Nodaway-Wiota-Colo association

Nearly level and very gently sloping, moderately well drained and poorly drained, silty soils that formed in alluvium on bottom land and stream terraces

This association consists mainly of nearly level soils on flood plains about 1 to 2 miles wide. Slopes range from 0 to 3 percent.

This association makes up about 12 percent of the county. It is about 30 percent Nodaway soils, 30 percent Wiota soils, 25 percent Colo soils, and 15 percent minor soils.

The nearly level, moderately well drained Nodaway soils commonly are adjacent to stream channels on bottom land. The very gently sloping, moderately well drained Wiota soils are on low stream terraces. The nearly level, poorly drained Colo soils are on bottom land along the major streams and their tributaries.

Typically, the surface layer of Nodaway soils is very dark grayish brown silt loam about 7 inches thick. The substratum to a depth of about 60 inches is stratified very dark grayish brown, dark grayish brown, and very dark gray silt loam.

Typically, the surface layer of Wiota soils is very dark brown silt loam about 8 inches thick. The subsurface layer is about 18 inches thick. It is very dark brown silt loam in the upper part and very dark grayish brown silty clay loam in the lower part. The subsoil to a depth of about 60 inches is dark brown and brown, friable silty clay loam.

Typically, the surface layer of Colo soils is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam about 25 inches thick. The subsoil is very dark gray, mottled, firm silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled silty clay loam.

Minor in this association are Nevin and Judson soils. Nevin soils are on stream terraces. Judson soils are on foot slopes.

This association is used mainly for cultivated crops, hay, and pasture. The soils on terraces and the higher bottom land are used for corn and soybeans. Those on first bottoms generally are used for pasture because of the hazard of flooding. The main management needs are measures that control the flooding, improve drainage, and stabilize streambanks and channels.

Figure 6.—A typical area of the Clarion association.

8. Clarion association

Gently sloping and moderately sloping, well drained, loamy soils that formed in glacial till on uplands

This association consists of undulating and gently rolling soils on wide ridgetops and long side slopes (fig. 6). Slopes range from 2 to 9 percent.

This association makes up about 10 percent of the county. It is about 80 percent Clarion soils and 20 percent minor soils.

The well drained, gently sloping and moderately sloping Clarion soils are on upland ridgetops and side slopes. Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and dark brown loam about 10 inches thick. The subsoil is brown and yellowish brown, friable loam about 32 inches thick. The substratum to a depth of about 60 inches is mottled yellowish brown and brown, calcareous loam.

Minor in this association are Nicollet, Webster, Storden, and Terril soils. The nearly level Nicollet soils are on wide ridgetops. The nearly level Webster soils are in drainageways. The strongly sloping Storden soils are on side slopes. Terril soils are on slightly concave foot slopes.

Most areas of this association are cultivated. The major soils are well suited to cultivated crops. Corn and soybeans are the major crops. The main management concern is controlling erosion. Farming the long, uniform slopes on the contour and terracing help to control erosion. A conservation tillage system that leaves crop residue on the surface and a cropping sequence that includes grasses and legumes also help to control erosion. Measures that maintain tilth and fertility are needed in areas that are intensively cultivated.

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 identifies the principal hazards and limitations to be considered in planning for specific uses.

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

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

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Gara-Armstrong complex, 14 to 18 percent slopes, is an example.

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

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

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

soil descriptions

6—Okoboji silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in depressions on uplands. It is subject to ponding (fig. 7). Areas are circular and range from 2 to 10 acres in size.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is black silty clay loam about 19 inches thick. The subsoil is about 23 inches thick. The upper part is very dark gray, firm silty clay loam. The lower part is olive gray, firm and friable silty clay loam. It has light olive brown mottles. The substratum to a depth of 60 inches is olive gray and light olive gray loam. It has light olive brown mottles.

Included with this soil in mapping are a few small areas of Harps soils on the rims of depressions. These soils are calcareous throughout and have a very high concentration of carbonates near the surface. They make up about 5 percent of the map unit.

The Okoboji soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow to ponded. Available water capacity is very high. The content of organic matter is about 9 to 11 percent in the surface layer. This layer is neutral or mildly alkaline. The subsoil has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth is fair, but the soil dries out more slowly than the adjacent soils. As a result, tillage is often delayed.

Most areas are cultivated. If adequately drained, this soil is moderately suited to cultivated crops, hay, and pasture. Because the soil is very wet and water tends to

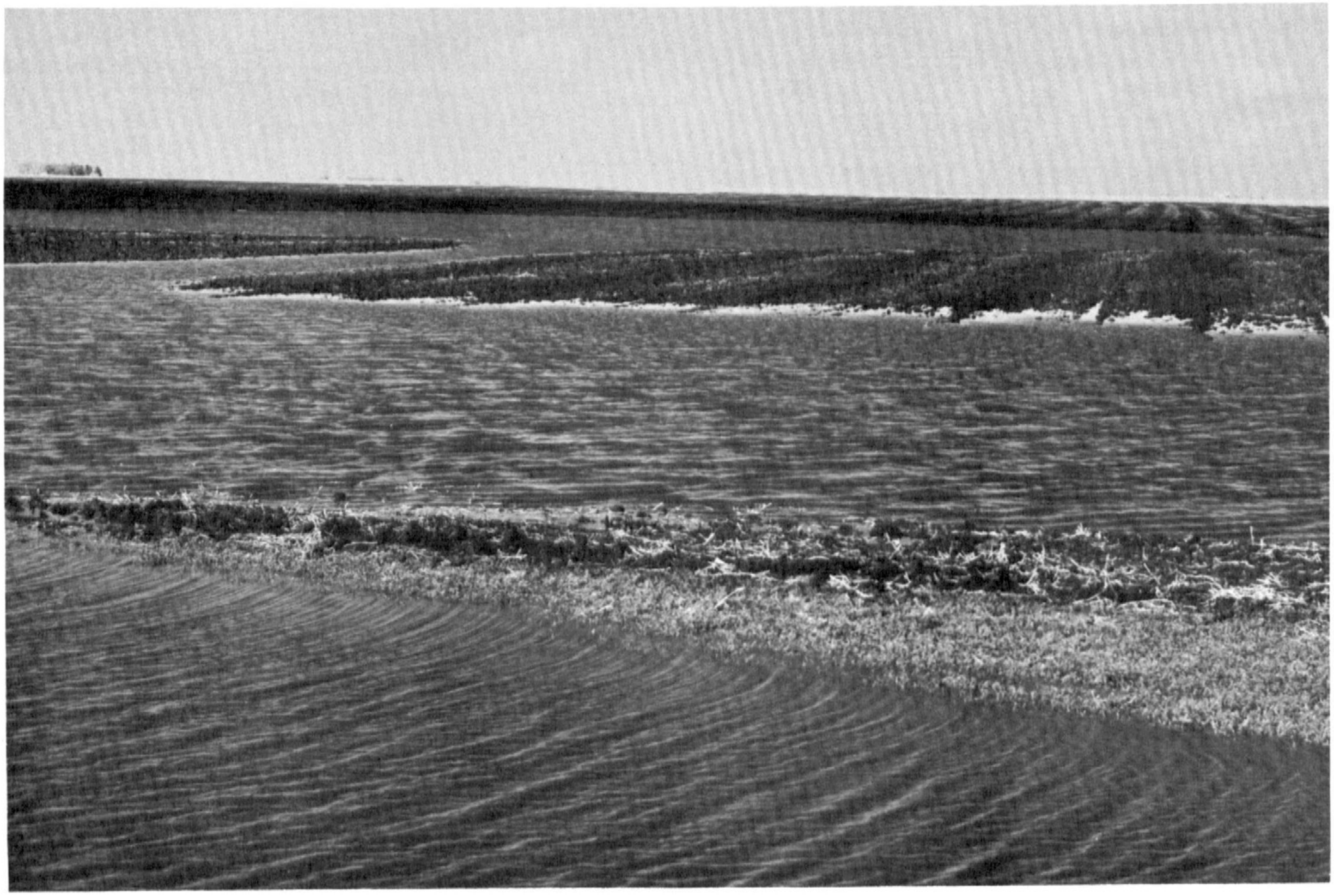

Figure 7.—A ponded area of Okoboji silty clay loam, 0 to 1 percent slopes, after heavy rainfall.

pond in many areas in the spring or during periods of heavy rainfall, surface intakes and tile drains are beneficial. In many areas, crops drown out and winter killing of legumes is a hazard. The soil warms slowly in the spring, and crops are subject to damage by early frost. Returning crop residue to the soil improves tilth and increases the rate of water infiltration.

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

The capability subclass is IIIw.

7—Wiota silt loam, 1 to 3 percent slopes. This very gently sloping, moderately well drained soil is on convex slopes on low stream terraces a few feet above the flood plains. Areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is about 18 inches thick. It is very dark brown silt loam in the upper part and very dark grayish brown silty clay loam in the lower part. The subsoil to a depth of 60 inches is dark brown and brown, friable silty clay loam.

Included with this soil in mapping are small areas of the nearly level, somewhat poorly drained Nevin soils. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Wiota soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer is medium acid unless lime has been applied. The subsoil has a very low supply of available phosphorus and a low supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to continuous cropping of corn and soybeans. Some areas adjacent to foot slopes receive runoff. Diversions help to control the runoff from the adjacent side slopes.

This soil is well suited to hay and pasture. A cover of grasses and legumes increases the rate of water infiltration, helps to control wind erosion, and improves tilth. Overgrazing or grazing when the soil is wet, however, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability class is I.

8B—Judson silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes and convex alluvial fans. Areas are long and narrow. Those on the foot slopes range from 5 to 15 acres in size, and those on the alluvial fans range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 23 inches thick. The upper part is very dark brown, the next part is very dark grayish brown, and the lower part is dark brown. The subsoil to a depth of 60 inches is brown, friable silty clay loam.

Included with this soil in mapping are small areas of Ely and Colo soils. The somewhat poorly drained Ely and poorly drained Colo soils are adjacent to the waterways that dissect the Judson soil. They make up about 5 percent of the map unit.

Permeability is moderate in the Judson soil. Surface runoff is medium. Available water capacity is very high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. Typically, this layer is slightly acid or neutral. The subsoil has a low supply of available phosphorus and potassium. Tilth is good.

Most areas are used as cropland. Some are pastured. This soil is well suited to cultivated crops, hay, and pasture. If cultivated crops are grown, erosion is a hazard. Some areas receive runoff from upland side slopes. Diversion terraces help to control the runoff from the adjacent upland side slopes and thus help to prevent siltation. A conservation tillage system that leaves crop residue on the surface increases the rate of water infiltration and helps to control erosion.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, causes surface compaction, excessive runoff, and deterioration of tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition. Terraces and diversions generally help to control the runoff from upslope areas.

The capability subclass is IIe.

11B—Colo-Ely silty clay loams, 2 to 5 percent slopes. These gently sloping soils are on foot slopes, alluvial fans, and narrow flood plains, mainly along small streams in the uplands. The poorly drained Colo soil is near stream channels. It is subject to flooding. The somewhat poorly drained Ely soil is at the base of upland slopes along the boundary of the mapped areas. Areas are long and narrow and range from 5 to more than 100 acres in size. They are about 40 to 60 percent Colo soil and 35 to 50 percent Ely soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Colo soil has a surface layer of black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam about 25 inches thick. The subsoil is very dark gray, firm silty clay loam about 14 inches thick. The substratum to a depth of 60 inches is dark gray, mottled silty clay loam.

Typically, the Ely soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 19 inches thick. The subsoil to a depth of 60 inches is friable silty clay loam. It is dark grayish brown and mottled in the upper part and mottled grayish brown and yellowish brown in the lower part.

Included with these soils in mapping are small areas of the moderately well drained Judson soils on foot slopes. These included soils make up 5 to 15 percent of the map unit.

The Colo and Ely soils are moderately permeable. They have a seasonal high water table. Surface runoff is slow on the Colo soil and medium on the Ely soil. Available water capacity is very high in both soils. The content of organic matter is about 6 to 7 percent in the surface layer of the Colo soil and 5 to 6 percent in the surface layer of the Ely soil. The surface layer of both soils is neutral or slightly acid. The substratum of the Colo soil has a low supply of available phosphorus and a very low supply of available potassium. The subsoil of the Ely soil has a very low supply of available phosphorus and potassium. Tilth is fair in both soils.

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

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The capability subclass is IIw.

24D2—Shelby clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on convex side slopes and narrow, convex nose slopes. Areas range from 10 to 30 acres in size. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. Some streaks and pockets of dark yellowish brown clay loam subsoil material are mixed with the surface layer. The subsoil is friable clay loam about 30 inches thick. It is dark yellowish brown in the upper part and brown and mottled in the lower part. The substratum to a depth of 60 inches is mottled grayish brown and yellowish brown, calcareous clay loam. In places the subsoil is reddish and contains more clay.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is medium acid unless the soil has been limed in the past few years. The subsoil has a low supply of available phosphorus and a high supply of available potassium. Tilth is fair.

This soil is used for row crops, hay, and pasture. It is moderately suited to cultivated crops, hay, and pasture. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by contour farming, stripcropping, or terracing. A conservation tillage system that leaves crop residue on the surface, contour farming, and terraces increase the rate of water infiltration and help to control runoff. Grassed waterways help to prevent the formation of gullies. In many areas terrace drop inlets are needed. Returning all of the crop residue to the soil improves tilth. More intense management is needed on this soil than on the less eroded Shelby soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

24E—Shelby loam, 14 to 18 percent slopes. This moderately steep, moderately well drained soil is on convex side slopes. Areas range from 10 to 40 acres in size. They are irregular in shape and occur as narrow bands that commonly border drainageways.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is dark brown clay loam about 4 inches thick. The subsoil is yellowish brown, mottled, friable clay loam about 30 inches thick. The substratum to a depth of 60 inches is light olive gray, mottled, calcareous clay loam. In places the subsoil is reddish and contains more clay.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is medium acid unless the soil has been limed in the past few years. The subsoil has a low supply of available phosphorus and a high supply of available potassium. Tilth is fair.

Most areas are used for hay and pasture. Some were used for cultivated crops in the past. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is better suited to grasses and legumes than to other crops. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and stripcropping help to control erosion. Conservation tillage and contour farming increase the rate of water infiltration and help to control runoff. Grassed waterways help to prevent the formation of gullies. Slopes are too steep for terracing. Returning crop residue to the soil improves tilth.

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

The capability subclass is IVe.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on slightly concave foot slopes. Areas are long and narrow and range from 5 to 10 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown and dark brown loam about 25 inches thick. The subsoil to a depth of 60 inches is dark brown and brown, friable loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. A few are pastured. This soil is well suited to cultivated crops. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, or a cropping sequence that includes grasses and legumes. The soil receives runoff from the adjacent uplands. Diversion terraces help to control the runoff and thus help to prevent the crop damage caused by the deposition of sediment.

If this soil is used for pasture, overgrazing causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

27C—Terril loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on slightly concave foot slopes. Areas are long and narrow and range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 22 inches thick. The subsoil to a depth of 60 inches is dark brown and brown, friable loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. A few are pastured. This soil is suited to cultivated crops. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, and terraces or by a combination of these practices. The soil receives runoff from the adjacent uplands. Diversion terraces help to control the runoff and thus help to prevent the crop damage caused by the deposition of sediment.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

55—Nicollet loam, 1 to 3 percent slopes. This very gently sloping, somewhat poorly drained soil generally is on slightly convex or plane ground moraines characterized by low relief. In places, however, it is on toe slopes or in the upper part of drainageways. Areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 13 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable loam about 27 inches thick. The substratum to a depth of 60 inches is grayish brown, mottled, calcareous loam.

Included with this soil in mapping are a few small areas of the poorly drained Webster and very poorly drained Okoboji soils. These soils are in the lower areas. Their subsoil is heavier textured than that of the Nicollet soil. Water ponds in areas of the Okoboji soils. Included soils make up 5 to 10 percent of the map unit.

The Nicollet soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and a very low or low supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to cultivated crops, hay, and pasture. A drainage system improves the timeliness of fieldwork in the spring. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion. Returning crop residue to the soil helps to maintain good tilth.

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

The capability class is I.

62C2—Storden loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex slopes in the uplands. Areas are somewhat circular and range from 5 to 10 acres in size.

Typically, the surface layer is brown, calcareous loam about 7 inches thick. It is mixed with some streaks and pockets of light olive substratum material. The substratum to a depth of 60 inches is light olive brown, calcareous loam.

Included with this soil in mapping are small areas of the somewhat excessively drained Zenor soils on knobs. These soils contain more sand and gravel than the Storden soil. Also, they tend to be droughty. They make up about 10 percent of the map unit.

Permeability is moderate in the Storden soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. This layer is moderately alkaline. The substratum has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are cultivated. This soil is moderately suited to corn, soybeans, and other cultivated crops and to small grain. It is well suited to hay and pasture. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Contour farming and terracing are practical in most areas, but they are not so practical in undulating areas where slopes are short. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and helps to prevent surface crusting. More intense management is needed on this soil than on the less eroded Storden soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Typically, the slopes are short. Areas are long and narrow and range from 10 to 20 acres in size.

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

Included with this soil in mapping are areas of the somewhat excessively drained Zenor soils. These soils contain more sand and gravel than the Storden soil. Also, they are droughty. They make up about 10 percent of the map unit.

Permeability is moderate in the Storden soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. This layer is mildly alkaline or moderately alkaline. The substratum has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are cultivated. This soil is moderately suited to cultivated crops, hay, and pasture. If cultivated crops are grown, further erosion is a hazard (fig. 8). A combination of conservation practices, such as a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping, helps to prevent excessive soil loss. In many areas where slopes are short and irregular, controlling erosion is difficult. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Storden soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

62E—Storden loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex side slopes in the uplands. The slopes are short. Areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark grayish brown, calcareous loam about 8 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are some small areas of the somewhat excessively drained Zenor soils. These soils contain more sand and gravel than the Storden soil. Also, they tend to be droughty. They make up about 20 percent of the map unit.

Permeability is moderate in the Storden soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is mildly alkaline or moderately alkaline. The substratum has a very low supply of available phosphorus and potassium. Tilth is fair.

This soil is poorly suited to cultivated crops because of the hazard of erosion. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. In many areas where slopes are short and irregular, controlling erosion is difficult. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration.

Most areas are pastured. If this soil is used for pasture, overgrazing causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

62F—Storden loam, 18 to 25 percent slopes. This steep, well drained soil is on convex side slopes in the uplands. The slopes are short. Areas occur as nearly continuous bands that border creeks and drainageways. They range from 10 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, calcareous loam about 7 inches thick. The substratum to a depth of 60 inches is brown and yellowish brown, calcareous loam.

Permeability is moderate. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is mildly alkaline or moderately alkaline. The substratum has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are used for pasture. This soil generally is unsuited to cultivated crops because of the steep slopes and a severe hazard of erosion. If the soil is used for

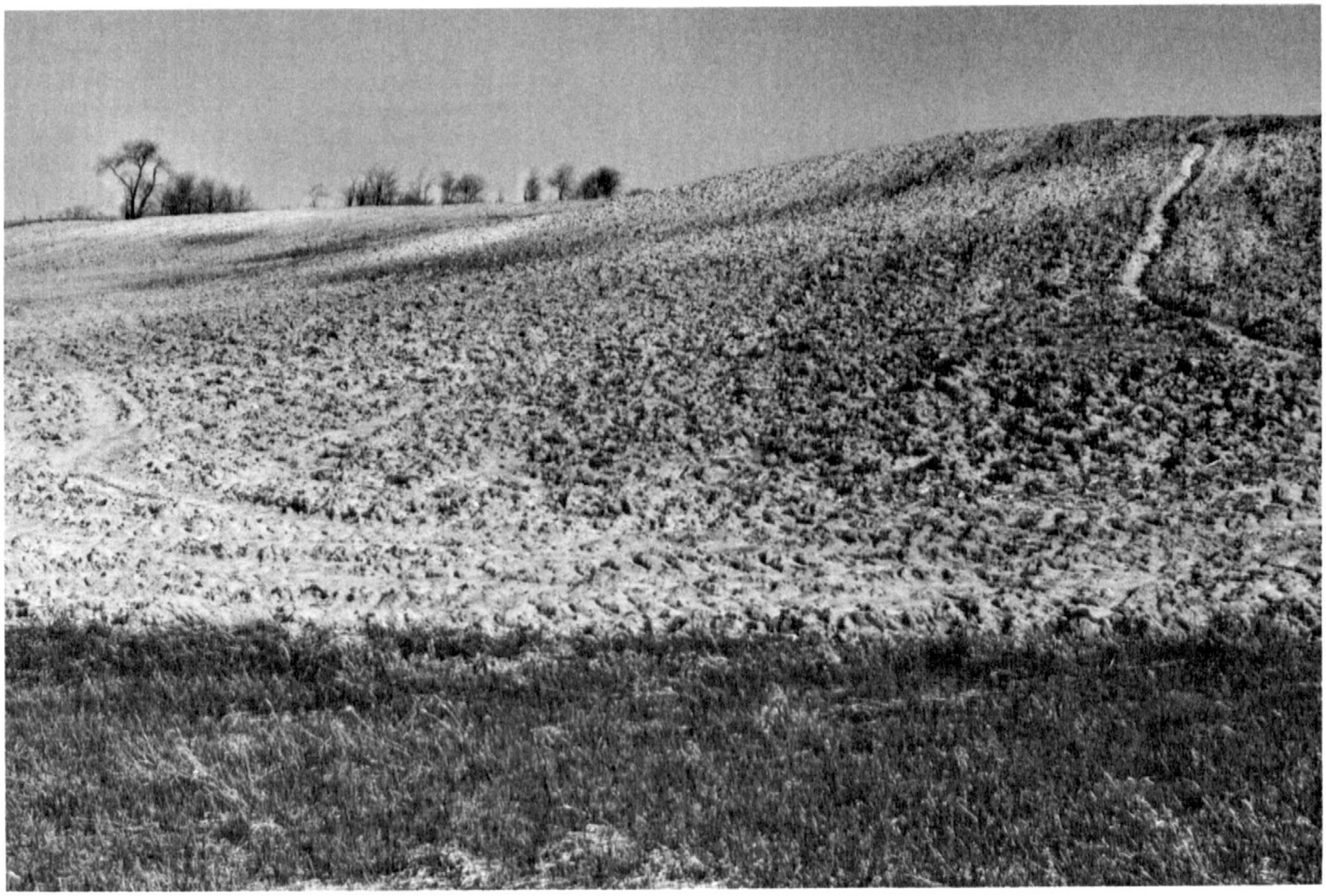

Figure 8.—A cultivated area of Storden loam, 9 to 14 percent slopes, moderately eroded. No topsoil remains in the light colored areas.

pasture, overgrazing causes surface compaction and excessive runoff. Because much of the rainfall runs off rapidly, the available water supply is not adequate for good plant growth in periods of low rainfall. Proper stocking rates and pasture rotation help to keep the pasture and the soil in good condition.

The capability subclass is VIe.

65G—Lindley silt loam, 18 to 40 percent slopes. This steep and very steep, well drained soil is on dissected, convex side slopes along the major streams. Areas occur as long, narrow bands on the lower part of the side slopes and range from 100 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is brown and dark yellowish brown silt loam about 7 inches thick. The subsoil is about 40 inches thick. It is yellowish brown, friable loam in the upper part and yellowish brown and dark yellowish brown, mottled, firm and very firm clay loam in the lower part. The substratum to a depth of 60 inches is yellowish brown, mottled clay loam.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is slightly acid or medium acid. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium.

Most areas are used as woodland. Many remain in native hardwoods. This soil is moderately suited to trees. It generally is unsuitable for cultivated crops, hay, and pasture because of the steep and very steep slopes and a severe hazard of erosion. Erosion and the equipment limitation are the main management concerns in the wooded areas. Laying out logging trails or roads on the contour helps to control erosion. Because of the steep and very steep slopes, operating some equipment is difficult or hazardous. Seedling mortality and plant competition generally are slight.

The capability subclass is VIIe.

76B—Ladoga silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on slightly convex upland divides. Areas generally are long and narrow and range from 20 to 80 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil to a depth of 60 inches is firm and friable silty clay loam. It is brown and dark yellowish brown in the upper part and mottled grayish brown and yellowish brown in the lower part.

Included with this soil in mapping are small areas of nearly level, somewhat poorly drained soils. These soils make up about 5 percent of the map unit. Their surface layer is thicker than that of the Ladoga soil.

Permeability is moderately slow in the Ladoga soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is good.

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

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

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

The capability subclass is IIe.

76C2—Ladoga silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on the edges of convex, narrow upland divides and on side slopes between waterways. Areas generally are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is brown, mottled, firm silty clay loam about 34 inches thick. The substratum to a depth of 60 inches is light brownish gray, mottled silty clay loam.

Included with this soil in mapping are a few small areas of severely eroded soils that have an exposed subsoil. These soils make up about 5 percent of the map unit.

Permeability is moderately slow in the Ladoga soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. This layer is medium acid unless lime has been applied. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

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

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

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

The capability subclass is IIIe.

76D2—Ladoga silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on convex side slopes in the uplands. Areas generally are long and narrow and range from 10 to 20 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. It is mixed with some streaks and pockets of yellowish brown subsoil material. The subsoil is firm silty clay loam about 32 inches thick. It is yellowish brown and mottled in the upper part and mottled gray and yellowish brown in the lower part. The substratum to a depth of 60 inches is light brownish gray, mottled silty clay loam.

Included with this soil in mapping are areas of severely eroded soils. Also included are small areas of Adair and Lamoni soils on the upper slopes. These soils contain more clay in the subsoil than the Ladoga soil. They are seasonally wet and seepy. Included soils make up about 5 percent of the map unit.

Permeability is moderately slow in the Ladoga soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is medium acid unless lime has been applied. The subsoil has a high supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

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

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. If permanent pastures are improved, the content of organic matter in this moderately eroded soil slowly increases. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IIIe.

80B—Clinton silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on slightly convex upland ridgetops. Areas are long and narrow and range from 10 to 50 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil to a depth of 60 inches is friable and firm silty clay loam. It is dark yellowish brown and brown in the upper part and mottled brown, grayish brown, light olive brown, and yellowish brown in the lower part. In places the surface layer is eroded and is more clayey.

Included with this soil in mapping are small areas of somewhat poorly drained soils. These soils are in the slightly concave positions within the larger mapped areas. They make up about 5 percent of the map unit.

Permeability is moderately slow in the Clinton soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is slightly acid or medium acid unless lime has been applied. The subsoil has a high supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are used for cultivated crops, hay, pasture, or woodland. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Row crops can be grown in many years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas erosion control measures, such as contour farming and terracing, are practical, but they are not so practical in undulating areas where slopes are short. If terraces are built, cuts should not expose the subsoil. If the soil is intensively row cropped, the surface layer puddles readily after rainfall and a crust forms as the soil dries. This crust retards the emergence of seedlings. It is less apparent in areas where a meadow crop has been included in the cropping sequence. A rotary hoe or other such equipment helps to break up the crust. Returning crop residue to the soil or regularly adding other organic material improves tilth and fertility and increases the rate of water infiltration.

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

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

The capability subclass is IIe.

80C—Clinton silt loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex upland ridgetops, narrow divides, and side slopes. Areas are long, narrow, and irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil to a depth of 60 inches is firm silty clay loam. It is dark yellowish brown and brown in the upper part and mottled grayish brown and light olive brown in the lower part.

Permeability is moderately slow. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is medium acid. The subsoil has a high supply of available phosphorus and a very low supply of available potassium.

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

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

The capability subclass is IIIe.

80C2—Clinton silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on convex ridgetops, narrow divides, and side slopes in the uplands. Areas are long, narrow, and irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 7 inches thick. It is mixed with some streaks and pockets of yellowish brown subsoil material. The subsoil is yellowish brown, mottled, firm silty clay loam about 46 inches thick. The substratum to a depth of 60 inches is yellowish brown, mottled silty clay loam.

Included with this soil in mapping are a few small areas of severely eroded soils that have an exposed subsoil. These soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Clinton soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is medium acid unless lime has been applied. The subsoil has a high supply of available phosphorus and a very low supply of available potassium. Tilth is poor.

Most areas are used for cultivated crops, hay, and pasture. This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Row crops can be grown in many years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas erosion control measures, such as contour farming and terracing, are practical, but they are not so practical in undulating areas where slopes are short. If terraces are built, cuts should not expose the subsoil. If the soil is intensively row cropped, the surface layer puddles after rainfall and a crust forms as the soil dries. This crust retards the emergence of seedlings. It is less apparent in areas where a meadow crop has been included in the cropping sequence. A rotary hoe or other such equipment helps to break up the crust. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Clinton soils to maintain productivity and improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing during wet periods causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IIIe.

80D2—Clinton silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on convex side slopes in the uplands. Areas are long, narrow, and irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 6 inches thick. It is mixed with some streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, firm silty clay loam about 42 inches thick. It is mottled in the lower part. The substratum to a depth of 60 inches is yellowish brown, mottled silty clay loam.

Included with this soil in mapping are a few small areas of severely eroded soils that have an exposed subsoil. Also included are a few small areas of Lindley and Armstrong soils on the lower slopes. These soils have a higher content of sand than the Clinton soil. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Clinton soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is medium acid unless lime has been applied. The subsoil has a high supply of available phosphorus and a very low supply of available potassium. Tilth is poor.

Most areas are used for cultivated crops, hay, and pasture. This soil is moderately suited to corn, soybeans, and small grain and well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Row crops can be grown in some years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Grassed waterways help to prevent gullying. In most areas erosion control measures, such as contour farming and terracing, are practical, but they are not so practical in undulating areas where slopes are short. If terraces are built, cuts should not expose the subsoil. If the soil is intensively row cropped, the surface layer puddles readily after rainfall and a crust forms as the soil dries. This crust retards the emergence of seedlings. It is less apparent in areas where a meadow crop has been included in the cropping sequence. A rotary hoe or other such equipment helps to break up the crust. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Clinton soils to maintain productivity and improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IIIe.

88—Nevin silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on plane or convex slopes on low stream terraces. Areas range from 10 to 40 acres in size and are broad and irregular in shape.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark gray and very dark grayish brown silty clay loam about 16 inches thick. The subsoil is dark grayish brown, friable and firm silty clay loam about 31 inches thick. The substratum to a depth of 60 inches is brown, mottled silty clay loam.

Included with this soil in mapping are areas of the moderately well drained Wiota soils at the slightly higher elevations and areas of the poorly drained Colo soils on bottom land. These soils make up about 10 percent of the map unit.

The Nevin soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 6 percent in the surface layer. This layer is slightly acid or medium acid unless the soil has been limed in the past few years. The subsoil has a medium supply of available phosphorus and a high supply of available potassium. Tilth is good.

This soil is cultivated and intensively row cropped. It is well suited to cultivated crops. Some areas adjacent to foot slopes receive runoff. Diversions help to control the runoff from the adjacent side slopes. Tile drainage generally is not needed but is beneficial in some areas.

This soil is well suited to hay and pasture. Hay is grown more often than pasture plants, and alfalfa is the main plant. Both warm and cool season grasses should be included in the pasture rotation system. Including grasses and legumes in the cropping sequence increases the rate of water infiltration and improves tilth. Overgrazing or grazing when the soil is wet, however, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability class is I.

90—Okoboji mucky silt loam, 0 to 1 percent slopes. This level, very poorly drained soil is in depressions on uplands. It is subject to ponding. Areas are circular and range from 10 to 30 acres in size.

Typically, the surface layer is black mucky silt loam about 12 inches thick. The subsurface layer is black silty clay loam about 24 inches thick. The subsoil is very dark gray and dark gray, firm silty clay loam about 15 inches thick. It has olive brown mottles. The substratum to a depth of 60 inches is gray, calcareous silty clay loam. It has dark yellowish brown mottles. In places the organic matter content in the surface layer is more than 20 percent.

Included with this soil in mapping are a few small areas of Harps soils on the rims of depressions. These soils are calcareous throughout and have a very high concentration of carbonates near the surface. They make up about 5 percent of the map unit.

The Okoboji soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow to ponded. Available water capacity is very high. The content of organic matter is about 9 to 18 percent in the surface layer. This layer is neutral or mildly alkaline. The subsoil has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth is fair, but the soil dries out more slowly than the adjacent soils. As a result, tillage is often delayed.

Most areas are cultivated. If adequately drained, this soil is moderately suited to cultivated crops, hay, and pasture. Because the soil is very wet and water tends to pond in many areas in the spring or during periods of heavy rainfall, surface intakes and tile drains are beneficial. In many areas, crops drown out and winter killing of legumes is a hazard. The soil warms slowly in the spring, and crops are subject to damage by early frost. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss.

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

The capability subclass is IIIw.

93D2—Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on convex side slopes that are partly dissected by hillside drainageways. The moderately well drained Shelby soil is on the lower side slopes. The somewhat poorly drained Adair soil occurs as narrow bands on the shoulder of the side slopes. Areas are long and narrow and range from 10 to 40 acres in size. They are about 60 percent Shelby soil and 40 percent Adair soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is very dark grayish brown clay loam about 8 inches thick. It is mixed with some streaks and pockets of dark yellowish brown subsoil material. The subsoil is about 30 inches thick. It is dark yellowish brown, friable clay loam in the upper part and brown, mottled, firm clay loam in the lower part. The substratum to a depth of 60 inches is mottled grayish brown and yellowish brown, calcareous clay loam.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 6 inches thick. It is mixed with some streaks and pockets of reddish brown subsoil material. The upper part of the subsoil is reddish brown, mottled, firm clay loam. The next part is reddish brown, brown, and grayish brown, mottled, very firm clay. The lower part to a depth of 60 inches is mottled yellowish brown, light gray, and strong brown, very firm clay loam. In some small areas the subsoil is gray and clayey.

The Shelby soil is moderately slowly permeable. The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid on both soils. Available water capacity is high in the Shelby soil and moderate in the Adair soil. Both soils are seasonally seepy. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is slightly acid or medium acid unless the soil has been limed in the past few years. The supply of available phosphorus is low in the subsoil of the Shelby soil and very low in the subsoil of the Adair soil. The supply of available potassium is high in the subsoil of the Shelby soil and very low in the subsoil of the Adair soil. Tilth is fair in the Shelby soil and poor in the Adair soil.

These soils are used for cultivated crops, hay, and pasture. They are poorly suited to row crops and moderately suited to hay, pasture, and oats. Further erosion is a hazard in cultivated areas. Farming on the contour, terracing, and stripcropping help to prevent excessive soil loss. A conservation tillage system that leaves crop residue on the surface increases the rate of water infiltration and helps to control runoff. Grassed waterways help to prevent the formation of gullies. In many areas terrace drop inlets are needed. Interceptor tiles help to control seepage. Returning all of the crop residue to the soils improves tilth and fertility. More intense management is needed on these soils than on the less eroded Shelby and Adair soils to maintain productivity and improve tilth.

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

The capability subclass is IVe.

93E—Shelby-Adair complex, 14 to 18 percent slopes. These moderately steep soils are on convex side slopes that are partly dissected by hillside drainageways. The moderately well drained Shelby soil is on the lower side slopes. The somewhat poorly drained Adair soil occurs as narrow bands on the shoulder of the side slopes. Areas are long and narrow and range from 20 to 30 acres in size. They are about 60 percent Shelby soil and 40 percent Adair soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is very dark brown and dark brown loam about 11 inches thick. The subsoil is yellowish brown, mottled, firm clay loam about 30 inches thick. The substratum to a depth of 60 inches is light olive brown, calcareous clay loam. It has strong brown mottles.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 8 inches thick. The subsoil is mottled, firm clay loam about 48 inches thick. It is dark brown and dark reddish brown in the upper part and strong brown in the lower part. The substratum to a depth of 60 inches is mottled strong brown, grayish brown, and brownish gray clay loam. In some small areas the subsoil is gray and clayey.

The Shelby soil is moderately slowly permeable. The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid on the Shelby soil and very rapid on the Adair soil. Available water capacity is high in the Shelby soil and moderate in the Adair soil. Both soils are seasonally seepy. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is slightly acid or medium acid unless it has been limed in the past few years. The supply of available phosphorus is low in the subsoil of the Shelby soil and very low in the subsoil of the Adair soil. The supply of available potassium is high in the subsoil of the Shelby soil and very low in the subsoil of the Adair soil. Tilth is good in the Shelby soil and fair in the Adair soil.

These soils are used for row crops, hay, and pasture. They generally are unsuitable for row crops and hay and are poorly suited to pasture. Erosion is a hazard in cultivated areas. In many areas grassed waterways help to prevent the formation of gullies. Interceptor tiles help to control seepage. Slopes are too steep for terracing. Returning all of the crop residue to the soils helps to maintain tilth and fertility.

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

The capability subclass is VIe.

95—Harps loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on the convex rims around depressions on upland flats. Areas generally are 3 to 15 acres in size, although some are much larger.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark gray loam about 12 inches thick. The subsoil is dark gray, gray, and olive gray, mottled, friable loam about 13 inches thick. The substratum to a depth of 60 inches is olive gray and olive, mottled loam. The soil is calcareous throughout.

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

The Harps soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. This layer is moderately alkaline. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. If a tile drainage system is installed and fertilizer is applied, this soil is well suited to cultivated crops. Phosphorus and potassium deficiencies are common because of the high lime content in this soil (fig. 9). The potential for soybeans can be improved by planting varieties that are resistant to iron deficiencies.

The capability subclass is IIw.

107—Webster silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on upland flats and in drainageways. Areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 9 inches thick. The subsoil is dark gray, friable clay loam about 12 inches thick. The substratum to a depth of 60 inches is grayish brown and olive, mottled, calcareous loam.

Included with this soil in mapping are small areas of the well drained Clarion and somewhat poorly drained Nicollet soils on rises. These soils make up about 10 percent of the map unit.

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

Most areas are cultivated. If adequately drained, this soil is well suited to cultivated crops, hay, and pasture. Some depressional areas are ponded during periods of heavy rainfall. The soil warms slowly in the spring. It tends to dry out and become cloddy and hard if worked when wet. Returning crop residue to the soil helps to maintain tilth and increases the rate of water infiltration.

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

The capability subclass is IIw.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains and on the lower parts of upland drainageways. It is subject to flooding. Areas are broad and range from 20 to 100 acres in size.

Figure 9.—Chlorotic soybeans on Harps loam, 0 to 2 percent slopes. The high content of lime in this soil restricts the availability of nutrients and causes the chlorosis.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam about 25 inches thick. The subsoil is very dark gray, mottled, firm silty clay loam about 14 inches thick. The substratum to a depth of 60 inches is dark gray, mottled silty clay loam.

This soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is very high. The content of organic matter is about 6 to 7 percent in the surface layer. This layer is neutral to medium acid unless the soil has been limed in the past few years. The substratum has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

Most areas are cultivated. Some are pastured. If adequately drained and protected from flooding, this soil is well suited to cultivated crops, hay, and pasture. A drainage system improves the timeliness of fieldwork. Tile and surface drains can function adequately if suitable outlets are available. Diversions, levees, and channel improvements help to control floodwater and the runoff from adjacent areas.

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

The capability subclass is IIw.

135—Coland clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on first bottoms and low terraces (fig. 10). It is subject to flooding. Areas are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 28 inches thick. The subsoil is dark gray, mottled, friable clay loam about 8 inches thick. The substratum to a depth of 60 inches is grayish brown, olive gray, and light olive gray, calcareous sandy clay loam.

Included with this soil in mapping are soils that are calcareous throughout. These soils are in positions on

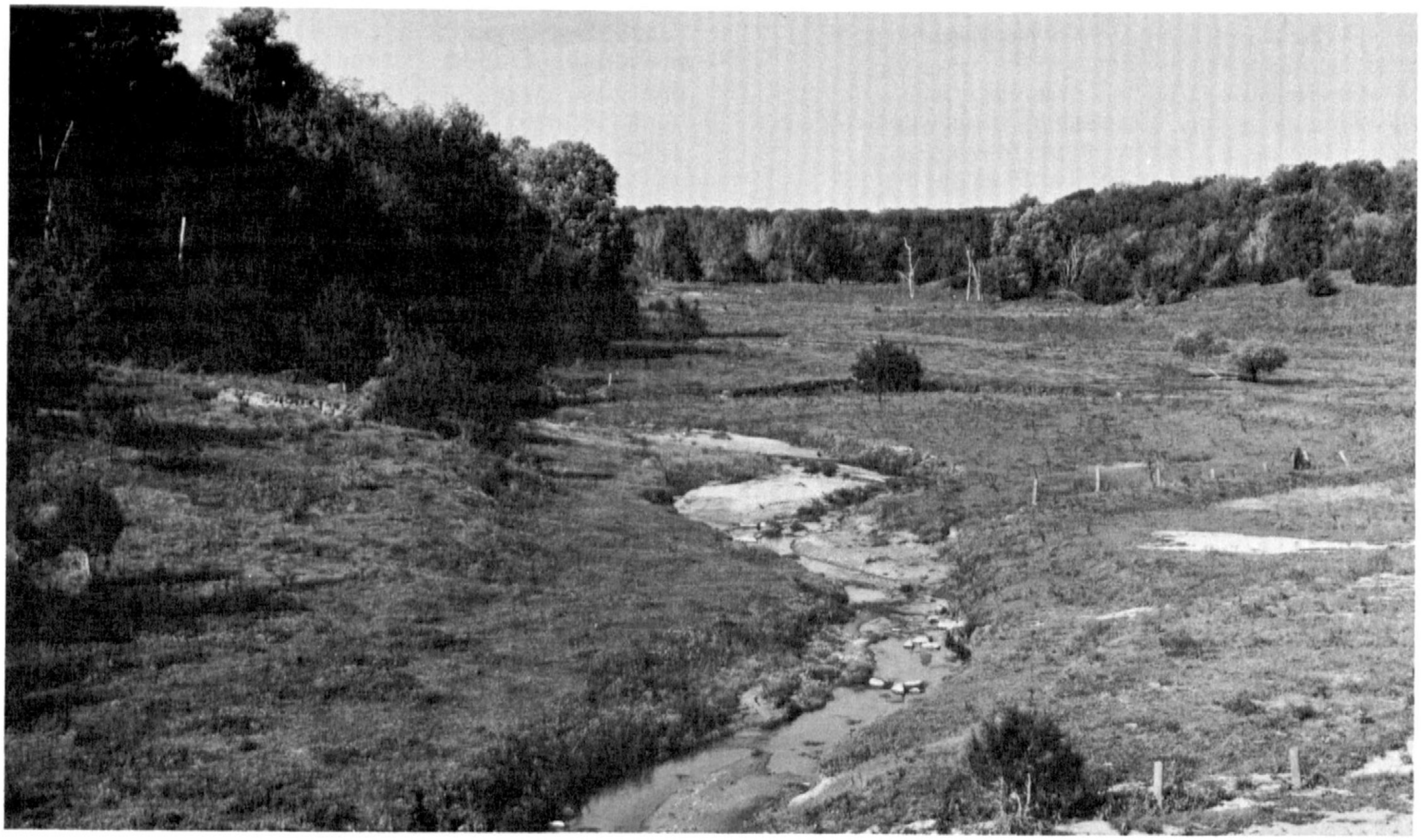

Figure 10.—An area of Coland clay loam, 0 to 2 percent slopes, along a stream.

the landscape similar to those of the Coland soil. They make up about 15 percent of the map unit.

The Coland soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is very high. The content of organic matter is about 5 to 7 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

Most areas are cultivated. If drained and protected from flooding and runoff, this soil is well suited to cultivated crops. Tile drains generally function satisfactorily if suitable outlets are available. The soil warms slowly in the spring. If tilled when wet, it tends to dry out and become cloddy and hard. Returning crop residue to the soil improves tilth and increases the rate of water infiltration. In low lying areas and old bayous, floodwater tends to pond. Streambank cutting occurs in places.

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

The capability subclass is IIw.

138B—Clarion loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on upland knolls. Areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 11 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 19 inches thick. The substratum to a depth of 60 inches is mottled yellowish brown and grayish brown, calcareous loam.

Included with this soil in mapping are a few small areas of the somewhat poorly drained Nicollet and poorly drained Webster soils on the lower parts of the landscape. Also included are small areas of Storden soils on knobs. These soils are calcareous throughout. Included soils make up 5 to 10 percent of the map unit.

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

Most areas are cultivated. This soil is well suited to cultivated crops, hay, and pasture. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping or by a combination of these. Returning crop residue to the soil helps to maintain good tilth and increases the rate of water infiltration.

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

The capability subclass is IIe.

138C—Clarion loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on knolls and convex side slopes that border streams and upland drainageways. Areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is very dark brown loam about 10 inches thick. The subsoil is brown, friable loam about 18 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In some areas the surface layer is thinner.

Included with this soil in mapping are a few small areas of Storden soils on knobs. These soils are calcareous throughout. They make up about 5 percent of the map unit.

Permeability is moderate in the Clarion soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.0 to 3.5 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping or by a combination of these. Returning crop residue to the soil helps to maintain good tilth and increases the rate of water infiltration.

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

The capability subclass is IIIe.

138C2—Clarion loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on knolls and convex side slopes that border streams and upland drainageways. Areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is dark brown loam about 8 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is brown and yellowish brown, friable loam about 16 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Storden and Zenor soils in similar positions on the landscape. Storden soils are calcareous throughout. Zenor soils contain more sand and fine gravel than the Clarion soil. Included soils make up less than 10 percent of the map unit.

Permeability is moderate in the Clarion soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2.0 to 2.5 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. If cultivated crops are grown, further erosion is a hazard. A combination of conservation practices, such as a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping, helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. More intense management is needed in this soil than on the less eroded Clarion soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is dark brown loam about 7 inches thick. It is mixed with some streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable loam about 14 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Storden soils in similar positions on the landscape. These soils are calcareous throughout. Also included are small areas of Zenor soils. These soils contain more sand and fine gravel than the Clarion soil. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Clarion soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are cultivated. This soil is moderately suited to cultivated crops and well suited to hay and pasture. If cultivated crops are grown, further erosion is a hazard. A combination of conservation practices, such as a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping, helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Clarion soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

168B—Hayden loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex upland ridgetops and knolls. Areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is dark yellowish brown and yellowish brown, friable and firm clay loam about 27 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Included with this soil in mapping are a few small depressional areas that are subject to ponding. The soils in these areas are wetter than the Hayden soil. They make up about 5 percent of the map unit.

Permeability is moderate in the Hayden soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium. Tilth is good.

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

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

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

The capability subclass is IIe.

168C—Hayden loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex upland side slopes and ridgetops. Areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 8 inches thick. The subsoil is yellowish brown, firm clay loam about 32 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium. Tilth is good.

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

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

The capability subclass is IIIe.

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

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

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium. Tilth is fair.

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

A cover of pasture plants or hay is effective in controlling erosion. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IIIe.

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

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

Permeability is moderate. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium. Tilth is fair.

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

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. If permanent pastures are improved, the content of organic matter slowly increases in this moderately eroded soil. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IIIe.

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

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 3 inches thick. The subsoil is yellowish brown, firm clay loam about 24 inches thick.

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

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

Permeability is moderate in the Hayden soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium.

Most areas are used for hay and pasture. This soil is poorly suited to corn, soybeans, and small grain and moderately suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

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

The capability subclass is IVe.

168F—Hayden loam, 18 to 25 percent slopes. This steep, well drained soil is on convex upland side slopes. Areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is dark grayish brown loam about 3 inches thick. The subsurface layer is grayish brown loam about 2 inches thick. The subsoil is yellowish brown, firm clay loam about 20 inches thick. The substratum to a depth of 60 inches is light yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Storden soils on the upper side slopes. These soils are calcareous throughout. They make up about 15 percent of the map unit.

Permeability is moderate in the Hayden soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a low supply of available potassium.

This soil generally is unsuitable for cultivated crops and small grain because of the steep slope and a severe hazard of erosion. It is moderately suited to grasses and legumes for pasture. A cover of pasture plants is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

Most areas remain in native hardwoods. This soil is suited to trees. Trees grow best on the lower part of the north- and east-facing slopes. Erosion and the equipment limitation are the main management concerns. Carefully selecting sites for logging trails or roads and laying out the trails or roads on the contour or nearly on the contour help to control erosion. Because of the steep slope, operating some equipment is difficult or hazardous.

The capability subclass is VIe.

169B—Clarion loam, 2 to 5 percent long slopes. This gently sloping, well drained soil is on convex upland ridgetops. Areas are long and narrow and range from 50 to 100 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and dark brown loam about 10 inches thick. The subsoil is brown and yellowish brown, friable loam about 32 inches thick. The substratum to a depth of 60 inches is mottled yellowish brown and brown, calcareous loam.

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

Most areas are cultivated. This soil is well suited to cultivated crops. If cultivated crops are grown, erosion is a hazard. The soil can be easily farmed on the contour and terraced because slopes are long and uniform. A conservation tillage system that leaves crop residue on the surface and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and helps to maintain tilth.

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

The capability subclass is IIe.

169C2—Clarion loam, 5 to 9 percent long slopes, moderately eroded. This moderately sloping, well drained soil is on upland ridgetops and side slopes. Areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. It is mixed with some streaks and pockets of brown subsoil material. The subsoil is brown and yellowish brown, friable loam about 28 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2.0 to 2.5 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to cultivated crops. If cultivated crops are grown, further erosion is a hazard. The soil can be easily farmed on the contour and terraced because slopes are long and uniform. A conservation tillage system that leaves crop residue on the surface, stripcropping, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and helps to maintain tilth. More intense management is needed on this soil than on the less eroded Clarion soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

175B—Dickinson fine sandy loam, 1 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on convex upland slopes and on dunes on stream terraces. Areas are broad and irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 27 inches thick. The upper part is brown, very friable fine sandy loam. The lower part is dark yellowish brown and yellowish brown, loose loamy sand. The substratum to a depth of 60 inches is yellowish brown sand. In places loamy glacial till is at a depth of 40 inches or more.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are used for cultivated crops. Some are used for hay and pasture. This soil is well suited to cultivated crops, hay, and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Stripcropping and a conservation tillage system that leaves crop residue on the surface help to prevent excessive soil loss. The soil is droughty in periods of below normal rainfall. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain tilth.

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

The capability subclass is IIe.

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

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark brown fine sandy loam about 4 inches thick. The subsoil is about 24 inches thick. The upper part is brown, very friable fine sandy loam. The lower part is dark yellowish brown, very friable loamy sand. The substratum to a depth of 60 inches is yellowish brown sand. In some areas loamy glacial till is at a depth of 40 inches or more.

Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated or are used for hay and pasture. This soil is moderately suited to cultivated crops, hay, and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Stripcropping, a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, or a combination of these practices helps to prevent excessive soil loss. The soil is droughty in periods of below normal rainfall. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain tilth.

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

The capability subclass is IIIe.

179F—Gara loam, 18 to 25 percent slopes. This steep, moderately well drained soil is on dissected side slopes that border upland drainageways. Areas generally are elongated and range from 10 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is about 33 inches thick. It is brown, friable clay loam in the upper part and dark yellowish brown and yellowish brown, mottled, firm and friable clay loam in the lower part. The substratum to a depth of 60 inches is multicolored, calcareous clay loam.

Included with this soil in mapping are small areas of Armstrong soils along the upslope margins of the unit. These soils contain more clay in the subsoil than the Gara soil. They make up about 10 percent of the map unit.

Permeability is moderately slow in the Gara soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is less than 0.5 percent in the surface layer. This layer is neutral to medium acid unless lime has been applied. The subsoil has a very low or low supply of available phosphorus and a very low supply of available potassium.

Most areas support trees and pasture plants. This soil is moderately suited to pasture, hay, and trees. It generally is unsuitable for cultivated crops because of the steep slope and a severe hazard of erosion. A permanent plant cover is effective in controlling sheet and gully erosion. In wooded areas the main concerns of management are erosion and the equipment limitation. Carefully selecting sites for logging trails or roads and laying out the trails or roads on the contour or nearly on the contour help to control erosion. Because of the steep slope, operating some equipment is difficult or hazardous. Seedling mortality and plant competition generally are slight.

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

The capability subclass is VIe.

201B—Coland-Terril complex, 2 to 5 percent slopes. These gently sloping soils are in upland drainageways. The poorly drained Coland soil is in the center of drainageways. It is subject to flooding. The moderately well drained Terril soil is along the sides of foot slopes. Areas are long and narrow and range from 5 to 20 acres in size. They are about 50 percent Coland soil and 40 percent Terril soil. The two soils occur as areas so narrow or so intricately mixed that mapping them separately is not practical.

Typically, the Coland soil has a surface layer of black clay loam about 10 inches thick. The subsurface layer is black and very dark gray clay loam about 26 inches thick. The substratum to a depth of 60 inches is olive gray, mottled loam.

Typically, the Terril soil has a surface layer of very dark brown loam about 10 inches thick. The subsurface layer is very dark brown loam about 20 inches thick. The subsoil to a depth of 60 inches is brown, friable loam.

Included with these soils in mapping are a few small depressional areas where water ponds. These areas make up 5 to 10 percent of the map unit.

Permeability is moderate in the Coland and Terril soils. The Coland soil has a seasonal high water table. Surface runoff is slow on the Coland soil and medium on the Terril soil. Available water capacity is very high in the Coland soil and high in the Terril soil. The content of organic matter is about 5.0 to 7.0 percent in the surface layer of the Coland soil and 4.5 to 5.5 percent in the surface layer of the Terril soil. The surface layer of both soils is neutral or slightly acid. The supply of available phosphorus is low in the substratum of the Coland soil and very low in the subsoil of the Terril soil. The supply of available potassium is very low in the substratum of the Coland soil and low or very low in the subsoil of the Terril soil. Tilth is fair in the Coland soil and good in the Terril soil.

Most areas are cultivated. The smaller areas are generally cropped along with areas of the adjacent soils. Some areas are pastured. These soils are well suited to cultivated crops, hay, and pasture. Wetness is the main limitation. Some areas receive runoff from side slopes and thus are subject to siltation. Other areas, near small streams, are subject to short duration flooding. In places diversions and channel improvements help to control floodwater and the runoff from the adjacent side slopes. Grassed waterways help to control erosion and prevent gullying (fig. 11). A drainage system improves the timeliness of fieldwork and helps to maintain tilth.

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The capability subclass is IIw.

203—Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on stream terraces. Areas are irregular in shape and range from 5 to 25 acres in size.

Figure 11.—A grassed waterway in an area of Coland-Terril complex, 2 to 5 percent slopes.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 15 inches thick. The subsoil is about 16 inches of dark grayish brown, friable and very friable loam and sandy loam. The substratum to a depth of 60 inches is brown, calcareous gravelly coarse sand. In places the depth to sand or gravel is more than 40 inches.

This soil is moderately permeable in the subsoil and very rapidly permeable in the substratum. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 4 to 5 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is slightly droughty in years of below normal rainfall. A subsurface drainage system improves the timeliness of fieldwork during extended wet periods. Placement of drainage lines is difficult in some areas, however, because of the loose, water-bearing sand. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain good tilth.

Pastured areas can be easily overstocked because the available water capacity is only moderate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIs.

220—Nodaway silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on first bottoms along the major streams and their tributaries and on alluvial fans. In areas where the streams have been straightened, it is along the old channels. It is subject to flooding. Areas are long and moderately wide and are 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The substratum to a depth of 60 inches is stratified very dark grayish brown, dark grayish brown, and very dark gray silt loam.

Included with this soil in mapping are small areas of the poorly drained Colo soils. These soils are on the lower parts of the bottom land that have not received recent deposits of silty sediment. They make up about 5 percent of the map unit.

The Nodaway soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is very high. The content of organic matter is about 1 to 2 percent in the surface layer. Typically, this layer is neutral or slightly acid. The substratum has a medium supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. Some are used for pasture. If protected from flooding, this soil is well suited to cultivated crops, hay, and pasture. Diversions, levees, and channel improvements help to control floodwater and the runoff from adjacent areas.

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

The capability subclass is IIw.

259—Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, poorly drained soil is on stream terraces. Areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 13 inches thick. The subsoil is dark gray, mottled, firm and friable clay loam about 10 inches thick. The substratum to a depth of 60 inches is olive gray, mottled, calcareous sandy loam, loamy coarse sand, and sand. In places the depth to sand or gravel is more than 40 inches.

This soil is moderately permeable in the upper part and rapidly permeable in the lower part. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 6 to 8 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are cultivated. If adequately drained, this soil is well suited to corn, soybeans, and small grain. Tile drains function satisfactorily in this soil, but trenches may cave in while the tile is being installed. If tilled when wet, the soil tends to dry out and become cloddy and hard.

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

The capability subclass is IIw.

308—Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is on stream terraces. Areas are irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 10 inches thick. The subsoil is about 18 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable sandy loam. The substratum to a depth of 60 inches is dark yellowish brown and yellowish brown, calcareous loamy sand and sand. In some places the depth to sand or gravel is more than 40 inches. In other places the surface layer and subsoil contain more sand.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to cultivated crops. It tends to be droughty during periods of low rainfall because of the underlying sand and gravel. Returning crop residue to the soil or regularly adding other organic material conserves moisture.

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

The capability subclass is IIs.

308B—Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on stream terraces. Areas are irregular in shape and range from 5 to 10 acres in size.

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

Permeability is moderate in the upper part of the profile and rapid in the lower part. Surface runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

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

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

The capability subclass is IIe.

325—Le Sueur loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on slightly convex upland rises. Areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 34 inches of brown, dark grayish brown, and grayish brown, mottled, friable and firm clay loam and loam. The substratum to a depth of 60 inches is mottled grayish brown and yellowish brown, calcareous loam.

This soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. This layer is slightly acid or medium acid unless limed. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to cultivated crops. In periods of above average rainfall, a few of the more level areas are wet. In these areas a drainage system improves the timeliness of fieldwork.

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

A few small areas remain in native hardwoods. The hazards or limitations that affect planting are slight if the proper species are selected and competing vegetation is controlled or removed.

The capability class is I.

356G—Hayden-Storden loams, 25 to 50 percent slopes. These very steep, well drained soils are on upland side slopes along the major streams and rivers. Most areas are characterized by many deep hillside drainageways. The Hayden soil is on the north- and east-facing side slopes. Areas range from 20 to several hundred acres in size. They are about 50 percent Hayden soil and 50 percent Storden soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Hayden soil has a surface layer of grayish brown loam about 3 inches thick. The subsurface layer is pale brown loam about 2 inches thick. The subsoil is yellowish brown, friable clay loam about 20 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Typically, the Storden soil has a surface layer of dark brown, calcareous loam about 8 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Permeability is moderate in both soils. Surface runoff is very rapid. Available water capacity is high. The content of organic matter is less than 0.5 percent to 1.0 percent in the surface layer. The surface layer of the Hayden soil is medium acid. That of the Storden soil is mildly alkaline. The subsoil of the Hayden soil has a medium supply of available phosphorus and a low supply of available potassium. The substratum of the Storden soil has a very low supply of available phosphorus and potassium.

Most areas are used as woodland. These soils are suited to trees. The erosion hazard and the equipment limitation are the main management concerns. Carefully selecting sites for logging trails or field lanes and laying out the trails or field lanes on the contour help to control erosion. Because of the very steep slope, operating some equipment is difficult or hazardous. Seedling mortality and plant competition are slight.

In a few areas these soils have been cleared of trees and are used for pasture. They are highly susceptible to erosion unless they are protected by a plant cover.

The capability subclass is VIIe.

368—Macksburg silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on wide upland divides. Areas have rounded boundaries and range from 60 to several hundred acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown silty clay loam about 15 inches thick. The subsoil to a depth of 60 inches is mottled dark grayish brown, grayish brown, olive gray, olive, and strong brown, friable silty clay loam.

This soil is moderately slowly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is very high. The content of organic matter is about 4.5 to 5.5 percent in the surface layer. This layer is slightly acid or medium acid unless limed. The subsoil has a low supply of available phosphorus and a medium supply of available potassium. Tilth is good.

Most areas are used for row crops. This soil is well suited to cultivated crops, hay, and pasture. A tile drainage system improves the timeliness of fieldwork in years when rainfall is above normal. Returning crop residue to the soil or regularly adding other organic material improves fertility and helps to maintain good tilth.

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

The capability class is I.

370B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on ridges in the uplands. Areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil to a depth of 60 inches is brown and yellowish brown, friable and firm silty clay loam.

Included with this soil in mapping are a few small areas of the nearly level, somewhat poorly drained Macksburg soils. These soils make up less than 10 percent of the map unit.

Permeability is moderately slow in the Sharpsburg soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. This layer is slightly acid or medium acid unless limed. The subsoil has a low supply of available phosphorus and a medium supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping or by a combination of these. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

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

The capability subclass is IIe.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on ridges and side slopes in the uplands. Areas are irregular in shape or long and narrow and range from 5 to 30 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with some streaks and pockets of yellowish brown subsoil material. The subsoil is yellowish brown, mottled, friable silty clay loam about 30 inches thick. The substratum to a depth of 60 inches is mottled grayish brown and yellowish brown silty clay loam.

Permeability is moderately slow. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is medium acid unless limed. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth is fair.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, a cropping sequence that includes grasses and legumes, and stripcropping or by a combination of these. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth, helps to control erosion, and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Sharpsburg soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

370D2—Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on ridges and side slopes in the uplands. Areas are irregular in shape or long and narrow and range from 5 to 20 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown and brown, friable silty clay loam about 26 inches thick. The substratum to a depth of 60 inches is yellowish brown silty clay loam.

Permeability is moderately slow. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a low supply of available phosphorus and a medium supply of available potassium. Tilth is fair.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by grassed waterways, a conservation tillage system that leaves crop residue on the surface, terraces, and a

Figure 12.—Contour farming and stripcropping on Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded.

cropping sequence that includes grasses and legumes or by a combination of these. Contour farming and stripcropping also help to control erosion (fig. 12). They are practical in most areas. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth, helps to control erosion, and increases the rate of water infiltration. More intense management is needed on this soil than on the less eroded Sharpsburg soils to maintain productivity and improve tilth.

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

The capability subclass is IIIe.

419F—Vanmeter silt loam, 14 to 30 percent slopes. This steep, moderately well drained soil is on convex upland side slopes. Areas are long and narrow and irregular in shape and range from 20 to 60 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is grayish brown and light gray, firm silty clay about 28 inches thick. Below this to a depth of 60 inches is multicolored clay shale. The soil is calcareous throughout.

Included with this soil in mapping are small areas where sandstone and limestone crop out. These areas make up about 15 percent of the map unit. Their positions on the landscape are similar to those of the Vanmeter soil.

Permeability is very slow in the Vanmeter soil. Surface runoff is very rapid. Available water capacity is moderate. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is mildly alkaline. The subsoil has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are used as woodland. This soil is suited to trees, but seedling mortality, the hazard of erosion, the equipment limitation, and the windthrow hazard are severe. Because they do not survive well, seedlings should be planted at close intervals. Thinning the stand helps to provide adequate growing space for the surviving trees. Laying out logging trails or field lanes on the contour helps to control erosion. Because of the steep slope, operating some equipment is difficult or hazardous.

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

The capability subclass is VIIe.

419G—Vanmeter silt loam, 30 to 60 percent slopes. This very steep, moderately well drained soil is on convex upland side slopes. Areas are long and narrow and irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 24 inches thick. The upper part is brown, friable silty clay loam. The next part is reddish brown, firm silty clay. The lower part is dark grayish brown, firm clay. Below this to a depth of 60 inches is olive and very dark gray, very firm clay shale. The soil is calcareous throughout.

Included with this soil in mapping are small areas where sandstone and limestone crop out. These areas make up about 15 percent of the map unit. Their positions on the landscape are similar to those of the Vanmeter soil.

Permeability is very slow in the Vanmeter soil. Surface runoff is very rapid. Available water capacity is moderate. The content of organic matter is about 0.5 to 1.0 percent in the surface layer. This layer is mildly alkaline. The subsoil has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are used as woodland. This soil is suited to trees, but seedling mortality, the hazard of erosion, the equipment limitation, and the windthrow hazard are severe. Because they do not survive well, seedlings should be planted at close intervals. Thinning the stand helps to provide adequate growing space for the surviving trees. Laying out logging trails or field lanes on the contour helps to control erosion. Because of the very steep slope, operating some equipment is difficult or hazardous.

The capability subclass is VIIe.

485—Spillville loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land. It is subject to flooding. Areas are irregular in shape and range from 10 to more than 100 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark brown, friable loam about 36 inches thick. The substratum to a depth of 60 inches is very dark grayish brown loam.

Included with this soil in mapping are small areas of the poorly drained Coland soils. These soils are in concave areas. They have a higher content of clay than the Spillville soil. They make up about 10 percent of the map unit.

The Spillville soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. This layer is neutral or slightly acid. The substratum has a low supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is well suited to cultivated crops, hay, and pasture. If protected from flooding, most areas are suited to intensive row cropping. Levees and dikes help to control the floodwater. Tile drains function satisfactorily if adequate outlets are available.

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

The capability subclass is IIw.

507—Canisteo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in swales and wide drainageways on uplands. Areas are irregular in shape and range from 40 to several hundred acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray, calcareous silty clay loam about 14 inches thick. The subsoil is about 11 inches of dark gray, mottled, friable, calcareous clay loam and olive gray, friable, calcareous loam. The substratum to a depth of 60 inches is olive gray, mottled, calcareous loam.

Included with this soil in mapping are a few areas of Okoboji soils in depressions where water tends to pond. These soils make up 5 to 10 percent of the map unit.

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

Most areas are cultivated. If adequately drained, this soil is well suited to cultivated crops and to grasses and legumes for hay and pasture. It warms slowly in the spring. It tends to dry out and become cloddy and hard if worked when wet. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. The high content of lime restricts the availability of phosphorus, potassium, and other micronutrients in this soil.

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

The capability subclass is IIw.

536—Hanlon fine sandy loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on natural levees and first bottoms. It is subject to flooding. Areas are elongated and generally are more than 25 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown fine sandy loam about 21 inches thick. The subsoil is very dark grayish brown, very friable sandy loam about 15 inches thick. The substratum to a depth of 60 inches is dark grayish brown sandy loam.

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

The Hanlon soil is moderately rapidly permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. If adequately protected from flooding, this soil is well suited to cultivated crops, hay, and pasture. Levees and dikes help to control the floodwater. Tile drains function satisfactorily if adequate outlets are available.

Pastured areas can be easily overstocked because the available water capacity is only moderate. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIw.

566B—Moingona loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on foot slopes. Areas are elongated and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 10 inches thick. The subsoil to a depth of 60 inches is clay loam. It is brown and firm in the upper part and dark yellowish brown, yellowish brown, and light olive brown and friable in the lower part.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.5 to 4.0 percent in the surface layer. This layer is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. If erosion is controlled, this soil is suited to cultivated crops. It receives runoff from the adjacent uplands. Diversion terraces help to protect the soil from excessive runoff. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

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

A few small areas remain in native hardwoods. This soil is suited to trees. The hazards or limitations that affect planting are slight if the proper species are selected and competing vegetation is controlled or removed.

The capability subclass is IIe.

638C2—Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded. These moderately sloping, well drained soils are on upland knolls and side slopes. Areas are irregular in shape and range from 10 to 20 acres in size. They are about 55 percent Clarion soil and 45 percent Storden soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of very dark brown loam about 7 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable loam about 23 inches thick. The substratum to a depth of 60 inches is yellowish brown and pale brown, calcareous loam.

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

Permeability is moderate in the Clarion and Storden soils. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2.0 to 3.0 percent in the surface layer of the Clarion soil and 1.0 to 1.5 percent in the surface layer of the Storden soil. The surface layer of the Clarion soil is slightly acid or neutral, and that of the Storden soil is moderately alkaline. The subsoil of the Clarion soil and the substratum of the Storden soil have a very low supply of available phosphorus and potassium. Tilth is good in the Clarion soil and fair in the Storden soil.

Most areas are cultivated. If erosion is controlled, these soils are suited to cultivated crops. Erosion can be controlled by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, and a cropping sequence that includes grasses and legumes or by a combination of these. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. More intense management is needed on these soils than on the less eroded Clarion and Storden soils to maintain productivity and improve tilth.

If these soils are used for pasture, overgrazing causes surface compaction and excessive runoff. Proper stocking rates and pasture rotation help to keep the pasture and the soils in good condition.

The capability subclass is IIIe.

638D2—Clarion-Storden loams, 9 to 14 percent slopes, moderately eroded. These strongly sloping, well drained soils are on upland knolls and side slopes. Areas are irregular in shape and range from 10 to 40 acres in size. They are about 55 percent Clarion soil and 45 percent Storden soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Clarion soil has a surface layer of dark brown loam about 6 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable loam about 20 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Typically, the Storden soil has a surface layer of brown, calcareous loam about 6 inches thick. It is mixed with streaks and pockets of yellowish brown substratum material. The substratum to a depth of 60 inches is yellowish brown and brownish yellow, calcareous loam.

Permeability is moderate in the Clarion and Storden soils. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2.0 to 3.0 percent in the surface layer of the Clarion soil and 1.0 to 1.5 percent in the surface layer of the Storden soil. The surface layer of the Clarion soil is slightly acid or neutral, and that of the Storden soil is moderately alkaline. The subsoil of the Clarion soil and the substratum of the Storden soil have a very low supply of available phosphorus and potassium. Tilth is good in the Clarion soil and fair in the Storden soil.

Most areas are cultivated. If erosion is controlled, these soils are suited to cultivated crops. Erosion can be controlled by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, and a cropping sequence that includes grasses and legumes or by a combination of these. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration. More intense management is needed on these soils than on the less eroded Clarion and Storden soils to maintain productivity and improve tilth.

If these soils are used for pasture, overgrazing causes surface compaction and excessive runoff. Proper stocking rates and pasture rotation help to keep the pasture and the soils in good condition.

The capability subclass is IVe.

736B—Lester loam, 2 to 5 percent long slopes. This gently sloping, well drained soil is on convex upland ridgetops. Areas are long and narrow and range from 10 to 40 acres in size.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is about 23 inches of brown and light olive brown, friable clay loam and loam. The substratum to a depth of 60 inches is light olive brown, calcareous loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer is slightly acid or medium acid unless limed. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. If erosion is controlled, this soil is well suited to cultivated crops. It can be easily farmed on the contour and terraced because slopes are long and uniform. A conservation tillage system that leaves crop residue on the surface and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

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

A few small areas remain in native hardwoods. This soil is suited to trees. The hazards or limitations that affect planting are slight if the proper species are selected and competing vegetation is controlled or removed.

The capability subclass is IIe.

736C2—Lester loam, 5 to 9 percent long slopes, moderately eroded. This moderately sloping, well drained soil is on convex, narrow upland divides and side slopes. Areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. It is mixed with streaks and pockets of brown clay loam subsoil material. The subsoil is brown and dark yellowish brown, friable clay loam about 20 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In places, the surface layer has a lower content of organic matter and the subsoil contains more clay.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is medium acid unless limed. The subsoil has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to cultivated crops. It can be easily farmed on the contour and terraced because slopes are long and uniform. A conservation tillage system that leaves crop residue on the surface and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves tilth and fertility and helps to prevent surface crusting. More intense management is needed on this soil than on the less eroded Lester soils to maintain productivity and improve tilth.

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

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

The capability subclass is IIIe.

822D2—Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, somewhat poorly drained soil is on convex upland side slopes near the upper end of drainageways. Areas are long and narrow and range from 15 to 40 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. It is mixed with streaks and pockets of dark grayish brown subsoil material. The subsoil is about 41 inches thick. The upper part is dark grayish brown, very firm clay loam and clay. The lower part is grayish brown, very firm and firm clay loam. The substratum to a depth of 60 inches is grayish brown, mottled clay loam. In some small areas the subsoil is reddish and contains less clay.

The Lamoni soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer is strongly acid or medium acid unless limed. The subsoil has a low supply of available phosphorus and potassium. Tilth is poor.

Most areas are cultivated. This soil is poorly suited to cultivated crops because of the hazard of further erosion. It is moderately suited to hay and pasture. Erosion can be controlled by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, and a cropping sequence that includes grasses and legumes or by a combination of these. More intense management is needed on this soil than on the less eroded Lamoni soils to maintain productivity and improve tilth.

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

The capability subclass is IVe.

823—Ridgeport sandy loam, 0 to 2 percent slopes. This nearly level, somewhat excessively drained soil is on stream terraces. Areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is very dark brown sandy loam about 5 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown and brown, very friable sandy loam and gravelly sandy loam. The lower part is dark yellowish brown, loose gravelly loamy sand. The substratum to a depth of 60 inches is yellowish brown, calcareous gravelly sand.

Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Surface runoff is very slow. Available water capacity is low. The content of organic matter is about 2.0 to 2.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is only moderately suited to cultivated crops because it tends to be droughty. A conservation tillage system that leaves crop residue on the surface conserves moisture. Returning crop residue to the soil or regularly adding other organic material conserves moisture, improves fertility, and helps to maintain tilth.

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

The capability subclass is IIIs.

823B—Ridgeport sandy loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on stream terraces. Areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 4 inches thick. The subsoil is brown and dark yellowish brown, very friable gravelly sandy loam about 24 inches thick. The substratum to a depth of 60 inches is light yellowish brown, calcareous gravelly coarse sand.

Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Surface runoff is slow. Available water capacity is low. The content of organic matter is about 2.0 to 2.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to cultivated crops. It tends to be droughty. A conservation tillage system that leaves crop residue on the surface, contour farming, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture.

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

The capability subclass is IIIe.

823C—Ridgeport sandy loam, 5 to 9 percent slopes. This moderately sloping, somewhat excessively drained soil is on stream terraces. Areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The subsoil is brown and dark yellowish brown, very friable gravelly sandy loam about 22 inches thick. The substratum to a depth of 60 inches is yellowish brown and light yellowish brown, calcareous sand and gravel.

Permeability is moderately rapid in the upper part of the profile and very rapid in the lower part. Surface runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to cultivated crops. It tends to be droughty. A conservation tillage system that leaves crop residue on the surface, contour farming, terraces, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture.

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

The capability subclass is IIIe.

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

Typically, the surface layer is very dark grayish brown sandy loam about 11 inches thick. The subsoil is dark brown and dark yellowish brown, very friable and loose sandy loam about 23 inches thick. The substratum to a depth of 60 inches is yellowish brown and light olive brown, calcareous gravelly sandy loam and gravelly loamy sand.

Included with this soil in mapping are a few small areas of Storden soils in similar positions on the landscape. These soils are calcareous. They make up about 5 percent of the map unit.

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. Surface runoff is slow. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is good.

Most areas are cultivated. If erosion is controlled, this soil is moderately suited to cultivated crops. It tends to be droughty. A conservation tillage system that leaves crop residue on the surface, contour farming, stripcropping, and a cropping sequence that includes grasses and legumes help to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and tilth and conserves moisture.

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

The capability subclass is IIIe.

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

Typically, the surface layer is dark brown sandy loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 20 inches thick. It is brown and yellowish brown, very friable sandy loam that contains fine gravel. The substratum to a depth of 60 inches is yellowish brown and brownish yellow loamy sand in which the content of fine gravel is about 15 percent.

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

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. Surface runoff is medium. Available water capacity is moderate. The content of organic matter is about 1.0 to 1.5 percent in the surface layer. This layer is neutral or slightly acid. The subsoil has a low supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

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

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

The capability subclass is IIIe.

829D2—Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on upland side slopes in glacial outwash areas. The Zenor soil is somewhat excessively drained and the Storden soil well drained. Areas are irregular in shape and range from more than 5 to 10 acres in size. They are about 60 percent Zenor soil and 40 percent Storden soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

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

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

Permeability is moderately rapid in the upper part of the Zenor soil and rapid in the lower part. It is moderate in the Storden soil. Surface runoff is medium on both soils. Available water capacity is moderate in the Zenor soil and high in the Storden soil. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of both soils. The subsoil of the Zenor soil has a low supply of available phosphorus and a very low supply of available potassium. The substratum of the Storden soil has a very low supply of available phosphorus and potassium. Tilth is fair in both soils.

Most areas are used for hay or pasture. These soils are suited to grasses and legumes. Proper stocking rates and pasture rotation help to keep the pasture and the soils in good condition.

If cultivated crops are grown on these soils, further erosion is a hazard. It can be controlled by a conservation tillage system that leaves crop residue on the surface, contour farming, terraces, and a cropping sequence that includes grasses and legumes or by a combination of these. Returning crop residue to the soils or regularly adding other organic material improves fertility and tilth and conserves moisture. More intense management is needed on these soils than on the less eroded Zenor and Storden soils to maintain productivity and improve tilth.

The capability subclass is IVe.

956—Harps-Okoboji complex, 0 to 1 percent slopes. These level soils are in and around upland depressions. The poorly drained Harps soil is at the edge of small depressions. The very poorly drained Okoboji soil is in closed depressions. It is subject to ponding. Areas range from 10 to 50 acres in size. They are about 60 percent Harps soil and 40 percent Okoboji soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Harps soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark gray loam about 12 inches thick. The subsoil is dark gray and gray, friable loam about 15 inches thick. The substratum to a depth of 60 inches is olive gray loam. The soil is calcareous throughout.

Typically, the Okoboji soil has a surface layer of black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 16 inches thick. The subsoil is very dark gray and dark gray, firm silty clay loam about 24 inches thick. The substratum to a depth of 60 inches is olive gray, mottled, calcareous loam.

Permeability is moderate in the Harps soil and moderately slow in the Okoboji soil. Both soils have a seasonal high water table. Surface runoff is very slow. Available water capacity is high in the Harps soil and very high in the Okoboji soil. The content of organic matter is about 4.5 to 5.5 percent in the surface layer of the Harps soil and 9.0 to 11.0 percent in the surface layer of the Okoboji soil. The subsoil of both soils has a very low supply of available phosphorus. The subsoil of the Harps soil has a very low supply of available potassium, and the subsoil of the Okoboji soil has a low supply of available potassium. Tilth is good in the Harps soil and fair in the Okoboji soil.

Most areas have been drained and are cultivated. These soils are moderately suited to corn, soybeans, and other cultivated crops and to grasses for hay and pasture. In undrained areas they are well suited to wetland wildlife habitat. The ponding and excess lime limit crop production. An early frost in fall is also a concern. Surface water intakes or surface drains help to prevent the crop damage caused by the ponding. A subsurface drainage system and ditches also remove excess water. Iron chlorosis and damage from herbicide carryover are common if soybeans are planted on the Harps soil. Selecting the proper variety of soybeans and applying herbicides and fertilizer minimize these problems.

If these soils are used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. In depressions, most legumes are drowned in the spring and winter killing is a hazard. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The capability subclass is IIIw.

993D2—Gara-Armstrong complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping, moderately well drained and somewhat poorly drained soils are on convex hillsides in the uplands. The Armstrong soil generally is upslope from the Gara soil. Areas are long and narrow and range from 5 to 20 acres in size. They are about 60 percent Gara soil and 40 percent Armstrong soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Gara soil has a surface layer of dark grayish brown and brown loam about 8 inches thick. The subsoil is yellowish brown and grayish brown, firm clay loam about 38 inches thick. The substratum to a depth of 60 inches is olive brown and yellowish brown clay loam.

Typically, the Armstrong soil has a surface layer of very dark grayish brown and brown silt loam about 7 inches thick. The upper part of the subsoil is brown and reddish brown, firm clay about 23 inches thick. The lower part to a depth of 60 inches is mottled yellowish red, grayish brown, and light gray clay loam.

The Gara soil is moderately slowly permeable. The Armstrong soil is slowly permeable. It has a seasonal high water table and is seepy during wet periods. Surface runoff is rapid on both soils. Available water capacity is high in the Gara soil and moderate in the Armstrong soil. The content of organic matter is about 0.5 to 1.5 percent in the surface layer of both soils. This layer is medium acid unless limed. The subsoil has a low or very low supply of available phosphorus and a very low supply of available potassium. Tilth is good in the Gara soil and fair in the Armstrong soil.

Most areas are used for pasture, hay, or row crops. These soils are moderately suited or poorly suited to corn, soybeans, and small grain. They are moderately suited to grasses and legumes for hay and pasture. If row crops are grown, further erosion is a hazard. Row crops can be grown in some years, however, if erosion is controlled. Terraces, contour farming, and a conservation tillage system that leaves crop residue on the surface help to control erosion. In some areas contour farming and terracing are practical, but they are not so practical in undulating areas where slopes are short. If terraces are built, cuts should not expose the clayey subsoil. Seepage can occur in terrace channels. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to maintain tilth, and increases the rate of water infiltration. More intense management is needed on these soils than on the less eroded Gara and Armstrong soils to maintain productivity and improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. If permanent pastures are improved, the content of organic matter slowly increases in these moderately eroded soils. In seepy areas on the upper slopes, pasture management is difficult in spring and early in summer. Overgrazing or grazing when the soils are wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

These soils are suited to trees. The hazards or limitations that affect planting are slight in areas of the Gara soil if the proper species are selected. Because they do not survive well in areas of the Armstrong soil, seedlings should be planted at close intervals.

The capability subclass is IVe.

993E—Gara-Armstrong complex, 14 to 18 percent slopes. These moderately steep, moderately well drained and somewhat poorly drained soils are on convex hillsides in the uplands. Areas are long and narrow and range from 10 to 30 acres in size. They are about 40 percent Gara soil and 40 percent Armstrong soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Gara soil has a surface layer of very dark brown loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil to a depth of 60 inches is mottled yellowish brown and light olive brown, firm clay loam.

Typically, the Armstrong soil has a surface layer of very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The upper part of the subsoil is brown, firm and friable clay loam. The next part is brown, yellowish red, and strong brown, firm clay and clay loam. The lower part to a depth of 60 inches is mottled light brownish gray and yellowish brown, firm clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Lamoni soils on the upper side slopes. These included soils are less sloping than the Gara and Armstrong soils. They make up about 20 percent of the map unit.

The Gara soil is moderately slowly permeable. The Armstrong soil is slowly permeable. It has a seasonal high water table and is seepy during wet periods. Surface runoff is rapid on both soils. Available water capacity is high in the Gara soil and moderate in the Armstrong soil. The content of organic matter is about 1 to 2 percent in the surface layer of both soils. This layer is medium acid unless limed. The subsoil has a low or very low supply of available phosphorus and a very low supply of available potassium. Tilth is good in the Gara soil and fair in the Armstrong soil.

Most areas are used for pasture or hay. These soils generally are unsuited to cultivated crops because of a severe hazard of erosion. If the soils are used for pasture, overgrazing causes surface compaction and excessive runoff. Proper stocking rates help to keep the pasture and the soils in good condition.

Small areas remain in native hardwoods. These soils are suited to trees. Because they do not survive well in areas of the Armstrong soil, seedlings should be planted at close intervals. Thinning the stand helps to provide adequate growing space for the surviving trees. Carefully selecting sites for logging trails or field lanes helps to control erosion. Because of the moderately steep slope, operating some equipment is difficult or hazardous.

The capability subclass is VIe.

1220—Nodaway silt loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on first bottoms adjacent to meandering streams or curving old stream channels (fig. 13). It is subject to flooding. Areas are long and narrow and range from 20 to 100 acres in size.

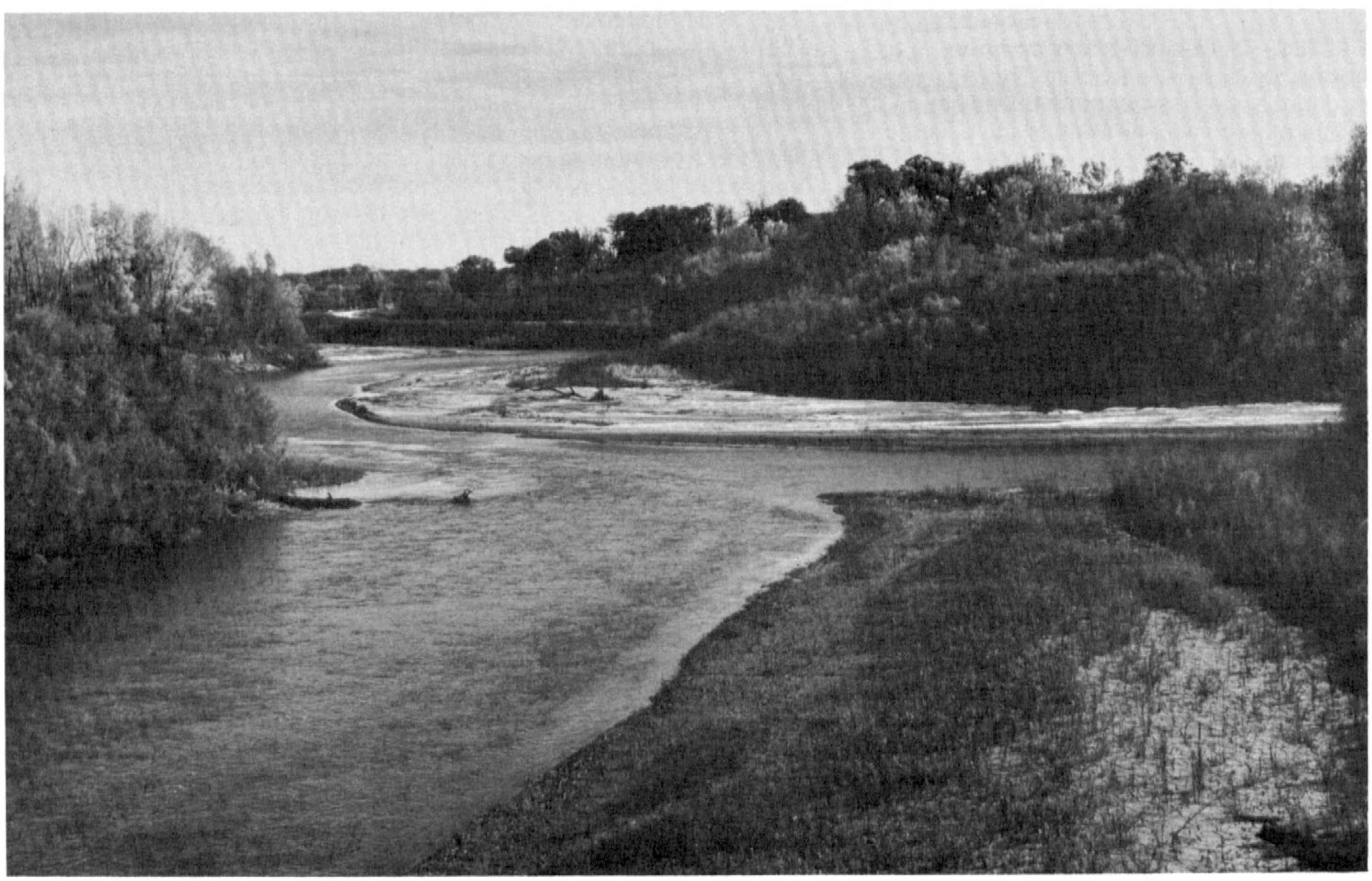

Figure 13.—An area of Nodaway silt loam, channeled, 0 to 2 percent slopes.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The next 12 inches is very dark grayish brown and dark grayish brown silt loam. The substratum to a depth of 60 inches is very dark grayish brown silt loam that has thin strata of sand throughout.

Included with this soil in mapping are areas of the poorly drained Colo soils. These soils are in old stream channels and low lying areas that have not received recent deposits of silty sediment. They make up about 20 percent of the map unit.

The Nodaway soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is very high. The content of organic matter is about 2 to 3 percent in the surface layer. Typically, this layer is neutral. The substratum has a medium supply of available phosphorus and potassium. Tilth is good.

Most areas are used for permanent pasture or support trees. A few areas between old channels are cultivated. Because of the flooding and the numerous old stream channels and oxbows, this soil generally is unsuitable for cultivated crops and hay. It is moderately suited to pasture. Trees should be removed, channels straightened or filled, levees built, and drainage ditches dug before the soil can be cropped. Measures that protect the pasture and trees from floodwater are also needed.

The capability subclass is Vw.

1314—Hanlon-Spillville complex, channeled, 0 to 2 percent slopes. These nearly level, moderately well drained and somewhat poorly drained soils are on first bottoms adjacent to the major streams and rivers. They are subject to flooding. Areas generally are dissected by old stream channels and oxbows. They are long and wide and range from 40 to more than 100 acres in size. They are about 50 percent Hanlon soil and 30 percent Spillville soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Hanlon soil has a surface layer of very dark brown fine sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 20 inches thick. The subsoil is very dark grayish brown fine sandy loam about 20 inches thick. The substratum to a depth of 60 inches is dark grayish brown fine sandy loam.

Typically, the Spillville soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark brown loam about 36 inches thick. The substratum to a depth of 60 inches is very dark grayish brown loam.

Included with these soils in mapping are small areas of the poorly drained Coland soils and areas of excessively drained, stratified sandy soils in old stream channels and on low lying parts of the landscape. These included soils make up about 20 percent of the map unit.

Permeability is moderately rapid in the Hanlon soil and moderate in the Spillville soil. Both soils have a seasonal high water table. Surface runoff is slow. Available water capacity is high. The organic matter content is about 2 to 3 percent in the surface layer of the Hanlon soil and 4 to 5 percent in the surface layer of the Spillville soil. The surface layer of both soils is neutral. The subsoil of the Hanlon soil has a very low supply of available phosphorus and potassium. The substratum of the Spillville soil has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are pasture or are idle land. These soils generally are unsuitable for cultivation. Trees should be removed, channels straightened or filled, levees built, and drainage ditches dug before the soils can be cropped. Measures that protect pasture and trees from floodwater are also needed.

The capability subclass is Vw.

1585—Spillville-Coland complex, channeled, 0 to 2 percent slopes. These nearly level, somewhat poorly drained and poorly drained soils are on bottom land along narrow, meandering stream tributaries. They are subject to flooding. Areas are long and narrow and range from 20 to 100 acres in size. They are about 60 percent Spillville soil and 40 percent Coland soil. The two soils occur as areas so intricately mixed that mapping them separately is not practical.

Typically, the Spillville soil has a surface layer of very dark brown loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 26 inches thick. The substratum to a depth of 60 inches is brown loam.

Typically, the Coland soil has a surface layer of black clay loam about 10 inches thick. The subsurface layer is black and very dark gray clay loam about 26 inches thick. The substratum to a depth of 60 inches is olive gray, mottled loam.

These soils are moderately permeable. They have a seasonal high water table. Surface runoff is slow. Available water capacity is high in the Spillville soil and very high in the Coland soil. The content of organic matter is about 4 to 5 percent in the surface layer of the Spillville soil and 5 to 7 percent in the surface layer of the Coland soil. The surface layer of both soils is neutral. The substratum has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are used for pasture. Measures that reduce the wetness and help to prevent flooding improve pastures. Overgrazing or grazing when the soils are wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

Figure 14.—A large sand and gravel pit on a stream terrace.

These soils generally are unsuitable for cultivation. Trees should be removed, channels straightened or filled, levees built, and drainage ditches dug before the soils can be cropped.

The capability subclass is Vw.

5010—Pits, sand and gravel. These are open pits from which sand and gravel have been removed (fig. 14). They are 20 to more than 30 feet deep. Many are still being mined, but in some areas where the sand and gravel strata have been exhausted, they are inactive. Areas are irregular in shape and commonly are 5 to 40 acres in size. A few are 100 acres in size.

Permeability varies but generally is moderately rapid to very rapid. Typically, reaction ranges from strongly acid to neutral.

Water accumulates in some of the pits. Many of the inactive pits provide habitat for fish and are used for fishing. Many, however, are on private property and are not open to the public.

No capability class or subclass is assigned.

5040—Orthents, loamy. These are level to strongly sloping soils that have been used as borrow areas for construction. Many of these areas are along Interstate 80. In some areas the original soil has been removed to a depth of 5 to 20 feet or more. The soils range from somewhat excessively drained to moderately well drained, depending on the kind of material from which they were derived and the condition of the restored borrow area. Areas typically range from 6 to 50 acres in size.

Typically, the upper 5 feet is light olive brown, friable and firm, calcareous loam. In many areas cobbles and pebbles are on the surface. In some areas the color is olive gray. In other areas the texture is sandy loam. About 4 to 10 inches of topsoil has been redistributed, often unevenly, throughout some borrow areas. This topsoil is very dark gray to dark brown.

Included with these soils in mapping are small areas of sand and some areas where the soil material is very firm. Also included are a few covered areas that were once dumps or landfills.

Permeability varies, depending on the texture and density of the soils. Soils that were once buried 5 to 20 feet or more beneath the surface have less pore space and are more dense than the original surface layer. Available water capacity is moderate or low. Surface runoff ranges from slow to rapid. Unless the topsoil has been redistributed, the content of organic matter is very low. As a result, preparing a good seedbed is difficult and droughtiness is a limitation. Reaction varies in the surface layer. In most areas the supply of available phosphorus and potassium is very low.

Most areas are idle land near highways. These soils commonly are not suited to cultivated crops. They are better suited to small grain and to grasses and legumes for hay and pasture. The areas where topsoil has been redistributed are better suited to corn and soybeans than the other areas. Erosion is a moderate or severe hazard if the more sloping areas are cultivated. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Also, other measures that stabilize the soils are needed.

No capability class or subclass is assigned.

5060—Pits, clay. These are pits from which shale has been mined for use in brick and tile manufacturing. Areas are rectangular and range from 10 to 80 acres in size.

Most of the pits are abandoned. They support little or no vegetation and are used as dumps or landfills. In the pits still being mined, the water level should be lowered by pumps. Some of the larger pits contain permanent ponds.

No capability class or subclass is assigned.

prime farmland

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

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

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

About 258,000 acres throughout Dallas County, or nearly 68 percent of the total acreage, meets the requirements for prime farmland. About 252,000 acres of this land is used for crops, mainly corn and soybeans. The crops grown on this land account for an estimated two-thirds of the local farm income each year.

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

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

Some soils that have a seasonal high water table and soils that are frequently flooded qualify for prime farmland only in areas where these limitations have been overcome by a drainage system or flood control. The need for these measures is indicated in parentheses after the name of these soils on the following list. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

The map units that meet the requirements for prime farmland are:

7	Wiota silt loam, 1 to 3 percent slopes
8B	Judson silty clay loam, 2 to 5 percent slopes
11B	Colo-Ely silty clay loams, 2 to 5 percent slopes (where the Colo soil is drained and protected from flooding)
27B	Terril loam, 2 to 5 percent slopes
55	Nicollet loam, 1 to 3 percent slopes

76B	Ladoga silt loam, 2 to 5 percent slopes
80B	Clinton silt loam, 2 to 5 percent slopes
88	Nevin silty clay loam, 0 to 2 percent slopes
95	Harps loam, 0 to 2 percent slopes (where drained)
107	Webster silty clay loam, 0 to 2 percent slopes (where drained)
133	Colo silty clay loam, 0 to 2 percent slopes (where drained)
135	Coland clay loam, 0 to 2 percent slopes (where drained)
138B	Clarion loam, 2 to 5 percent slopes
168B	Hayden loam, 2 to 5 percent slopes
169B	Clarion loam, 2 to 5 percent long slopes
175B	Dickinson fine sandy loam, 1 to 5 percent slopes
201B	Coland-Terril complex, 2 to 5 percent slopes (where the Coland soil is drained and protected from flooding)
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
220	Nodaway silt loam, 0 to 2 percent slopes
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes (where drained)
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes
325	Le Sueur loam, 0 to 2 percent slopes
368	Macksburg silty clay loam, 0 to 2 percent slopes
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes
485	Spillville loam, 0 to 2 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes (where drained)
536	Hanlon fine sandy loam, 0 to 2 percent slopes (where protected from flooding)
566B	Moingona loam, 2 to 6 percent slopes
736B	Lester loam, 2 to 5 percent long slopes

use and management of the soils

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

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

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

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

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

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

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

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

In 1976, more than 354,000 acres in Dallas County was farmland, according to the 1977 Iowa Agriculture Statistics. Of this total, about 26,000 acres was used for pasture; 253,000 acres for row crops, mainly corn and soybeans; 10,000 acres for close-grown crops, mainly oats; and 12,000 acres for hay. The rest was idle.

The paragraphs that follow describe the main management concerns in the areas used for crops and pasture.

Soil erosion is the major problem on about 35 percent of the cropland and pasture in Dallas County. If the slope is more than 2 percent, water erosion is a hazard. Clarion, Hayden, Sharpsburg, and Wadena soils, for example, have slopes of more than 2 percent, and are subject to erosion.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as Adair soils. Erosion also reduces the productivity of soils that tend to be droughty, such as Zenor soils. Second, erosion on farmland can result in pollution of streams by sediment. Control of erosion improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing the pollution of streams.

Erosion control provides a protective plant cover, reduces the runoff rate, and increases the infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods can hold soil losses to an amount that will not reduce the productive capacity of the soils. On livestock farms, where part of the acreage is pasture and hayland, including legumes and grasses in the cropping system not only provides nitrogen and improves tilth for the following crops but also reduces the risk of erosion on the more sloping soils. Management practices that help to prevent surface compaction and severe gully erosion are especially important on steep soils, such as Hayden and Storden soils (fig. 15).

Figure 15.—Gully erosion in an overgrazed area of Storden soils.

In most areas of the gently sloping Clarion, Hayden, and Lester soils, slopes are so short and irregular that contour farming or terracing is not practical. On these soils a cropping system that provides a protective plant cover or a conservation tillage system is needed to control erosion. A conservation tillage system that leaves crop residue on the surface increases the infiltration rate, reduces the runoff rate, and helps to control erosion. No-tillage for corn and soybeans, which is becoming common on an increasing acreage, is effective in controlling erosion in the more sloping areas. It is effective on most of the soils in Dallas County.

Following are examples of the major kinds of conservation tillage. No-tillage is a system in which the seedbed is prepared and the seed planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the soil surface. Till-plant also is a system in which the seedbed is prepared and the seed planted in one operation. Tillage is limited to a strip not wider than one-third of the row. A protective cover of crop residue is left on two-thirds of the surface. Chisel-disk or rotary tillage is a system in which the soil is loosened throughout the field and crop residue is partly incorporated into the soil. Preparing the seedbed and planting can be one or separate operations. Conservation tillage is not effective unless enough crop residue is left on the surface after planting to control erosion.

Terraces and diversions reduce the length of slopes and the hazards of runoff and erosion (fig. 16). They are most practical on the deep, well drained soils that have regular slopes. In some areas Clarion, Ladoga, Sharpsburg, and Storden soils are suitable for terraces and diversions.

Contour farming and stripcropping help to control erosion. They are most effective in areas where slopes are smooth and uniform, such as some areas of the sloping Clarion, Ladoga, Sharpsburg, and Storden soils.

Figure 16.—Grassed back slope terraces.

Wind erosion is a hazard on most of the soils in the county that are not protected by a plant cover. It is most severe in areas that have been cropped to soybeans. It can damage soils in a few hours if winds are strong and the soils are dry and have no plant cover or surface mulch. Maintaining a plant cover or a surface mulch or keeping the surface rough through proper tillage minimizes the damage caused by wind erosion. Windbreaks made up of suitable trees and shrubs, such as Tatarian honeysuckle and eastern white pine, also help to control wind erosion.

Information about the design of erosion control practices for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is needed on about 28 percent of the acreage used for crops and pasture in the county. Some soils, such as the Okoboji, are naturally so wet that the production of the commonly grown crops generally is not possible. Most areas of these soils are drained, however, and are presently being cropped. Unless a drainage system is installed, the poorly drained soils are so wet that crops are damaged in most years. Examples are Biscay, Canisteo, Coland, Colo, Harps, and Webster soils.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of tile drainage and tile intakes is needed in most areas of the very poorly drained soils that are intensively row cropped. In some areas a surface drainage system also is needed. A tile drainage system generally is adequate in areas of the poorly drained soils. Drains should be more closely spaced in the slowly permeable soils than in the more rapidly permeable soils. Finding adequate outlets for tile drainage systems is difficult in many areas of Okoboji soils.

Information about the design of drainage systems for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is affected by reaction and by the content of plant nutrients. It is low in the subsoil of most of the soils in Dallas County. Most of the prairie soils, such as Canisteo, Clarion, Nicollet, and Webster, have a very low supply of available phosphorus and potassium. The forested soils, such as Clinton, Hayden, and Lindley, have a medium or high supply of available phosphorus and a very low supply of available potassium.

The inherent level of nitrogen available to plants is related to the content of organic matter. Prairie soils typically have a medium or high content of organic matter. The poorly drained and very poorly drained soils, such as Canisteo, Coland, Colo, Okoboji, and Webster, have a high or very high content of organic matter. Forested soils typically have a low content of organic matter.

The soils in the county typically range from strongly acid to moderately alkaline. The mildly alkaline to moderately alkaline soils, such as Canisteo, Harps, and Storden, have free carbonates in the surface layer. A high pH level or alkaline conditions reduce the level of available phosphorus and micronutrients. The forested soils and soils that formed in loess or Kansan till have a lower pH level than prairie soils. Applications of lime may be needed on these soils. Applications of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime needed.

Soil tilth is an important factor in germination and emergence of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

In most of the soils in the county, tilth is good. Management practices that maintain or increase the content of organic matter improve tilth and soil structure.

Tilth is poorer in the forested soils, such as Clinton and Hayden, than in the prairie soils. It also is poorer in silty soils. If the forested or silty soils are cultivated when wet, they tend to become very cloddy when dry. As a result, preparing a good seedbed is difficult. The formation of a crust reduces the infiltration rate and increases the runoff rate and the risk of erosion. Returning crop residue to the soil and regularly adding manure and other organic material improve the soil structure and help to prevent surface crusting.

Applications of herbicide may be needed to control weeds in the areas used for crops and pasture. The need for herbicides and the rate of application are affected by the organic matter content, the pH level, carbonates, and soil texture.

In the areas used for pasture, the most common species are bromegrass, bluegrass, reed canarygrass, orchardgrass, switchgrass, big bluestem, indiangrass, alfalfa, crownvetch, red clover, and ladino clover.

Forage production can be enhanced by management practices. The management needed on established stands includes applications of fertilizer, control of weeds and brush, rotation and deferred grazing in a full-season grazing system, proper stocking rates, and adequate livestock watering facilities. Erosion is a severe hazard if the protective plant cover is destroyed when the more sloping areas of pasture and hayland are renovated. If cultivated crops are grown prior to seeding, soil losses can be reduced by a system of conservation tillage that leaves crop residue on the surface, contour farming, and grassed waterways. Interseeding grasses and legumes into the existing sod eliminates the need for destroying the plant cover during seedbed preparation.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 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 woodland and for engineering purposes.

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

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

Class I soils have 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, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

woodland management and productivity

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on the soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

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

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

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To 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 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 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 9 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 9, 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 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

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

George A. Cox, wildlife biologist, Iowa Conservation Commission, helped prepare this section.

Dallas County provides habitat for many kinds of wildlife. These wildlife species enhance the economy, the opportunity for recreation, and esthetic values.

The riparian growth adjacent to the Raccoon River and its tributaries provides woodland habitat for white-tailed deer, squirrel, red fox, raccoon, coyote, opossum, and a wide variety of birds. The riparian areas commonly are extremely rough and irregular. They are hazardous to livestock and are unsuitable for crops. The undisturbed vegetation, however, provides excellent wildlife habitat. The rivers are the habitat of mink, beaver, muskrat, and other furbearers.

Because of the recent glaciation, the northern part of the county is generally level to gently rolling. It has many enclosed depressions. It is dominated by intensive cropping and livestock production. The number of upland wildlife species, such as ring-necked pheasant, bobwhite quail, meadowlark, songbirds, cottontail rabbit, and other mammals, is limited because of the intensive farming. During periods of snowmelt and spring rains, the closed depressions provide seasonal wetland habitat for numerous waterfowl and shore birds. Plover, killdeer, sandpipers, and herons are frequently observed in the spring. The more permanent marshes, of which only a few remain, provide limited nesting opportunity for mallard and blue-winged teal. The timberland adjacent to the rivers provides good nesting and brooding habitat for wood ducks.

In the southern part of the county, where the soils are steeper or more rolling, ring-necked pheasant and bobwhite quail are in greater numbers than in the northern part because of more timberland and brushy waterways. The wildlife population is higher because of the diverse habitats.

Many areas in the county are already suitable for wildlife habitat, but many more could be developed for wildlife. This development would increase the opportunities for recreation and the esthetic and economic benefits. Small, odd-shaped areas that have little value as farmland could be developed as habitat for wildlife. If properly managed, the soils of all capability classes support good wildlife habitat.

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

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

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

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

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

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

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

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

Coniferous plants furnish browse, 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, wildrice, cordgrass, rushes, sedges, and reeds.

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

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

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

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

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

engineering

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

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

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

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations 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 11 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 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

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

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

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

Table 12 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 12 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 wind erosion.

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 13 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 13, 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 or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

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

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

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

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

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

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

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, 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 a high content of calcium carbonate. 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 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.

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

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

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

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

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

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

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

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

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

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

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

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

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

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

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

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

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to 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 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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

soil and water features

Table 17 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 and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 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 is 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 17 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 17.

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.

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

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

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

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

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*21*). 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 18, 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 Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

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

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

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the 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* (*19*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*21*). 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."

Adair series

The Adair series consists of somewhat poorly drained, slowly permeable soils on convex side slopes in the uplands. The upper part of these soils formed in a thin layer of loess or pedisediments, and the underlying paleosol formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 9 to 18 percent.

The Adair soils in this county are a taxadjunct to the series because their dark surface layer is too thin to qualify as a mollic epipedon.

Adair soils are similar to Lamoni soils and are commonly adjacent to Lamoni, Sharpsburg, and Shelby soils. Lamoni soils do not have hue of 5YR or 7.5YR in the matrix of the upper part of the Bt horizon. They are upslope from the Adair soils. Sharpsburg soils formed in loess. They are upslope from the Adair soils. Shelby soils are downslope from the Adair soils. Also, their Bt horizon has a lower content of clay.

Typical pedon of Adair clay loam, in an area of Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded; 850 feet north and 400 feet east of the southwest corner of sec. 36, T. 78 N., R. 28 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) clay loam (28 percent clay), dark grayish brown (10YR 4/2) dry; mixed with some streaks and pockets of reddish brown (5YR 4/4) subsoil material; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—6 to 13 inches; reddish brown (5YR 4/4) clay loam (36 percent clay); many fine distinct yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; firm; thin discontinuous brown (7.5YR 4/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—13 to 20 inches; reddish brown (5YR 4/4) clay (45 percent clay); common fine distinct yellowish red (5YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very firm; thin continuous brown (7.5YR 4/2) clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—20 to 27 inches; brown (10YR 5/3) clay (45 percent clay); common fine distinct yellowish red (5YR 4/6) and few fine distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; very firm; thin continuous brown (7.5YR 4/2) clay films on faces of peds; slightly acid; diffuse smooth boundary.

Bt4—27 to 44 inches; grayish brown (10YR 5/2) clay (45 percent clay); many fine distinct yellowish brown (10YR 5/6) and few medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; very firm; thin continuous brown (7.5YR 4/2) clay films on faces of peds; few manganese concretions; slightly acid; diffuse smooth boundary.

Bt5—44 to 60 inches; mottled yellowish brown (10YR 5/4), light gray (5Y 6/1), and strong brown (7.5YR 5/8) clay loam (45 percent clay); weak medium prismatic structure; very firm; thin discontinuous brown (7.5YR 4/2) clay films on faces of peds; neutral.

The thickness of the solum ranges from 40 to 65 inches. The depth to free carbonates ranges from 48 to 72 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is clay loam, silty clay loam, loam, or silt loam. In some pedons a stone line is at the boundary of the A and Bt horizons. The content of clay in the Bt1 and Bt2 horizons is as high as 56 percent. These horizons have hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6. The Bt horizon has few to many mottles with hue of 10YR, 2.5Y, or 5YR, value of 4 or 5, and chroma of 3 to 6.

Armstrong series

The Armstrong series consists of somewhat poorly drained, slowly permeable soils on convex side slopes in the uplands. The upper part of these soils formed in a thin layer of loess or pedisediments, and the underlying paleosol formed in glacial till. The native vegetation was prairie grasses and trees. Slope ranges from 9 to 18 percent.

Armstrong soils are similar to Gara soils and are commonly adjacent to Clinton, Gara, and Ladoga soils. Gara soils have a lower content of clay than the Armstrong soils. They are in downslope areas. Clinton and Ladoga soils have a lower content of sand than the Armstrong soils. They are in upslope areas.

Typical pedon of Armstrong silt loam, in an area of Gara-Armstrong complex, 14 to 18 percent slopes; 1,740 feet south and 150 feet east of the northwest corner of sec. 31, T. 78 N., R. 27 W.

A—0 to 4 inches; very dark gray (10YR 3/1) silt loam, brown (10YR 5/3) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

E—4 to 8 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure; friable; medium acid; clear smooth boundary.

BE—8 to 12 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; friable; nearly continuous silt coatings on faces of peds, pale brown (10YR 6/3) dry; medium acid; clear smooth boundary.

2Bt1—12 to 17 inches; brown (7.5YR 4/4) clay loam; few fine distinct yellowish red (5YR 4/6) mottles; moderate fine angular blocky structure; firm; thin discontinuous clay films; strongly acid; clear smooth boundary.

2Bt2—17 to 26 inches; brown (7.5YR 4/4) clay; common medium distinct yellowish red (5YR 4/6) and common fine faint grayish brown (2.5Y 5/2) mottles; weak fine prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; strongly acid; gradual smooth boundary.

2Bt3—26 to 35 inches; yellowish red (5YR 4/6) clay loam; many fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure; firm; thin discontinuous clay films; strongly acid; gradual smooth boundary.

2Bt4—35 to 47 inches; strong brown (7.5R 5/6) clay loam; common fine distinct light brownish gray (10YR 6/2) mottles; weak medium prismatic structure; firm; thin discontinuous clay films; strongly acid; gradual smooth boundary.

2BC—47 to 60 inches; mottled light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) clay loam; some vertical cleavage; firm; strongly acid.

The thickness of the solum and the depth to free carbonates range from 42 to 80 inches.

The A horizon has hue of 10YR, value of 3, and chroma of 1 or 2. It is loam, silt loam, or silty clay loam. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. In some pedons a stone line is in the upper part of the solum. The upper and middle parts of 2Bt horizon have hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. They have few to many mottles with hue of 2.5Y to 5YR, value of 3 to 8, and chroma of 2 to 6.

Biscay series

The Biscay series consists of poorly drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. These soils are in drainageways on stream terraces. They formed in loamy alluvium underlain by sand and gravel at a depth of 20 to 40 inches. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Biscay soils are similar to Canisteo and Webster soils and are commonly adjacent to Cylinder soils. Canisteo and Webster soils are not underlain by sand and gravel. Cylinder soils are on slightly convex rises. They have higher chroma directly below the mollic epipedon than the Biscay soils.

Typical pedon of Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 200 feet north and 2,625 feet east of the southwest corner of sec. 1, T. 81 N., R. 28 W.

Ap—0 to 9 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A1—9 to 16 inches; black (10YR 2/1) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

A2—16 to 22 inches; very dark gray (10YR 3/1) clay loam, very dark gray (10YR 3/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak very fine subangular blocky; friable; neutral; clear smooth boundary.

Bg1—22 to 27 inches; dark gray (2.5Y 4/1) clay loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; firm; neutral; clear smooth boundary.

Bg2—27 to 32 inches; dark gray (2.5Y 4/1) clay loam; common fine distinct gray (5Y 5/1) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

2Cg1—32 to 35 inches; olive gray (5Y 5/2) sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; very weak medium subangular blocky structure; very friable; about 10 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg2—35 to 52 inches; olive gray (5Y 5/2) loamy coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 10 percent gravel; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg3—52 to 60 inches; olive gray (5Y 5/2) sand; few medium distinct yellowish brown (10YR 5/6) mottles; single grained; loose; about 10 percent gravel; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 32 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches.

The A horizon is neutral in hue or has hue of 10YR or 2.5Y. It has value of 2 or 3 and chroma of 1 or less. It is clay loam, silty clay loam, loam, or sandy clay loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, loam, or sandy clay loam. It is commonly neutral or mildly alkaline. In some pedons it contains free carbonates. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is mildly alkaline or moderately alkaline. It is sandy loam, loamy coarse sand, loamy sand, coarse sand, or sand. The content of gravel in this horizon ranges from 5 to 50 percent.

Canisteo series

The Canisteo series consists of poorly drained, moderately permeable, calcareous soils in drainageways on uplands. These soils formed in glacial till and glacial sediments. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Canisteo soils are similar to Biscay, Harps, and Webster soils and are commonly adjacent to Harps, Nicollet, and Okoboji soils. Biscay soils are underlain by sand and gravel. Harps soils have a calcic horizon. They are on the convex rims around depressions. The solum of Nicollet, Okoboji, and Webster soils is noncalcareous. Nicollet soils have higher chroma directly below the mollic epipedon than the Canisteo soils. They are on slightly convex rises. Okoboji soils are in depressions. Their A horizon is thicker than that of the Canisteo soils.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes; 605 feet east and 93 feet north of the southwest corner of sec. 23, T. 80 N., R. 28 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A1—8 to 18 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—18 to 22 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg1—22 to 27 inches; dark gray (10YR 4/1) clay loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg2—27 to 33 inches; olive gray (5Y 5/2) loam; discontinuous dark gray (10YR 4/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; very weak medium subangular blocky structure parting to weak fine subangular blocky; friable; strong effervescence; moderately alkaline; clear wavy boundary.

Cg1—33 to 49 inches; olive gray (5Y 5/2) loam; common medium prominent dark yellowish brown (10YR 4/6) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; few soft white accumulations of lime; moderately alkaline; gradual smooth boundary.

Cg2—49 to 60 inches; olive gray (5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/6) and yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches.

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

Clarion series

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

Clarion soils are similar to Lester and Wadena soils and are commonly adjacent to Dickinson, Nicollet, Storden, Terril, and Webster soils. Lester soils have an argillic horizon. Wadena soils are underlain by sand and gravel. Dickinson soils are in positions on the landscape similar to those of the Clarion soils. Their solum has a higher content of sand than that of the Clarion soils. Nicollet and Webster soils are lower on the landscape than the Clarion soils. Also, their subsoil has lower chroma. Storden soils are calcareous. They are in positions on the landscape similar to those of the Clarion soils. Terril soils are on foot slopes and are lower on the landscape than the Clarion soils. Also, their A horizon is thicker.

Typical pedon of Clarion loam, 2 to 5 percent slopes; 1,360 feet north and 1,320 feet east of the southwest corner of sec. 14, T. 80 N., R. 28 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A1—7 to 13 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

A2—13 to 18 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; firm; neutral; clear smooth boundary.

Bw1—18 to 24 inches; brown (10YR 4/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw2—24 to 32 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—32 to 37 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; mildly alkaline; abrupt wavy boundary.

C—37 to 60 inches; mottled yellowish brown (10YR 5/4) and grayish brown (2.5Y 5/2) loam; massive; friable; few manganese concretions; many soft white accumulations of lime; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is loam, but the range includes sandy loam, silt loam, and clay loam. The Bw horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is loam or clay loam. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 to 6. It is commonly loam, but the range includes sandy loam that has a maximum sand content of 60 percent.

Clarion loam, 5 to 9 percent slopes, moderately eroded; Clarion loam, 9 to 14 percent slopes, moderately eroded; Clarion loam, 5 to 9 percent long slopes, moderately eroded; and the Clarion soils in the map units Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded, and Clarion-Storden loams, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the Clarion series because their dark surface soil is too thin to qualify as a mollic epipedon.

Clinton series

The Clinton series consists of moderately well drained, moderately slowly permeable soils on convex side slopes in the uplands. These soils formed in loess. The native vegetation was trees. Slope ranges from 2 to 14 percent.

Clinton soils are similar to Ladoga soils and are commonly adjacent to Lindley and Vanmeter soils. Ladoga soils have an E horizon that is less distinct than that of the Clinton soils. Also, their A horizon is thicker. Lindley and Vanmeter soils are lower on the landscape than the Clinton soils. Also, Lindley soils have a higher content of sand. Vanmeter soils formed in residuum of clayey shale.

Typical pedon of Clinton silt loam, 2 to 5 percent slopes; 1,620 feet west and 260 feet north of the southeast corner of sec. 12, T. 78 N., R. 29 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam (24 percent clay), pale brown (10YR 6/3) dry; moderate thin platy structure; very friable; slightly acid; clear smooth boundary.

E—8 to 11 inches; dark grayish brown (10YR 4/2) silt loam (24 percent clay), pale brown (10YR 6/3) dry; few fine faint brown (10YR 4/3) mottles; moderate thin platy structure; friable; very pale brown (10YR 7/3) uncoated silt grains; slightly acid; clear smooth boundary.

BE—11 to 14 inches; dark yellowish brown (10YR 4/4) silty clay loam (33 percent clay); moderate fine subangular blocky structure parting to moderate very fine subangular blocky; friable; white (10YR 8/2) uncoated silt grains; slightly acid; clear smooth boundary.

Bt1—14 to 20 inches; brown (10YR 4/3) silty clay loam (36 percent clay); weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; white (10YR 8/2) uncoated silt grains; medium acid; clear smooth boundary.

Bt2—20 to 24 inches; dark yellowish brown (10YR 4/4) silty clay loam (38 percent clay); weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin continuous dark brown (10YR 3/3) clay films on faces of peds; few manganese concretions; medium acid; clear smooth boundary.

Bt3—24 to 36 inches; brown (10YR 4/3) silty clay loam (36 percent clay); few fine distinct light brownish gray (10YR 6/2) and few fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; few manganese concretions; strongly acid; gradual smooth boundary.

Bt4—36 to 48 inches; mottled grayish brown (2.5Y 5/2), light olive brown (2.5Y 5/4), and yellowish brown (10YR 5/6) silty clay loam (36 percent clay); moderate medium prismatic structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; common manganese concretions; very dark gray (10YR 3/1) root pores; strongly acid; gradual smooth boundary.

Bt5—48 to 60 inches; mottled grayish brown (2.5Y 5/2), light olive brown (2.5Y 5/4), and yellowish brown (10YR 5/6) silty clay loam (32 percent clay); moderate medium prismatic structure; firm; discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; common manganese concretions; slightly acid.

The thickness of the solum ranges from 42 to 84 inches. In uneroded areas the A horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. In eroded areas the Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The A horizon is silt loam in uneroded areas and silt loam or silty clay loam in eroded areas. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. In eroded areas it is mixed with the Ap horizon. The upper part of the Bt horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. Its content of clay is 36 to 42 percent.

Coland series

The Coland series consists of poorly drained, moderately permeable soils on bottom land and in upland drainageways. These soils formed in loamy alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Coland soils are similar to Colo and Okoboji soils and are commonly adjacent to Hanlon and Spillville soils. The content of sand in the control section of Colo soils averages less than 15 percent. The solum of Okoboji soils contains more clay than that of the Coland soils. Hanlon and Spillville soils contain more sand and less clay in the control section than the Coland soils. They are in positions on the landscape similar to those of the Coland soils. Hanlon soils are moderately well drained, and Spillville soils are somewhat poorly drained.

Typical pedon of Coland clay loam, 0 to 2 percent slopes; 1,640 feet west and 625 feet north of the southeast corner of sec. 36, T. 81 N., R. 29 W.

Ap—0 to 8 inches; black (N 2/0) clay loam (32 percent clay), very dark gray (10YR 3/1) dry; moderate medium granular structure; friable; neutral; clear smooth boundary.

A1—8 to 13 inches; black (N 2/0) clay loam (32 percent clay), black (10YR 2/1) dry; weak fine subangular blocky structure parting to moderate medium granular; friable; neutral; gradual smooth boundary.

A2—13 to 21 inches; black (N 2/0) clay loam (32 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—21 to 30 inches; black (10YR 2/1) clay loam (34 percent clay), very dark gray (10YR 3/1) dry; continuous black (N 2/0) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A4—30 to 36 inches; very dark gray (10YR 3/1) clay loam (34 percent clay), dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—36 to 44 inches; dark gray (5Y 4/1) clay loam (34 percent clay); discontinuous very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct grayish brown (2.5Y 5/2) and common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Cg1—44 to 52 inches; grayish brown (2.5Y 5/2) sandy clay loam (28 percent clay); common medium prominent strong brown (7.5YR 5/8) and few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

Cg2—52 to 60 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) sandy clay loam (24 percent clay); common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; very slight effervescence; moderately alkaline.

The thickness of the solum ranges from 36 to 48 inches. The depth to free carbonates is more than 48 inches. The mollic epipedon is 36 or more inches thick.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It is clay loam or silty clay loam. The Bg horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 2 to 4 and chroma of 1 or less. The Cg horizon is neutral in hue or has hue of 2.5Y or 5Y. It has value of 2 to 6 and chroma of 2 or less. It is dominantly sandy clay loam, loam, or clay loam. In some pedons, however, contrasting sandy or gravelly material is below a depth of 4 feet.

Colo series

The Colo series consists of poorly drained, moderately permeable soils on bottom land and in upland drainageways. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Colo soils are similar to Coland and Okoboji soils and are commonly adjacent to Ely, Judson, and Nodaway soils. Coland soils have more sand in the control section than the Colo soils. The B horizon of Okoboji soils has a higher content of clay than that of the Colo soils. Ely soils have a dark grayish brown B horizon. They are on foot slopes. Judson soils have higher chroma below the A horizon than the Colo soils. They are on foot slopes. Nodaway soils are lighter colored and less clayey than the Colo soils. They are finely stratified. They are in positions on the landscape similar to those of the Colo soils.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes; 400 feet west and 250 feet south of the northeast corner of sec. 35, T. 78 N., R. 29 W.

A1—0 to 9 inches; black (10YR 2/1) silty clay loam (32 percent clay), dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; diffuse smooth boundary.

A2—9 to 24 inches; black (10YR 2/1) silty clay loam (32 percent clay), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

A3—24 to 34 inches; black (10YR 2/1) silty clay loam (34 percent clay), gray (10YR 5/1) dry; weak fine prismatic structure parting to weak fine subangular blocky; firm; neutral; diffuse smooth boundary.

Bw—34 to 48 inches; very dark gray (10YR 3/1) silty clay loam (36 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; neutral; diffuse smooth boundary.

Cg—48 to 60 inches; dark gray (10YR 4/1) silty clay loam (32 percent clay); many fine distinct grayish brown (10YR 5/2) and common fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; neutral.

The thickness of the solum ranges from 36 to 54 inches. The depth to free carbonates is more than 60 inches. The mollic epipedon is 36 or more inches thick.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or less. It is silty clay loam or silt loam. The Bw horizon is neutral in hue or has hue of 2.5Y or 10YR. It has value of 2 to 4 and chroma of 1 or less. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 or 4, and chroma of 1 or less. It typically is silty clay loam but in some pedons is sandy or gravelly below a depth of 48 inches.

Cylinder series

The Cylinder series consists of somewhat poorly drained soils that are moderately permeable in the upper part and very rapidly permeable in the lower part. These soils are on low rises on stream terraces. They formed in loamy alluvium underlain by sand and gravel at a depth of 32 to 40 inches. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Cylinder soils are similar to Nicollet soils and are commonly adjacent to Biscay and Wadena soils. Nicollet soils contain less sand throughout than the Cylinder soils. They have a fine-loamy control section. Biscay soils have lower chroma below the mollic epipedon than the Cylinder soils. They are in drainageways. Wadena soils are in the slightly higher lying areas on the stream terraces. Their B horizon is browner than that of the Cylinder soils.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 2,580 feet south and 60 feet west of the center of sec. 6, T. 81 N., R. 28 W.

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

A—8 to 18 inches; very dark brown (10YR 2/2) loam, very dark gray (10YR 3/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

AB—18 to 23 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—23 to 30 inches; dark grayish brown (2.5Y 4/2) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw2—30 to 35 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; few pebbles; neutral; clear smooth boundary.

2BC—35 to 39 inches; dark grayish brown (2.5Y 4/2) sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; very weak fine subangular blocky structure; very friable; about 15 percent pebbles; neutral; clear smooth boundary.

2C1—39 to 50 inches; brown (10YR 4/3) gravelly coarse sand; single grained; loose; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—50 to 60 inches; brown (10YR 5/3) gravelly coarse sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 48 inches. The depth to sand and gravel ranges from 32 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam. The Bw1 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is loam or clay loam. The Bw2 horizon has few or common mottles with hue of 10YR or 2.5Y and value and chroma of 4 to 6. The 2BC horizon ranges from loam to gravelly sand. The 2C horizon is sand or gravelly coarse sand. The content of gravel in this horizon is 5 to 50 percent.

Dickinson series

The Dickinson series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils are on convex side slopes on stream terraces and uplands. They formed in loamy sediments and eolian sand. The native vegetation was prairie grasses. Slope ranges from 1 to 9 percent.

Dickinson soils are similar to Ridgeport and Zenor soils and are commonly adjacent to Clarion soils. The solum and the C horizon of the similar soils contain more gravel than those of the Dickinson soils. Clarion soils have a fine-loamy control section. They are higher on the landscape than the Dickinson soils.

Typical pedon of Dickinson fine sandy loam, 1 to 5 percent slopes; 1,300 feet west and 350 feet north of the center of sec. 20, T. 79 N., R. 27 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; neutral; clear smooth boundary.

A—7 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak medium granular structure; very friable; slightly acid; gradual smooth boundary.

Bw1—15 to 25 inches; brown (10YR 4/3) fine sandy loam; weak fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

Bw2—25 to 36 inches; dark yellowish brown (10YR 4/4) loamy sand; single grained; loose; slightly acid; gradual smooth boundary.

BC—36 to 42 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; slightly acid; gradual smooth boundary.

C—42 to 60 inches; yellowish brown (10YR 5/6) sand; single grained; loose; neutral.

The thickness of the solum ranges from 24 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is fine sandy loam or sandy loam. The Bw horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is fine sandy loam or sandy loam in the upper part and grades to loamy sand or loamy fine sand in the lower part. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6.

Ely series

The Ely series consists of somewhat poorly drained, moderately permeable soils on concave foot slopes. These soils formed in silty local alluvium and colluvium. The native vegetation was prairie grasses. Slope ranges from 2 to 5 percent.

Ely soils are similar to Judson soils and are commonly adjacent to Colo and Sharpsburg soils. The B horizon of Judson soils is browner than that of the Ely soils. Colo soils are lower on the landscape than the Ely soils. Also, their A horizon is thicker. Sharpsburg soils are higher on the landscape than the Ely soils. Also, their subsoil has higher chroma.

Typical pedon of Ely silty clay loam, in an area of Colo-Ely silty clay loams, 2 to 5 percent slopes; 1,740 feet west and 1,190 feet south of the northeast corner of sec. 23, T. 78 N., R. 27 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (32 percent clay), very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A—8 to 19 inches; black (10YR 2/1) silty clay loam (32 percent clay), black (10YR 2/1) dry; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—19 to 27 inches; very dark gray (10YR 3/1) silty clay loam (34 percent clay), dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1—27 to 43 inches; dark grayish brown (10YR 4/2) silty clay loam (34 percent clay); common fine distinct strong brown (7.5YR 5/6) mottles; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—43 to 52 inches; dark grayish brown (10YR 4/2) silty clay loam (34 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate medium subangular blocky; friable; discontinuous very dark gray (10YR 3/1) pores; friable; neutral; clear smooth boundary.

BC—52 to 60 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam (32 percent clay); weak fine prismatic structure parting to weak medium subangular blocky; friable; very dark gray (N 3/0) root pores; neutral.

The thickness of the solum ranges from 40 to 66 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It ranges from silt loam to silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. Mottles with hue of 7.5Y or 10YR, value of 4 or 5, and chroma of 3 to 8 are throughout the Bw and BC horizons.

Gara series

The Gara series consists of moderately well drained, moderately slowly permeable soils on convex interfluves and dissected side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses and trees. Slope ranges from 9 to 25 percent.

Gara soils are similar to Armstrong and Lindley soils and are commonly adjacent to Armstrong and Ladoga soils. Armstrong soils are higher on the landscape than the Gara soils. Also, their B horizon contains more clay. Lindley soils have a distinct E horizon. Their A horizon is thinner than that of the Gara soils. Ladoga soils contain less sand throughout than the Gara soils. They are in upslope areas.

Typical pedon of Gara loam, 18 to 25 percent slopes; 620 feet south and 130 feet east of the northwest corner of sec. 36, T. 78 N., R. 28 W.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; medium acid; clear smooth boundary.

E—6 to 10 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak medium platy structure parting to weak fine granular; very friable; medium acid; clear smooth boundary.

Bt1—10 to 14 inches; brown (10YR 4/3) clay loam; weak very fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; light gray (10YR 7/2) uncoated silt grains; medium acid; clear smooth boundary.

Bt2—14 to 20 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; thin continuous brown (10YR 4/3) clay films on faces of peds; strongly acid; clear smooth boundary.

Bt3—20 to 27 inches; yellowish brown (10YR 5/6) clay loam; moderate fine subangular blocky structure; firm; thin continuous dark brown (10YR 3/3) clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt4—27 to 43 inches; mottled yellowish brown (10YR 5/6), light olive brown (2.5Y 5/4), and light gray (5Y 6/1) clay loam; moderate medium subangular blocky structure; firm; thin discontinuous brown (10YR 4/3) clay films on faces of peds; strongly acid; clear wavy boundary.

C—43 to 60 inches; mottled light olive brown (2.5Y 5/4), yellowish brown (10YR 5/8), and light gray (5Y 6/1) clay loam; weak medium prismatic structure; firm; strong effervescence; few soft white accumulations of lime; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 36 to 60 inches. The thickness of the A horizon ranges from 6 to 10 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or silt loam. The Bt2 and Bt3 horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. The content of clay in these horizons ranges from 32 to 35 percent. The C horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 to 8.

Hanlon series

The Hanlon series consists of moderately well drained, moderately rapidly permeable soils on natural levees near stream channels on bottom land. These soils formed in loamy alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Hanlon soils are similar to Spillville soils and are commonly adjacent to Coland and Spillville soils. Spillville soils are fine-loamy. They are higher on the landscape than the Hanlon soils. Coland soils are in drainageways. Their solum contains more clay than that of the Hanlon soils.

Typical pedon of Hanlon fine sandy loam, 0 to 2 percent slopes; 1,220 feet west and 975 feet south of the northeast corner of sec. 16, T. 81 N., R. 29 W.

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

A1—9 to 18 inches; very dark brown (10YR 2/2) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—18 to 30 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—30 to 45 inches; very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; very friable; neutral; gradual wavy boundary.

C—45 to 60 inches; dark grayish brown (10YR 4/2) sandy loam; massive; friable; mildly alkaline.

The thickness of the solum ranges from 40 to 72 inches. The thickness of the mollic epipedon ranges from 40 to 70 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is fine sandy loam or sandy loam. The Bw horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It ranges from loamy sand to loam.

Harps series

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

Harps soils are similar to Canisteo soils and are commonly adjacent to Canisteo and Okoboji soils. Canisteo soils are in drainageways. The calcium carbonate equivalent is less than 15 percent in these soils. Okoboji soils are cumulic and noncalcareous. They are in closed depressions.

Typical pedon of Harps loam, 0 to 2 percent slopes; 650 feet south and 800 feet west of the northeast corner of sec. 29, T. 81 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; few small snail shells; violent effervescence; moderately alkaline; clear smooth boundary.

Ak—8 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; few small snail shells; violent effervescence; moderately alkaline; clear smooth boundary.

ABk—14 to 20 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; few small snail shells; violent effervescence; moderately alkaline; clear smooth boundary.

Bgk—20 to 24 inches; dark gray (5Y 4/1) and gray (5Y 5/1) loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak medium prismatic structure parting to weak fine subangular blocky; friable; few soft white accumulations of lime; violent effervescence; moderately alkaline; clear smooth boundary.

Bg—24 to 33 inches; olive gray (5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few iron concretions; violent effervescence; moderately alkaline; gradual smooth boundary.

Cg1—33 to 43 inches; olive gray (5Y 5/2) and olive (5Y 5/3) loam; few fine prominent yellowish brown (10YR 5/8) and common fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; few small iron concretions; violent effervescence; moderately alkaline; clear smooth boundary.

Cg2—43 to 60 inches; olive gray (5Y 5/2) loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few small iron concretions; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 21 inches.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It typically is loam or clay loam. The calcium carbonate equivalent in the upper 6 to 18 inches ranges from 15 to 40 percent. The Bg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 or 2. It is loam, clay loam, or sandy clay loam. The content of clay in the C horizon is 18 to 24 percent. This horizon has colors similar to those of the Bg horizon. It has few and common, distinct and prominent mottles with hue of 7.5YR, 10YR, or 2.5Y, value of 4 or 5, and chroma of 4 to 8.

Hayden series

The Hayden series consists of well drained, moderately permeable soils on convex side slopes and ridgetops in the uplands. These soils formed in glacial till. The native vegetation was trees. Slope ranges from 2 to 50 percent.

Hayden soils are similar to Lester soils and are commonly adjacent to Le Sueur, Moingona, and Storden soils. Lester and Le Sueur soils have a weak E horizon, if one occurs. Their A horizon is thicker and darker than that of the Hayden soils. Also, Le Sueur soils have lower chroma in the B horizon. They are nearly level and are on ridgetops. Moingona soils are on foot slopes. They are lower on the landscape than the Hayden soils. Also, their A horizon is thicker. Storden soils are calcareous. They are in positions on the landscape similar to those of the Hayden soils.

Typical pedon of Hayden loam, 2 to 5 percent slopes; 1,840 feet west and 495 feet south of the northeast corner of sec. 31, T. 80 N., R. 27 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; medium acid; gradual smooth boundary.

E—8 to 11 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium platy structure parting to very weak fine subangular blocky; friable; brown (10YR 5/3) and light gray (10YR 7/2) uncoated silt grains; medium acid; clear smooth boundary.

Bt1—11 to 17 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; pale brown (10YR 6/3) uncoated silt grains; medium acid; gradual smooth boundary.

Bt2—17 to 23 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3—23 to 34 inches; yellowish brown (10YR 5/4) clay loam; many fine distinct strong brown (7.5YR 5/6) and few fine faint grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; firm; thin continuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; clear smooth boundary.

Bt4—34 to 38 inches; yellowish brown (10YR 5/4) clay loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; slightly acid; abrupt wavy boundary.

C—38 to 60 inches; yellowish brown (10YR 5/6) loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 54 inches. The A or Ap horizon is loam, sandy loam, or fine sandy loam. The A horizon, if it occurs, has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The Ap horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. The Bt2 and Bt3 horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 5. They typically are clay loam or loam but in some pedons are sandy clay loam, sandy loam, or fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 to 6. It is loam, fine sandy loam, or sandy loam.

Judson series

The Judson series consists of moderately well drained, moderately permeable soils on convex foot slopes and alluvial fans. These soils formed in silty local alluvium and colluvium. The native vegetation was prairie grasses. Slope ranges from 2 to 5 percent.

Judson soils are similar to Ely soils and are commonly adjacent to Colo, Nodaway, and Sharpsburg soils. Ely soils have grayer matrix colors directly below the mollic epipedon than the Judson soils. Colo soils are in downslope areas. They have lower chroma directly below the mollic epipedon than the Judson soils. Also, their A horizon is thicker. Nodaway soils are stratified. They are on bottom land. Sharpsburg soils are noncumulic. They are upslope from the Judson soils.

Typical pedon of Judson silty clay loam, 2 to 5 percent slopes; 2,250 feet south and 125 feet east of the northwest corner of sec. 23, T. 78 N., R. 27 W.

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

A1—9 to 15 inches; very dark brown (10YR 2/2) silty clay loam, very dark gray (10YR 3/1) dry; thin discontinuous black (10YR 2/1) coatings on faces of peds; weak fine granular structure; friable; neutral; gradual smooth boundary.

A2—15 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; thin discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—24 to 32 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; thin discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—32 to 48 inches; brown (10YR 4/3) silty clay loam; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—48 to 60 inches; brown (10YR 4/3) silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; neutral.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The Bw horizon has hue of 10YR and value and chroma of 3 or 4. The content of clay in the B horizon ranges from 30 to 35 percent.

Ladoga series

The Ladoga series consists of moderately well drained, moderately slowly permeable soils on convex side slopes and ridgetops in the uplands. These soils formed in loess. The native vegetation was prairie grasses and trees. Slope ranges from 2 to 14 percent.

Ladoga soils are similar to Clinton soils and are commonly adjacent to Armstrong, Gara, and Vanmeter soils. Clinton soils are lighter colored than the Ladoga soils. Also, their A horizon is thinner. Armstrong and Gara soils have a higher content of sand than the Ladoga soils. They are in downslope areas. Vanmeter soils formed in residuum of clayey shale. They are on side slopes below the Ladoga soils.

Typical pedon of Ladoga silt loam, 2 to 5 percent slopes; 1,220 feet east of the center of sec. 10, T. 78 N., R. 29 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam (25 percent clay), grayish brown (10YR 5/2) dry; cloddy; friable; neutral; clear smooth boundary.

E—8 to 12 inches; dark grayish brown (10YR 4/2) silt loam (23 percent clay), light brownish gray (10YR 6/2) dry; weak medium platy structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

Bt1—12 to 16 inches; brown (10YR 4/3) silty clay loam (28 percent clay); weak fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; light brownish gray (10YR 6/2) uncoated silt grains; slightly acid; clear smooth boundary.

Bt2—16 to 24 inches; dark yellowish brown (10YR 4/4) silty clay loam (34 percent clay); moderate fine subangular blocky structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; light brownish gray (10YR 6/2) uncoated silt grains; medium acid; clear smooth boundary.

Bt3—24 to 36 inches; brown (10YR 4/3) silty clay loam (38 percent clay); common fine faint grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt4—36 to 48 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam (38 percent clay); weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; few manganese concretions; slightly acid; gradual smooth boundary.

BC—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam (32 percent clay); many fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; slightly acid.

The thickness of the solum ranges from 36 to 72 inches. The A or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. The Bt2 and Bt3 horizons have hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The content of clay in the Bt horizon ranges from 36 to 42 percent.

Lamoni series

The Lamoni series consists of somewhat poorly drained, slowly permeable soils on convex side slopes in the uplands. These soils formed in a paleosol which was formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

The Lamoni soils in this county are a taxadjunct to the series because their dark surface layer is too thin to qualify as a mollic epipedon.

Lamoni soils are similar to Adair soils and are commonly adjacent to Adair and Shelby soils. Adair soils are lower on the landscape than the Lamoni soils. Also, their Bt horizon has redder hue. Shelby soils have higher chroma in the upper part of the B horizon than the Lamoni soils. They are fine-loamy. They are in positions on the landscape similar to those of the Lamoni soils.

Typical pedon of Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded; 2,440 feet east and 250 feet north of the southwest corner of sec. 21, T. 78 N., R. 29 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam (32 percent clay), very dark grayish brown (10YR 3/2) dry; mixed with some streaks and pockets of dark grayish brown (10YR 4/2) subsoil material; weak fine subangular blocky structure; friable; strongly acid; abrupt smooth boundary.

2Bt1—7 to 14 inches; dark grayish brown (10YR 4/2) clay loam (38 percent clay); discontinuous very dark gray (10YR 3/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; clear smooth boundary.

2Bt2—14 to 23 inches; dark grayish brown (2.5Y 4/2) clay (42 percent clay); few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very firm; thin discontinuous very dark grayish brown (2.5Y 3/2) clay films on faces of peds; slightly acid; clear smooth boundary.

2Bt3—23 to 35 inches; grayish brown (2.5Y 5/2) clay loam (38 percent clay); few fine distinct gray (10YR 5/1) and common medium distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; very firm; thin discontinuous dark grayish brown (2.5Y 4/2) clay films on faces of peds; few manganese concretions; neutral; gradual smooth boundary.

2BC—35 to 48 inches; grayish brown (2.5Y 5/2) clay loam (36 percent clay); many coarse prominent strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; firm; thin discontinuous dark grayish brown (2.5Y 4/2) clay films on faces of peds; few pebbles; few manganese concretions; neutral; gradual smooth boundary.

2C—48 to 60 inches; grayish brown (2.5Y 5/2) clay loam (32 percent clay); common medium prominent strong brown (7.5YR 5/8) mottles; massive; firm; few pebbles; few manganese concretions; neutral.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the dark surface soil ranges from 7 to 10 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is clay loam, loam, silt loam, or silty clay loam. The B horizon has hue of 10YR, 2.5Y, or 5Y. It has value of 4 in the upper part and value of 5 or 6 in the lower part. It has chroma of 2 in the upper part and chroma of 1 to 6 in the lower part. The content of clay in this horizon ranges from 32 to 45 percent.

Le Sueur series

The Le Sueur series consists of somewhat poorly drained, moderately permeable soils on rises and low ridges in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses and trees. Slope ranges from 0 to 2 percent.

The Le Sueur soils in this county are a taxadjunct to the series because their dark surface layer is too thin to qualify as a mollic epipedon. Also, their E horizon is more than 3 inches thick, and the C horizon has hue of 10YR.

Le Sueur soils are similar to Nicollet soils and are commonly adjacent to Hayden and Lester soils. Nicollet soils do not have an argillic horizon. Hayden and Lester soils have higher chroma directly below the mollic epipedon than the Le Sueur soils. They are in upslope areas.

Typical pedon of Le Sueur loam, 0 to 2 percent slopes; 300 feet south and 100 feet east of the center of sec. 2, T. 81 N., R. 26 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

E—8 to 14 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

Bt1—14 to 20 inches; brown (10YR 4/3) clay loam; light gray (10YR 7/1) silt coatings on faces of peds; moderate fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—20 to 28 inches; dark grayish brown (10YR 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt3—28 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; gradual smooth boundary.

BC—36 to 48 inches; grayish brown (2.5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; friable; thin discontinuous dark gray (10YR 4/1) clay films on faces of peds; slightly acid; clear wavy boundary.

C—48 to 60 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) loam; massive; friable; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 60 inches. The thickness of the dark surface layer ranges from 7 to 10 inches.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR, value of 4 or 5, and chroma of 2 or 3. It is silt loam or loam. The Bt2 and Bt3 horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 8. They are clay loam or loam. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 8.

Lester series

The Lester series consists of well drained, moderately permeable soils on convex side slopes and ridgetops in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses and trees. Slope ranges from 2 to 9 percent.

Lester soils are similar to Clarion and Hayden soils and are commonly adjacent to Le Sueur soils. Clarion soils have a mollic epipedon and do not have an argillic horizon. Hayden soils have a prominent E horizon. Their A horizon is thinner than that of Lester soils. The nearly level Le Sueur soils have lower chroma in the Bt horizon than the Lester soils.

Typical pedon of Lester loam, 2 to 5 percent long slopes; 500 feet west and 50 feet south of the center of sec. 15, T. 81 N., R. 26 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—8 to 15 inches; brown (10YR 4/3) clay loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; thin discontinuous very dark brown (10YR 2/2) clay films on faces of peds; grayish brown (10YR 5/2) uncoated silt grains; slightly acid; clear smooth boundary.

Bt2—15 to 21 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; friable; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; slightly acid; clear smooth boundary.

Bt3—21 to 27 inches; brown (10YR 4/3) clay loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; thin continuous dark grayish brown (10YR 4/2) clay films on faces of peds; slightly acid; gradual smooth boundary.

BC—27 to 31 inches; light olive brown (2.5Y 5/4) loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; thin discontinuous clay films on faces of peds; neutral; clear wavy boundary.

C1—31 to 46 inches; light olive brown (2.5Y 5/4) loam; common fine distinct yellowish brown (10YR 5/6) and common fine distinct light olive gray (5Y 6/2) mottles; massive; friable; strong effervescence; moderately alkaline; diffuse smooth boundary.

C2—46 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct yellowish brown (10YR 5/6) and common fine distinct light olive gray (5Y 6/2) mottles; massive; friable; strong effervescence; few soft white accumulations of lime; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 54 inches. The A or Ap horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is loam or clay loam, but the range includes sandy loam and silt loam. The Bt2 and Bt3 horizons have hue of 10YR, value of 4 or 5, and chroma of 3 or 4. They are clay loam or loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 6.

Lindley series

The Lindley series consists of well drained, moderately slowly permeable soils on convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was trees. Slope ranges from 18 to 40 percent.

Lindley soils are similar to Gara soils and are commonly adjacent to Clinton soils. Clinton soils are fine textured. They are upslope from the Lindley soils. Gara soils have a weak E horizon. Their A horizon is thicker than that of the Lindley soils.

Typical pedon of Lindley silt loam, 18 to 40 percent slopes; 1,640 feet north and 370 feet west of the southeast corner of sec. 12, T. 78 N., R. 29 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; very friable; slightly acid; abrupt smooth boundary.
E1—3 to 6 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak thin platy structure; very friable; strongly acid; clear smooth boundary.
E2—6 to 10 inches; dark yellowish brown (10YR 4/4) silt loam, pale brown (10YR 6/3) dry; weak thick platy structure parting to weak fine subangular blocky; very friable; white (10YR 8/1) uncoated silt grains; strongly acid; clear smooth boundary.
BE—10 to 13 inches; yellowish brown (10YR 5/4) loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; friable; very pale brown (10YR 7/3) uncoated silt grains; strongly acid; clear smooth boundary.
Bt1—13 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; firm; thin continuous brown (10YR 4/3) clay films on faces of peds; strongly acid; clear smooth boundary.
Bt2—18 to 27 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct strong brown (7.5YR 5/8) and few fine faint grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; thin continuous brown (10YR 4/3) clay films on faces of peds; strongly acid; gradual smooth boundary.
Bt3—27 to 43 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct grayish brown (2.5Y 5/2) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; very firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films on faces of peds; few manganese concretions; strongly acid; diffuse smooth boundary.
BC—43 to 50 inches; yellowish brown (10YR 5/6) clay loam; many medium prominent light brownish gray (10YR 6/2) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; firm; strongly acid; diffuse smooth boundary.
C—50 to 60 inches; yellowish brown (10YR 5/6) clay loam; many medium distinct light brownish gray (10YR 6/2) mottles; massive; firm; slightly acid.

The thickness of the solum ranges from 30 to 50 inches. The A horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. The E horizon has hue of 10YR, value of 4 to 6, and chroma of 2 to 4. It is silt loam, loam, or clay loam. The Bt1 and Bt2 horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. They are clay loam or loam. They are strongly acid to slightly acid.

Macksburg series

The Macksburg series consists of somewhat poorly drained, moderately slowly permeable soils on wide ridgetops in the uplands. These soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Macksburg soils are similar to Nevin soils and are commonly adjacent to Sharpsburg soils. Nevin soils are fine-silty. Sharpsburg soils have higher chroma in the subsoil than the Macksburg soils. Also, they are on the steeper slopes.

Typical pedon of Macksburg silty clay loam, 0 to 2 percent slopes; 790 feet east and 380 feet south of the northwest corner of sec. 34, T. 78 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam (30 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
A—8 to 19 inches; black (10YR 2/1) silty clay loam (32 percent clay), very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.
AB—19 to 23 inches; very dark grayish brown (10YR 3/2) silty clay loam (36 percent clay), dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.
Bt1—23 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam (38 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; friable; thin discontinuous very dark gray (10YR 3/1) clay films on faces of peds; medium acid; gradual smooth boundary.
Bt2—32 to 43 inches; dark grayish brown (2.5Y 4/2) silty clay loam (36 percent clay); few fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous very dark grayish brown (2.5Y 3/2) clay films on faces of peds; few manganese concretions; medium acid; clear smooth boundary.
Bt3—43 to 49 inches; mottled grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/8) silty clay loam (34 percent clay); weak medium prismatic structure; friable; thin discontinuous dark grayish brown (2.5Y 4/2) clay films on faces of peds; slightly acid; clear smooth boundary.
BC—49 to 60 inches; olive gray (5Y 5/2) and olive (5Y 5/3) silty clay loam (32 percent clay); few medium prominent strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; friable; thin discontinuous dark grayish brown (2.5Y 4/2) clay films on faces of peds; neutral.

The thickness of the solum ranges from 48 to 72 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silty clay loam that has a content of clay ranging from 28 to 34 percent. The Bt1 and Bt2 horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. They are silty clay loam or silty clay. The content of clay in these horizons ranges from 36 to 42 percent.

Moingona series

The Moingona series consists of moderately well drained, moderately permeable soils on alluvial fans and foot slopes. These soils formed in loamy local alluvium and colluvium. The native vegetation was prairie grasses and trees. Slope ranges from 2 to 6 percent.

Moingona soils are similar to Shelby soils and are commonly adjacent to Hayden soils. Shelby soils have a higher content of coarse fragments than the Moingona soils. Hayden soils have an E horizon. They are upslope from the Moingona soils.

Typical pedon of Moingona loam, 2 to 6 percent slopes; 900 feet north and 400 feet west of the center of sec. 31, T. 80 N., R. 27 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A—8 to 18 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 5/3) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bt1—18 to 25 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; light brownish gray (10YR 6/2) uncoated silt grains; neutral; gradual smooth boundary.

Bt2—25 to 34 inches; brown (10YR 4/3) clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; neutral; gradual smooth boundary.

Bt3—34 to 47 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; few iron concretions; neutral; gradual smooth boundary.

BC—47 to 60 inches; light olive brown (2.5Y 5/4) clay loam; some vertical cleavage; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; neutral.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The Ap or A horizon has hue of 10YR and value and chroma of 2 or 3. It is sandy loam, loam, or clay loam. The Bt2 and Bt3 horizons have hue of 10YR, value of 4 or 5, and chroma of 3 or 4. They are loam, sandy clay loam, or clay loam.

Nevin series

The Nevin series consists of somewhat poorly drained, moderately permeable soils on low stream terraces or second bottoms. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Nevin soils are similar to Macksburg soils and are commonly adjacent to Wiota soils. Macksburg soils have a higher content of clay in the B horizon than the Nevin soils. Wiota soils have higher chroma in the B horizon than the Nevin soils. Also, they are higher on the landscape.

Typical pedon of Nevin silty clay loam, 0 to 2 percent slopes; 1,650 feet south and 800 feet west of the northeast corner of sec. 25, T. 78 N., R. 26 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A1—8 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A2—18 to 24 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

BA—24 to 31 inches; dark grayish brown (10YR 4/2) silty clay loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—31 to 41 inches; dark grayish brown (10YR 4/2) silty clay loam; moderate medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—41 to 55 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct reddish brown (5YR 4/4) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm;

thin discontinuous very dark grayish brown (10YR 3/2) clay films on faces of peds; few manganese concretions; medium acid; clear wavy boundary.

C—55 to 60 inches; brown (10YR 5/3) silty clay loam; common fine faint yellowish brown (10YR 5/6) mottles; massive; friable; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The depth to free carbonates is more than 60 inches. The thickness of the mollic epipedon ranges from 18 to 24 inches.

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

Nicollet series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on rises and low ridges in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Nicollet soils are similar to Clarion, Cylinder, and Le Sueur soils and are commonly adjacent to Canisteo, Clarion, and Webster soils. Clarion soils have higher chroma in the subsoil than the Nicollet soils. They are in upslope areas. Cylinder soils are underlain by sand and gravel. Le Sueur soils have an argillic horizon. Their A horizon is thinner than that of the Nicollet soils. Canisteo and Webster soils have lower chroma in the subsoil than the Nicollet soils. They are in downslope areas.

Typical pedon of Nicollet loam, 1 to 3 percent slopes; 500 feet west and 1,170 feet south of the northeast corner of sec. 13, T. 81 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to moderate medium granular; friable; slightly acid; clear smooth boundary.

A1—8 to 16 inches; very dark grayish brown (10YR 3/2) loam, very dark gray (10YR 3/1) dry; continuous black (10YR 2/1) coatings on faces of peds; moderate fine subangular blocky structure parting to moderate medium granular; friable; neutral; gradual smooth boundary.

A2—16 to 21 inches; very dark grayish brown (10YR 3/2) loam, dark gray (10YR 4/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

BA—21 to 30 inches; dark grayish brown (10YR 4/2) loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw—30 to 38 inches; dark grayish brown (2.5Y 4/2) loam; common fine distinct yellowish brown (10YR 5/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

BC—38 to 48 inches; grayish brown (2.5Y 5/2) loam; many fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; friable; few small manganese and iron concretions; neutral; clear wavy boundary.

C—48 to 60 inches; grayish brown (2.5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; few small manganese and iron concretions; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 48 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The solum is medium acid to neutral.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loam or clay loam. It commonly has few to many mottles with hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 8. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 to 4.

Nodaway series

The Nodaway series consists of moderately well drained, moderately permeable soils on bottom land. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Nodaway soils are commonly adjacent to Colo and Judson soils. The adjacent soils are not stratified. Their A horizon is thicker and darker than that of the Nodaway soils. Colo soils are in positions on the landscape similar to those of the Nodaway soils. Judson soils are in upslope areas.

Typical pedon of Nodaway silt loam, 0 to 2 percent slopes; 2,520 feet south and 1,900 feet east of the northwest corner of sec. 16, T. 78 N., R. 28 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, brown (10YR 5/3) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine granular structure; friable; neutral; abrupt smooth boundary.

C—7 to 60 inches; very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and very dark gray (10YR 3/1) silt loam; finely stratified with brown (10YR 5/3) sandy loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; weak fine granular structure; friable; neutral.

The thickness of the solum is the same as the thickness of the A horizon. This horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The C horizon has hue of 10YR. It generally has value of 3 or 4 and chroma of 1 or 2, but in some strata value is 4 or 5 and chroma is 2 to 4. This horizon is dominantly silt loam or silty clay loam. In most pedons, however, it has thin lenses of sandy loam, and in some pedons fine sand or sand is below a depth of 40 inches.

Okoboji series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils in closed depressions on uplands. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope is 0 to 1 percent.

Okoboji soils are similar to Coland and Colo soils and are commonly adjacent to Canisteo, Harps, and Webster soils. Coland soils are fine-loamy. Colo soils are fine-silty. Canisteo, Harps, and Webster soils are higher on the landscape than the Okoboji soils. Also, they contain more sand and less clay in the control section and have a thinner mollic epipedon.

Typical pedon of Okoboji silty clay loam, 0 to 1 percent slopes; 1,470 feet south and 1,260 feet west of the northeast corner of sec. 27, T. 81 N., R. 27 W.

Ap—0 to 7 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

A1—7 to 17 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

A2—17 to 26 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

BA—26 to 32 inches; very dark gray (10YR 3/1) silty clay loam; discontinuous black (10YR 2/1) coatings on faces of peds; moderate fine subangular blocky structure; firm; mildly alkaline; gradual smooth boundary.

Bg1—32 to 40 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/6) mottles; moderate fine subangular blocky structure; firm; mildly alkaline; clear smooth boundary.

Bg2—40 to 49 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; friable; mildly alkaline; clear wavy boundary.

Cg—49 to 60 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loam; common fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; slight effervescence; few soft white accumulations of lime; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 20 to 50 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches.

The A horizon is neutral in hue or has hue of 2.5Y or 10YR. It has value of 2 or 3 and chroma of 1 or less. It typically is silty clay loam, but the range includes silt loam and mucky silt loam. The Bg1 horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It generally has few or common mottles with hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 3 to 8. The C horizon ranges from loam to silty clay loam. The matrix color and mottles in this horizon are similar to those in the lower part of the B horizon.

Ridgeport series

The Ridgeport series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. These soils are on stream terraces. They formed in loamy and sandy allvuium. The native vegetation was prairie grasses. Slope ranges from 0 to 9 percent.

Ridgeport soils are similar to Dickinson and Zenor soils and are commonly adjacent to Wadena soils. They have a lower content of clay in the control section than Wadena and Zenor soils. Dickinson soils do not have pebbles in the C horizon. Wadena soils are in positions on the landscape similar to those of the Ridgeport soils.

Typical pedon of Ridgeport sandy loam, 0 to 2 percent slopes; 2,080 feet west and 700 feet north of the southeast corner of sec. 1, T. 81 N., R. 28 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; very friable; neutral; clear smooth boundary.

A—8 to 13 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

BA—13 to 18 inches; dark brown (10YR 3/3) sandy loam; discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bw1—18 to 22 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Bw2—22 to 28 inches; brown (10YR 4/3) gravelly sandy loam; weak fine granular structure; very friable; neutral; clear smooth boundary.

2BC—28 to 38 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand; single grained; loose; neutral; clear smooth boundary.
2C—38 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. The solum is neutral or slightly acid.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is sandy loam or fine sandy loam. The Bw1 and Bw2 horizons have hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. The content of clay in these horizons ranges from 10 to 18 percent, and the content of sand ranges from 60 to 75 percent. The 2BC horizon is loamy sand, gravelly loamy sand, or gravelly sandy loam. The 2C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. It is gravelly sand, sand, or loamy sand.

Sharpsburg series

The Sharpsburg series consists of moderately well drained, moderately slowly permeable soils on convex side slopes and ridgetops in the uplands. These soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 2 to 14 percent.

Sharpsburg soils are similar to Wiota soils and are commonly adjacent to Adair, Ely, Judson, Macksburg, and Shelby soils. Wiota soils contain less clay in the B horizon than the Sharpsburg soils. Adair and Shelby soils are in downslope areas. They have a higher content of sand than the Sharpsburg soils. Also, the B horizon of Adair soils is redder. Ely and Macksburg soils have lower chroma in the subsoil than the Sharpsburg soils. Macksburg soils are in upslope areas. Ely and Judson soils are on foot slopes and are lower on the landscape than the Sharpsburg soils. Also, the A horizon of Judson soils is thicker.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes; 2,020 feet east and 250 feet north of the southwest corner of sec. 33, T. 78 N., R. 29 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam (32 percent clay), very dark grayish brown (10YR 3/2) dry; continuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
A—7 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam (34 percent clay), very dark grayish brown (10YR 3/2) dry; discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.
BA—14 to 19 inches; brown (10YR 4/3) silty clay loam (34 percent clay), dark grayish brown (10YR 4/2) dry; continuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
Bt1—19 to 26 inches; brown (10YR 4/3) silty clay loam (36 percent clay); weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; medium acid; gradual smooth boundary.
Bt2—26 to 33 inches; brown (10YR 4/3) silty clay loam (38 percent clay); few fine faint yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; thin discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; medium acid; gradual smooth boundary.
Bt3—33 to 44 inches; brown (10YR 5/3) silty clay loam (36 percent clay); common fine distinct yellowish brown (10YR 5/6) and common fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; thin discontinuous dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black accumulations; medium acid; gradual smooth boundary.
BC—44 to 60 inches; yellowish brown (10YR 5/4) silty clay loam (34 percent clay); many fine distinct yellowish brown (10YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; weak medium prismatic structure; firm; slightly acid.

The thickness of the solum ranges from 42 to 72 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. The content of clay in this horizon ranges from 28 to 34 percent. The upper part of the B horizon has value of 4 or 5 and chroma of 3 or 4. The lower part of the Bt horizon has mottles with hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6, and chroma of 2 to 6.

Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded, and Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the Sharpsburg series because their dark surface soil is too thin to qualify as a mollic epipedon.

Shelby series

The Shelby series consists of moderately well drained, moderately slowly permeable soils on convex side slopes in the uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 9 to 18 percent.

Shelby soils are similar to Moingona soils and are commonly adjacent to Adair, Lamoni, and Sharpsburg soils. Moingona soils have fewer coarse fragments than the Shelby soils. Adair and Lamoni soils are in upslope areas. They contain more clay in the subsoil than the Shelby soils. Also, Adair soils are redder, and Lamoni soils have a grayer subsoil. Sharpsburg soils contain less sand than the Shelby soils. They formed in loess. They are in upslope areas.

Typical pedon of Shelby loam, 14 to 18 percent slopes; 1,440 feet west and 700 feet south of the northeast corner of sec. 34, T. 78 N., R. 29 W.

A—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; medium acid; clear smooth boundary.

AB—7 to 11 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

Bt1—11 to 22 inches; yellowish brown (10YR 5/6) clay loam; moderate fine and very fine subangular blocky structure; friable; continuous very dark gray (10YR 3/1) clay films in pores; thin continuous brown (10YR 4/3) clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—22 to 30 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct yellowish brown (10YR 5/8) mottles; moderate fine subangular blocky structure; friable; thin discontinuous dark yellowish brown (10YR 4/4) clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—30 to 34 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct yellowish brown (10YR 5/8) and few fine distinct grayish brown (10YR 5/2) mottles; weak medium angular blocky structure; friable; thin discontinuous brown (10YR 4/3) clay films on faces of peds; slightly acid; gradual smooth boundary.

BC—34 to 41 inches; mottled yellowish brown (10YR 5/6), grayish brown (2.5Y 5/2), and light olive brown (2.5Y 5/4) clay loam; weak medium angular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

C—41 to 60 inches; light olive gray (5Y 6/2) clay loam; common fine faint strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 75 inches. The depth to free carbonates ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It ranges from loam to clay loam. The Bt2 and Bt3 horizons have hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The clay content of the Bt horizon ranges from 32 to 35 percent in most pedons.

Shelby clay loam, 9 to 14 percent slopes, moderately eroded, and the Shelby soil in the map unit Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the Shelby series because their dark surface soil is too thin to qualify as a mollic epipedon.

Spillville series

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

Spillville soils are similar to Hanlon and Terril soils and are commonly adjacent to Coland and Hanlon soils. Coland and Hanlon soils are in positions on the landscape similar to those of the Spillville soils. Coland soils contain more clay and less sand than the Spillville soils, and Hanlon soils contain more sand. The A horizon of Terril soils is thinner than that of the Spillville soils.

Typical pedon of Spillville loam, 0 to 2 percent slopes; 1,150 feet east and 100 feet north of the southwest corner of sec. 5, T. 81 N., R. 27 W.

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

A1—8 to 21 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

A2—21 to 44 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

C—44 to 60 inches; very dark grayish brown (10YR 3/2) loam; few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; neutral.

The thickness of the solum ranges from 30 to 56 inches. The thickness of the mollic epipedon ranges from 36 to 60 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is typically loam but in some pedons is silt loam containing noticeable sand. Below a depth of 36 inches, the hue is 10YR or 2.5Y, value is 2 or 3, and chroma is 1 or 2. The C horizon ranges from loam to sandy loam.

Storden series

The Storden series consists of well drained, moderately permeable, calcareous soils on convex side slopes in the uplands. These soils formed in glacial till.

The native vegetation was prairie grasses. Slope ranges from 5 to 50 percent.

Storden soils are commonly adjacent to Clarion, Hayden, Terril, and Zenor soils. Clarion, Hayden, and Zenor soils are in positions on the landscape similar to those of the Storden soils. Clarion soils have a mollic epipedon. Hayden soils have an argillic horizon. Zenor soils have a coarse-loamy control section. Terril soils are on foot slopes below the Storden soils. They have a mollic epipedon.

Typical pedon of Storden loam, 5 to 9 percent slopes, moderately eroded; 150 feet west and 1,000 feet south of the northeast corner of sec. 26, T. 81 N., R. 28 W.

Ap—0 to 7 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; mixed with some streaks and pockets of light olive brown (2.5Y 5/4) substratum material; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C—7 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; few soft white accumulations of lime; strong effervescence; moderately alkaline.

The solum is 6 to 10 inches thick. The A horizon has hue of 10YR, value of 3 to 5, and chroma of 2 to 4. A few pedons have a B horizon, which has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 6. It dominantly is loam but ranges from sandy loam to sandy clay loam.

Terril series

The Terril series consists of moderately well drained, moderately permeable soils on concave foot slopes in the uplands. These soils formed in loamy local alluvium. The native vegetation was prairie grasses. Slope ranges from 2 to 9 percent.

Terril soils are similar to Spillville soils and are commonly adjacent to Clarion and Storden soils. The mollic epipedon of Spillville soils is thicker than that of the Terril soils. Clarion and Storden soils commonly are steeper than the Terril soils and are higher on the landscape. Also, the mollic epipedon of Clarion soils is thinner. Storden soils generally do not have a mollic epipedon.

Typical pedon of Terril loam, 5 to 9 percent slopes; 2,520 feet north and 132 feet east of the southwest corner of sec. 22, T. 81 N., R. 28 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium granular structure; friable; neutral; clear smooth boundary.

A1—8 to 21 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—21 to 30 inches; very dark grayish brown (10YR 3/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BA—30 to 38 inches; dark brown (10YR 3/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—38 to 44 inches; brown (10YR 4/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—44 to 60 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; neutral.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 24 to 40 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is commonly loam. In some pedons, however, it is silt loam high in content of sand, and in others it is clay loam. The B horizon has hue of 10YR, value of 3 or 4, and chroma of 2 to 4. It is loam or clay loam.

Vanmeter series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on convex side slopes in the uplands. These soils formed in residuum of calcareous shale. The native vegetation was prairie grasses and trees. Slope ranges from 14 to 60 percent.

Vanmeter soils are commonly adjacent to Clinton and Ladoga soils. The adjacent soils are upslope from the Vanmeter soils. Also, their B horizon contains less clay.

Typical pedon of Vanmeter silt loam, 30 to 60 percent slopes; 275 feet south and 50 feet east of the center of sec. 22, T. 78 N., R. 27 W.

A—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure; friable; many roots; strong effervescence; mildly alkaline; clear smooth boundary.

Bw1—6 to 12 inches; brown (10YR 5/3) silty clay loam; moderate fine subangular blocky structure; friable; many roots; strong effervescence; mildly alkaline; clear smooth boundary.

Bw2—12 to 20 inches; reddish brown (5YR 4/3) silty clay; moderate fine angular blocky structure; firm; few roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bw3—20 to 30 inches; dark grayish brown (2.5Y 4/2) clay; moderate fine angular blocky structure; firm; few roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

Cr—30 to 60 inches; olive (5Y 4/3) and very dark gray (5Y 3/1) clay shale; medium platy rock strata; very firm; white soft lime accumulations; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. In some pedons a loamy or silty mantle as much as 20 inches thick overlies the clayey residuum. The content of shale fragments ranges, by volume, from 0 to 15 percent throughout the solum.

The A horizon has hue of 10YR, value of 4 or 5, and chroma of 1 or 2. It is silt loam, loam, or silty clay loam. The Bw2 horizon has hue of 2.5Y to 5YR, value of 4 to 6, and chroma of 2 to 6. In some pedons the Cr horizon has thin beds of siltstone, sandstone, and lignite.

Wadena series

The Wadena series consists of well drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. These soils are on stream terraces. They formed in loamy alluvium underlain by sand and gravel at a depth of 32 to 40 inches. The native vegetation was prairie grasses. Slope ranges from 0 to 5 percent.

Wadena soils are similar to Clarion and Ridgeport soils and are commonly adjacent to Cylinder and Ridgeport soils. Clarion soils are on uplands. They have a fine-loamy control section. The lower part of their solum contains less sand than that of the Wadena soils. Ridgeport soils are in positions on the landscape similar to those of the Wadena soils. They have a coarse-loamy control section. The upper part of their solum contains more sand than that of the Wadena soils. Cylinder soils are in the lower lying areas on the stream terraces. Their B horizon is grayer than that of the Wadena soils.

Typical pedon of Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes; 1,350 feet west and 205 feet north of the southeast corner of sec. 14, T. 81 N., R. 27 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A—8 to 13 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

AB—13 to 18 inches; very dark grayish brown (10YR 3/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1—18 to 24 inches; brown (10YR 4/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—24 to 31 inches; brown (10YR 4/3) loam that has a high content of sand; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—31 to 36 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; neutral; clear wavy boundary.

2C1—36 to 46 inches; dark yellowish brown (10YR 4/4) loamy sand; single grained; loose; about 5 percent fine gravel; neutral; gradual wavy boundary.

2C2—46 to 58 inches; yellowish brown (10YR 5/4) sand; single grained; loose; about 2 percent fine gravel; slight effervescence; mildly alkaline; gradual wavy boundary.

2C3—58 to 60 inches; yellowish brown (10YR 5/4) sand; loose; about 5 percent fine gravel; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 40 inches. The depth to sand and gravel ranges from 32 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. The solum is slightly acid or neutral.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam. The Bw1 and Bw2 horizons have hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. They are loam or clay loam. The BC horizon is sandy loam or loamy sand. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is neutral to moderately alkaline. It is sand or loamy sand. The content of gravel in this horizon varies.

Webster series

The Webster series consists of poorly drained, moderately permeable soils on flats, in swales, and on the upper part of drainageways in the uplands. These soils formed in glacial till and glacial sediments. The native vegetation was sedges and prairie grasses. Slope ranges from 0 to 2 percent.

Webster soils are similar to Biscay and Canisteo soils and are commonly adjacent to Clarion, Nicollet, and Okoboji soils. Biscay soils are underlain by sand and gravel. Canisteo soils have free carbonates within 10 inches of the surface. Clarion and Nicollet soils have higher chroma in the subsoil than the Webster soils. They are in upslope areas. Okoboji soils are in depressions. Their A horizon is thicker than that of the Webster soils.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes; 2,150 feet east and 160 feet north of the southwest corner of sec. 4, T. 80 N., R. 26 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, black (N 2/0) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A—8 to 17 inches; black (10YR 2/1) silty clay loam, black (N 2/0) dry; weak fine granular structure; friable; neutral; clear smooth boundary.
Bg1—17 to 23 inches; dark gray (10YR 4/1) clay loam; discontinuous black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg2—23 to 29 inches; dark gray (5Y 4/1) clay loam; very dark gray (10YR 3/1) coatings on faces of peds; moderate fine subangular blocky structure; friable; neutral; gradual wavy boundary.
Cg1—29 to 37 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline; gradual wavy boundary.
Cg2—37 to 60 inches; olive (5Y 5/3) loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. The solum is neutral or mildly alkaline.

The A horizon is neutral in hue or has hue of 10YR. It has value of 2 or 3 and chroma of 1 or less. It is silty clay loam or clay loam. The Bg2 horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It typically is clay loam but in some pedons is silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 3 or less. It is commonly loam, but the range includes sandy loam and clay loam.

Wiota series

The Wiota series consists of moderately well drained, moderately permeable soils on low stream terraces. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 1 to 3 percent.

Wiota soils are similar to Sharpsburg soils and are commonly adjacent to Nevin soils. Sharpsburg soils contain more clay in the control section than the Wiota soils. Nevin soils have lower chroma in the B horizon than the Wiota soils. They are nearly level.

Typical pedon of Wiota silt loam, 1 to 3 percent slopes; 2,020 feet north and 425 feet east of the southwest corner of sec. 26, T. 78 N., R. 29 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam (24 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.
A1—8 to 18 inches; very dark brown (10YR 2/2) silt loam (26 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.
A2—18 to 26 inches; very dark grayish brown (10YR 3/2) silty clay loam (28 percent clay), dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.
BA—26 to 30 inches; dark brown (10YR 3/3) silty clay loam (30 percent clay), grayish brown (10YR 5/2) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.
Bt1—30 to 47 inches; brown (10YR 4/3) silty clay loam (32 percent clay); weak medium subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; medium acid; gradual smooth boundary.
Bt2—47 to 60 inches; brown (10YR 4/3) silty clay loam (34 percent clay); weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous dark brown (10YR 3/3) clay films on faces of peds; medium acid.

The thickness of the solum ranges from 36 to 60 inches. The depth to free carbonates is more than 60 inches. The thickness of the mollic epipedon ranges from 18 to 30 inches. The solum is strongly acid to slightly acid.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam or silty clay loam. The Bt1 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The C horizon, if it occurs, is similar in color and texture to the Bt horizon.

Zenor series

The Zenor series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils are on upland side slopes. They formed in glacial outwash that is dominantly sandy loam over loamy sand. The native vegetation was prairie grasses. Slope ranges from 2 to 14 percent.

Zenor soils are similar to Dickinson and Ridgeport soils and are commonly adjacent to Clarion and Storden soils. Dickinson soils do not have pebbles. Ridgeport soils contain less clay in the lower part of the control section than the Zenor soils. Clarion and Storden soils contain more clay in the control section than the Zenor soils. They are in positions on the landscape similar to those of the Zenor soils.

Typical pedon of Zenor sandy loam, 2 to 5 percent slopes; 300 feet east and 725 feet south of the northwest corner of sec. 32, T. 81 N., R. 28 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark grayish brown (10YR 3/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine granular; very friable; neutral; clear smooth boundary.

A—8 to 11 inches; very dark grayish brown (10YR 3/2) sandy loam, very dark grayish brown (10YR 3/2) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

BA—11 to 17 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 5/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; very friable; about 4 percent gravel; neutral; gradual smooth boundary.

Bw—17 to 24 inches; dark yellowish brown (10YR 4/4) sandy loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; very friable; about 8 percent gravel; mildly alkaline; clear smooth boundary.

BC—24 to 34 inches; dark yellowish brown (10YR 4/4) sandy loam; very weak fine subangular blocky structure; single grained; loose; about 15 percent gravel; mildly alkaline; clear smooth boundary.

C1—34 to 41 inches; yellowish brown (10YR 5/4) gravelly sandy loam; single grained; loose; strong effervescence; moderately alkaline; clear smooth boundary.

C2—41 to 52 inches; yellowish brown (10YR 5/4) gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline; clear smooth boundary.

C3—52 to 60 inches; light olive brown (2.5Y 5/4) gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is sandy loam or loam. The Bw horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loam. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 3 to 6. It is gravelly sandy loam or gravelly loamy sand. The content of gravel in this horizon ranges from 5 to 20 percent.

Zenor sandy loam, 5 to 9 percent slopes, moderately eroded, and the Zenor soil in the map unit Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the Zenor series because their dark surface soil is too thin to qualify as a mollic epipedon.

formation of the soils

This section describes the factors of soil formation and relates them to the soils in Dallas County. It also describes the processes of soil formation. Detailed descriptions of the profiles considered representative of the series are given in the section "Soil series and their morphology."

factors of soil formation

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material. Human activities also affect soil formation.

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. Generally, a long period is needed for the formation of distinct horizons. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

parent material

The soils in Dallas County formed in glacial till, loess, alluvium, residuum of shale and sandstone, and eolian sand.

Glacial till is the most extensive parent material in the county. It was deposited during three glacial periods—the Nebraskan, the Kansan, and the Wisconsin. The first till to be deposited, the Nebraskan, has been buried by the Kansan till and is not identifiable on the landscape. The Kansan till is exposed in the southern one-fifth of the county. This unweathered till is a heterogeneous mixture. It is firm, calcareous clay loam that contains pebbles, boulders, and sand as well as silt and clay. It shows little evidence of sorting or stratification. The mineral composition also is heterogeneous and is similar to that of particles in unweathered loess (*6*).

The glacial deposits are 6 to 12 feet thick in areas where shale and sandstone crop out but are 100 feet thick or more in most areas in the county. The thickness and hardness of the underlying sediments or rock have apparently had a direct effect on the thickness of the glacial till.

Some soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial periods before the loess was deposited (*15*). They are called Yarmouth-Sangamon paleosols. The nearly level soils on this plain are strongly weathered and have a gray, plastic subsoil called gumbotil (*11, 12*). The gumbotil is several feet thick and very slowly permeable.

A widespread erosion surface has cut below the Yarmouth-Sangamon paleosol into Kansan till and older deposits. It generally is characterized by a stone line or subjacent till that is overlain by pedisediment (*11, 12, 13*). A paleosol formed in this material. This surface is referred to as Late Sangamon. These paleosols are less strongly weathered, more reddish, and not so thick as those in the nearly level areas.

The soils that formed in the Kansan till during the Yarmouth and Sangamon periods were covered by loess. Geologic erosion has removed the loess from many slopes and has exposed the paleosol. In some areas erosion has beveled or truncated the paleosol so that only the strongly weathered lower part remains. This erosion took place prior to loess deposition, or before about 25,000 years ago (*15*). In other areas erosion has removed all of the paleosol and has exposed till that is only slightly weathered at the surface. This erosion took place mostly in the postglacial period.

Lamoni soils formed in a truncated Yarmouth-Sangamon paleosol of strongly weathered, gray clay. Adair and Armstrong soils formed in the less strongly weathered, reddish paleosol. Shelby, Gara, and Lindley soils formed in slightly weathered glacial till from which the overlying paleosol was removed by geologic erosion.

The northern four-fifths of Dallas County was covered by the Des Moines lobe of the Wisconsin Glaciation. The glacial till, which is the parent material of most of the soils in this part of the county, was deposited by the Cary substage of this glaciation (*14*). Clarion, Nicollet, and Storden soils formed in till of the Cary substage. Canisteo, Webster, and Harps soils formed in glacial till and in glacial sediments or reworked glacial till (*22*). Okoboji soils formed in local alluvium derived from glacial till.

Loess is silty wind-deposited material that consists largely of silt particles and smaller amounts of clay and sand. It was deposited during the Wisconsin glacial period. The wind probably carried most of the loess from the flood plain along the Missouri River in the western part of Iowa to the uplands (*5*). The thickness of the loess and the differences among the soils that formed in it are related to the distance from the Missouri River. In Dallas County the loess is about 12 to 18 feet thick on the nearly level, stable divides. It is thinner on the side slopes. On most side slopes in the higher uplands, all of the loess has been removed by erosion and glacial till is exposed.

The loess in the southwestern and southern parts of Iowa gradually thins out and becomes finer textured than that in the eastern part. A marked change in texture is not evident in Dallas County. Sharpsburg, Ladoga, Clinton, and Macksburg soils formed in loess.

The loess and the soils that formed in loess in the western and southwestern parts of Iowa have been the subject of much study and investigation. Ruhe and others have studied the relationship of the loess to the topography of western Iowa (*10, 15*).

Alluvium is sediment deposited by water along the major and minor streams and drainageways. The texture of the alluvium varies widely because the sources of the material and the manner in which it was deposited differ from area to area. In Dallas County the main sources of alluvium are glacial till, loess, outwash deposited by melt water from glaciers, and layers of exposed shale.

When the rivers and streams overflow their channels and the water spreads outward toward the uplands, the sandy material is deposited first, adjacent to the stream. As the water moves more slowly, silt and very fine sand are deposited. During periods when the floodwater is high, the water spreads slowly toward the outer border of the flood plain and carries very fine silt and clay. As the floodwater recedes, these particles settle and are mixed with fine particles washed down as local alluvium. This pattern of deposition is evident in many places on the wider stream bottoms of the Raccoon and Des Moines Rivers and along Beaver Creek. Hanlon soils are the nearest to streams. Next are Spillville and Nodaway soils. Coland and Colo soils are the farthest from the main channel. They are finer textured and more poorly drained than the other alluvial soils and are somewhat lower on the landscape.

Some terraces or second bottoms are along the larger streams in the county. The soils on terraces have more strongly expressed profiles and are not flooded so frequently as the alluvial soils on first bottoms. Nevin and Wiota soils formed in silty alluvium on low stream terraces or second bottoms. Cylinder, Wadena, and Biscay soils formed in about 24 to 40 inches of loamy alluvium overlying sand and gravel. These materials were deposited by melt water from the receding Cary glacial ice.

Residuum of shale and sandstone is the oldest parent material in the county. It occurs as a series of beds deposited during a sedimentary cycle in the Pennsylvanian period. The beds consist of shale of various colors and textures and calcareous sandstone. They have a wide range in thickness. A few outcroppings of limestone, conglomerates, and organic layers, such as coal, are also evident, but they are not extensive. Vanmeter soils formed in residuum of multicolored, calcareous shale that is many feet thick. They are mainly on the lower parts of the side slopes that border the South Raccoon River.

Eolian, or wind-deposited, sand is dominantly fine quartz sand in Dallas County. It was deposited during the same period as the loess. The sources from which the sand was picked up and redeposited were probably near stream bottom land. Dickinson soils are the only soils in the county that formed in this material.

climate

The soils in Dallas County formed under a variety of climatic conditions. During the post-Cary Glaciation, about 13,000 to 10,500 years ago, the climate was cool and the vegetation was dominantly conifers (*23*). During the period beginning about 10,500 years ago and ending about 8,000 years ago, a warming trend changed the vegetation from conifers to mixed hardwoods. Beginning about 8,000 years ago, the climate became warmer and drier and herbaceous prairie plants became dominant. Probably about 3,000 years ago, a change from a dry to a more moist climate began (*8*). The present climate is midcontinental and subhumid.

A nearly uniform climate prevails throughout the county. The general climate has had an important overall influence on the characteristics of the soils but has not caused major differences among them. The influence of the general climate, however, is modified by local conditions. For example, soils on south-facing slopes formed under a microclimate that is warmer and less humid than that of the soils in nearby areas. Also, the poorly drained soils on bottoms formed under a microclimate that is wetter and colder than that of most of the surrounding soils. These local conditions account for some of the differences among the soils in the county.

Changes in temperature activate the weathering of the parent material by water and air. As the parent material weathers, changes caused by both physical and chemical actions take place. Rainfall affects the amount of leaching in the soil and the kinds of plants on the soil. Temperature and other climatic factors indirectly affect soil formation through their effect on the plant and animal life on and in the soil.

plant and animal life

Many kinds of living organisms affect soil formation. Burrowing animals, worms, crayfish, and micro-organisms, for example, influence soil properties. Differences in the kind of vegetation, however, commonly cause the most marked differences among soils (*9*).

The soils of Dallas County were influenced by prairie grasses and trees. The main prairie grasses were big bluestem and little bluestem. The main trees were deciduous. They were mostly oak, hickory, ash, and elm. On the broad, nearly level to gently rolling soils on uplands, tall prairie grasses were the dominant plants at the time when Dallas County was settled. The trees are in areas near most of the major streams and their major tributaries.

Because grasses have many roots and tops that decay, soils that formed under prairie vegetation typically have a thicker, darker surface layer than the soils that formed under trees. The organic matter in the soils that formed under trees is derived principally from fallen leaves. These soils generally are more acid than the soils that formed under grasses. Also, more of the bases and clay minerals have moved downward in their profiles.

Clarion, Nicollet, Webster, and Shelby soils are typical of soils that formed in glacial till under prairie vegetation. Sharpsburg and Macksburg soils formed in loess under prairie vegetation. Hayden and Lindley soils formed in glacial till under forest vegetation. Clinton soils formed in loess under forest vegetation. They have a thin, light colored A horizon; a gray E horizon that is very distinct when dry; and a B horizon that has stronger structure and shows more evidence of the accumulation of silicate clay than the B horizon in prairie soils.

Lester, Ladoga, and Gara soils have properties that are intermediate between those of soils that formed entirely under forest vegetation and those that formed entirely under prairie vegetation. They probably formed under grasses but later were covered by trees. Their morphology reflects the influence of both trees and grasses.

relief

Relief is an important factor in soil formation because of its effect on drainage, runoff, depth to the water table, and erosion. Slope ranges from nearly level to very steep in Dallas County. A difference in relief is the main reason for the differing properties among some of the soils in the county.

Slope affects the thickness and color of the A horizon and the thickness of the solum through its effect on erosion and the amount of water that runs off and percolates through the soil. For example, the thickness and color of the A horizon of the Storden, Clarion, and Nicollet soils, which formed in similar parent material, are related to slope. The thickness of the A horizon increases and the color darkens as the slope decreases. Generally, Storden soils are strongly sloping to very steep, Clarion soils are gently sloping or moderately sloping, and Nicollet soils are very gently sloping. The solum of the Storden soils is thinner than that of the Clarion and Nicollet soils. Also, carbonates are closer to the surface.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. In well drained soils the subsoil generally is brown because iron compounds are well distributed and are oxidized. In poorly drained or very poorly drained, poorly aerated soils, however, the subsoil is generally grayish and mottled. The poorly drained Webster and very poorly drained Okoboji soils, which are level or nearly level, are examples. The moderately well drained, gently sloping to strongly sloping Sharpsburg soils have a brownish B horizon. Macksburg soils have profile characteristics of somewhat poorly drained soils. Their subsoil, for example, is grayish brown.

The water that percolates through soils removes clay from the A horizon, and much of this clay accumulates in the B horizon. Generally, more water percolates through nearly level or depressional soils than through the soils in the more sloping areas, where some of the water runs off the surface. As a result, the content of clay in the B horizon generally is higher in the nearly level or depressional soils.

time

Time enables relief, climate, and plant and animal life to change the parent material. If these factors continue to operate for a long period, very similar kinds of soils form in widely different kinds of parent material. Soil formation, however, generally is interrupted by geologic events that expose new parent material.

In most of the county, new parent material has been added to the uplands at least three times. It has been added four times in the northern part (*17*). Throughout the entire county, the bedrock was first covered by glacial drift from two different glaciers and then loess was deposited. In the northern four-fifths of the county, another glacier subsequently deposited the present surface material.

Adair and Lamoni soils have the most weathered subsoil in the county. They formed in Kansan till, which began to weather in the Yarmouth and Sangamon periods. Then the till was covered by loess. More recently, the upper part of this ancient subsoil was exposed to weathering again when the loess was removed by erosion. Even older are the beds of shale and sandstone below the glacial till. These beds also have been exposed. Vanmeter soils formed in these areas. They vary considerably in the degree to which they have weathered.

According to radiocarbon dates, loess deposition began about 25,000 years ago and continued to about 14,000 years ago (*4, 10*). These dates indicate that the surface of the nearly level, loess-mantled divides in Iowa is about 14,000 years old. In Dallas County these stable areas include the nearly level soils and most of the gently sloping soils on divides, mainly Sharpsburg, Ladoga, and Macksburg soils. Radiocarbon dates from the base of the Cary glacial drift in the southern part of the Des Moines lobe indicate that the drift was deposited about 14,000 years ago. Thus, all of the soils that formed in this drift material are as young or younger than 14,000 years old. In much of Iowa, including Dallas County, geologic erosion has beveled and, in places, removed material on side slopes and deposited new sediments downslope (*15*). The surface layer of nearly level soils on upland divides is older than that on the beveled slopes that ascend to the divides. Thus, the soils on the side slopes are less than 14,000 years old. In Dallas County, Shelby, Gara, and Lindley soils are on these side slopes.

The sediment stripped from the side slopes accumulated downslope as local alluvium. The age of the soils on the side slopes is determined by dating the alluvial fill at the base of slopes. The alluvium in some stream valleys in western Iowa is less than 1,800 years old (*3*). Some of the soils that formed in alluvium in Dallas County are Hanlon, Spillville, Judson, and Colo. Some of the alluvium in which Nodaway soils formed was deposited after the county was settled.

human activities

Important changes took place when Dallas County was settled. Breaking the prairie sod and clearing the timber removed and changed the protective plant cover. Changes caused by water erosion generally are the most significant. As the land was brought under cultivation, the runoff rate increased and the rate at which water moved into the soil decreased. As a result, accelerated erosion removed part or all of the original surface layer from many of the more sloping soils. In some areas shallow to deep gullies have formed.

Cultivation and erosion also changed the structure and consistence of the surface layer of some soils and the content of organic matter and level of fertility. In severely eroded areas the plow layer commonly includes the upper part of the subsoil, which is less friable and finer textured than the surface layer. Even in areas that are not subject to erosion, compaction by heavy machinery reduces the thickness of the surface layer and changes the structure. The granular structure characteristic of native grassland breaks down when the soils are intensively cropped.

Some management measures decrease the susceptibilty to erosion, increase soil productivity, and reclaim areas not suitable for crops or pasture. For example, large areas on bottom land are suitable for cultivation because flooding and deposition are controlled by diversions at the base of slopes, by drainage ditches, and by other measures. In some areas erosion and runoff are controlled by terraces and other measures. Many soils are more productive than they were in their natural state because applications of commerical fertilizer and lime have overcome deficiencies in plant nutrients.

Erosion is the main cause of a decrease in the content of organic matter in soils (*18*). Though they cannot increase the content to the level that was characteristic of the native grassland, measures that control erosion can keep the content at a level that is needed when crops are grown.

processes of horizon development

Horizon differentiation is the result of four basic processes. These are additions, removals, transfers, and transformations (*16*). Each of these affects many substances in the soils, such as organic matter, soluble salts, carbonates, sesquioxides, and silicate clay minerals. The changes brought about by these processes help to determine the ultimate nature of the soil profile.

The accumulation of organic matter is an early phase in the formation of most soils. The content of organic matter ranges from high to very low in the A horizon of the soils in Dallas County. It is low in the thin A horizon of the Hayden soils and high in the thick A horizon of the Webster and Colo soils. In some soils it is low because erosion has removed part of the A horizon.

The removal of substances from parts of the profile is important in the development of soil horizons in Dallas County. The downward movement of calcium carbonates and bases is an example. Free carbonates have been leached from the upper part of most of the soils in the county. Exceptions are Storden, Canisteo, and Harps soils, which are calcareous throughout. Some soils are so strongly leached that they are strongly acid in the subsoil.

A number of transfers from one horizon to another are evident in the soils of the county. Phosphorus, for example, is removed from the subsoil by plant roots and transferred to the parts of the plant growing above the ground. It is then returned to the surface layer in the plant residue. This process affects the form and distribution of the phosphorus in the profile.

The translocation of silicate clay minerals has an important effect on horizon development. The clay minerals are carried downward in suspension by percolating water from the A horizon. They accumulate in the B horizon as fillings in pores and root channels and as clay films on the faces of peds This process has affected many of the soils in the county. In other soils, the clay content of the A horizon is not markedly different from that of the B horizon and other evidence of clay movement is minimal.

Another kind of transfer occurs only in very clayey soils. Cracks form when these soils shrink and swell. As a result, some of the material from the surface layer is transferred to the lower parts of the profile.

Transformations are physical and chemical. The weathering of soil particles to smaller sizes is an example of a transformation. The reduction of iron is another example. This process is called gleying. It occurs when the soil is saturated for long periods. It is evidenced by ferrous iron and gray colors in the soil. It is a characteristic of poorly drained soils, such as the Webster soils. Reductive extractable iron, or free iron, generally is not so evident in somewhat poorly drained soils, such as the Macksburg soils (*20*). Another kind of transformation is the weathering of the primary apatite mineral in the parent material to secondary phosphorus compounds.

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glossary

ABC soil. A soil having an A, a B, and a C horizon.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compact layers to depths below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 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, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves all or part of the 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.—Readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—Adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.
Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.
Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.
Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

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.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of another horizon.

E horizon.—The mineral horizon below an O or A horizon and above a B horizon. The E horizon is characterized by a loss of some combination of silicate clay, iron, and aluminum and by a remaining concentration of sand and silt particles of quartz or other resistant minerals.

B horizon.—The mineral horizon below an A, E, or O 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) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

R layer.—Hard bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 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

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 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, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Taxadjuncts are soils that differ from a recognized series in so few properties and to so small a degree that major interpretations are not affected.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-78 at Perry, Iowa]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	27.2	7.5	17.4	54	-23	0	.76	.30	1.14	3	6.0
February---	33.7	13.8	23.7	62	-18	0	1.05	.30	1.64	3	6.6
March------	43.8	23.9	33.9	79	-7	33	2.02	.85	3.00	5	6.7
April------	61.0	37.9	49.5	86	19	91	3.33	1.65	4.78	6	.5
May--------	72.7	49.2	61.0	91	30	353	4.25	2.32	5.94	7	.0
June-------	81.3	58.8	70.0	96	42	600	4.61	2.54	6.44	7	.0
July-------	85.3	62.7	74.1	99	47	747	3.76	1.66	5.55	6	.0
August-----	83.1	59.9	71.5	96	44	667	3.93	1.66	5.86	6	.0
September--	75.6	50.7	63.2	93	31	396	3.30	1.28	4.99	6	.0
October----	65.3	39.9	52.6	89	19	174	2.08	.64	3.26	5	.1
November---	47.5	26.9	37.2	74	3	10	1.32	.41	2.06	3	2.7
December---	33.3	15.2	24.3	61	-16	0	.95	.52	1.33	3	5.2
Yearly: Average-	59.2	37.2	48.2	---	---	---	---	---	---	---	---
Extreme-	---	---	---	100	-25	---	---	---	---	---	---
Total---	---	---	---	---	---	3,071	31.36	26.51	36.22	60	27.8

* 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 1951-78 at Perry, Iowa]

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 23	May 1	May 12
2 years in 10 later than--	April 18	April 25	May 7
5 years in 10 later than--	April 8	April 16	April 28
First freezing temperature in fall:			
1 year in 10 earlier than--	October 12	September 30	September 19
2 years in 10 earlier than--	October 17	October 6	September 25
5 years in 10 earlier than--	October 27	October 17	October 4

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-78 at Perry, Iowa]

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	180	160	141
8 years in 10	188	168	147
5 years in 10	202	183	159
2 years in 10	215	199	171
1 year in 10	223	207	177

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
6	Okoboji silty clay loam, 0 to 1 percent slopes	1,600	0.4
7	Wiota silt loam, 1 to 3 percent slopes	2,675	0.7
8B	Judson silty clay loam, 2 to 5 percent slopes	435	0.1
11B	Colo-Ely silty clay loams, 2 to 5 percent slopes	1,200	0.3
24D2	Shelby clay loam, 9 to 14 percent slopes, moderately eroded	385	0.1
24E	Shelby loam, 14 to 18 percent slopes	845	0.2
27B	Terril loam, 2 to 5 percent slopes	1,200	0.3
27C	Terril loam, 5 to 9 percent slopes	725	0.2
55	Nicollet loam, 1 to 3 percent slopes	40,815	10.7
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	3,175	0.8
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	2,475	0.6
62E	Storden loam, 14 to 18 percent slopes	3,025	0.8
62F	Storden loam, 18 to 25 percent slopes	1,200	0.3
65G	Lindley silt loam, 18 to 40 percent slopes	1,550	0.3
76B	Ladoga silt loam, 2 to 5 percent slopes	1,700	0.5
76C2	Ladoga silty clay loam, 5 to 9 percent slopes, moderately eroded	3,400	0.9
76D2	Ladoga silty clay loam, 9 to 14 percent slopes, moderately eroded	880	0.2
80B	Clinton silt loam, 2 to 5 percent slopes	575	0.2
80C	Clinton silt loam, 5 to 9 percent slopes	415	0.1
80C2	Clinton silty clay loam, 5 to 9 percent slopes, moderately eroded	1,675	0.4
80D2	Clinton silty clay loam, 9 to 14 percent slopes, moderately eroded	860	0.2
88	Nevin silty clay loam, 0 to 2 percent slopes	1,050	0.3
90	Okoboji mucky silt loam, 0 to 1 percent slopes	290	0.1
93D2	Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded	3,200	0.8
93E	Shelby-Adair complex, 14 to 18 percent slopes	275	0.1
95	Harps loam, 0 to 2 percent slopes	2,475	0.6
107	Webster silty clay loam, 0 to 2 percent slopes	30,820	8.1
133	Colo silty clay loam, 0 to 2 percent slopes	3,475	0.9
135	Coland clay loam, 0 to 2 percent slopes	8,650	2.3
138B	Clarion loam, 2 to 5 percent slopes	78,930	20.6
138C	Clarion loam, 5 to 9 percent slopes	3,075	0.8
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	15,925	4.2
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	3,525	0.9
168B	Hayden loam, 2 to 5 percent slopes	4,300	1.1
168C	Hayden loam, 5 to 9 percent slopes	635	0.2
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded	955	0.2
168D2	Hayden loam, 9 to 14 percent slopes, moderately eroded	860	0.2
168E	Hayden loam, 14 to 18 percent slopes	740	0.2
168F	Hayden loam, 18 to 25 percent slopes	1,625	0.4
169B	Clarion loam, 2 to 5 percent long slopes	12,775	3.3
169C2	Clarion loam, 5 to 9 percent long slopes, moderately eroded	7,210	1.9
175B	Dickinson fine sandy loam, 1 to 5 percent slopes	415	0.1
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	195	0.1
179F	Gara loam, 18 to 25 percent slopes	1,075	0.3
201B	Coland-Terril complex, 2 to 5 percent slopes	4,430	1.2
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,325	0.4
220	Nodaway silt loam, 0 to 2 percent slopes	4,525	1.2
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,070	0.3
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,475	0.9
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	800	0.2
325	Le Sueur loam, 0 to 2 percent slopes	465	0.1
356G	Hayden-Storden loams, 25 to 50 percent slopes	9,650	2.5
368	Macksburg silty clay loam, 0 to 2 percent slopes	1,665	0.4
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes	5,925	1.6
370C2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	9,025	2.4
370D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	385	0.1
419F	Vanmeter silt loam, 14 to 30 percent slopes	1,480	0.4
419G	Vanmeter silt loam, 30 to 60 percent slopes	840	0.2
485	Spillville loam, 0 to 2 percent slopes	2,925	0.8
507	Canisteo silty clay loam, 0 to 2 percent slopes	49,575	13.0
536	Hanlon fine sandy loam, 0 to 2 percent slopes	2,525	0.7
566B	Moingona loam, 2 to 6 percent slopes	785	0.2
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded	590	0.2
638D2	Clarion-Storden loams, 9 to 14 percent slopes, moderately eroded	375	0.1
736B	Lester loam, 2 to 5 percent long slopes	2,075	0.5
736C2	Lester loam, 5 to 9 percent long slopes, moderately eroded	2,975	0.8
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	975	0.3
823	Ridgeport sandy loam, 0 to 2 percent slopes	390	0.1
823B	Ridgeport sandy loam, 2 to 5 percent slopes	515	0.1
823C	Ridgeport sandy loam, 5 to 9 percent slopes	310	0.1
828B	Zenor sandy loam, 2 to 5 percent slopes	475	0.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded	615	0.2
829D2	Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded	580	0.2
956	Harps-Okoboji complex, 0 to 1 percent slopes	1,100	0.3
993D2	Gara-Armstrong complex, 9 to 14 percent slopes, moderately eroded	1,500	0.4
993E	Gara-Armstrong complex, 14 to 18 percent slopes	2,375	0.6
1220	Nodaway silt loam, channeled, 0 to 2 percent slopes	885	0.2
1314	Hanlon-Spillville complex, channeled, 0 to 2 percent slopes	7,050	1.8
1585	Spillville-Coland complex, channeled, 0 to 2 percent slopes	960	0.3
5010	Pits, sand and gravel	450	0.1
5040	Orthents, loamy	850	0.2
5060	Pits, clay	155	*
	Water	2,725	0.7
	Total	382,080	100.0

* Less than 0.1 percent.

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	Bromegrass-alfalfa	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass
	Bu	Bu	Bu	AUM*	Ton	AUM*	AUM*
6 Okoboji	84	32	67	7.3	3.4	3.3	4.3
7 Wiota	110	42	62	7.6	4.6	4.2	6.4
8B Judson	124	47	93	8.6	5.2	4.2	7.3
11B Colo-Ely	---	---	---	---	---	3.8	---
24D2 Shelby	81	31	44	5.6	3.4	3.3	4.9
24E Shelby	69	26	38	4.8	2.9	2.3	4.1
27B Terril	118	45	94	8.3	5.0	4.2	7.0
27C Terril	113	43	91	8.0	4.8	4.2	6.7
55 Nicollet	120	40	80	6.5	4.5	3.5	---
62C2 Storden	92	35	74	6.5	3.9	3.6	---
62D2 Storden	83	32	66	5.8	3.5	3.3	---
62E Storden	68	---	54	4.8	3.0	2.5	---
62F Storden	---	---	---	3.6	2.2	1.6	---
65G Lindley	---	---	---	---	---	---	2.0
76B Ladoga	113	43	62	7.8	4.7	4.3	6.8
76C2 Ladoga	105	40	57	7.3	4.4	3.9	6.3
76D2 Ladoga	96	36	53	6.6	4.0	3.7	5.7
80B Clinton	107	41	59	7.5	4.5	4.0	6.4
80C Clinton	102	39	56	7.1	4.3	3.8	6.1
80C2 Clinton	99	38	54	7.0	4.2	3.6	6.0
80D2 Clinton	90	34	50	6.3	3.8	3.5	5.3
88 Nevin	114	43	63	8.0	4.8	4.0	8.0
90 Okoboji	84	32	67	7.3	3.4	3.3	4.3

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Bromegrass-alfalfa	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass
	Bu	Bu	Bu	AUM*	Ton	AUM*	AUM*
93D2 Shelby-Adair	69	26	38	5.0	3.0	3.0	4.0
93E. Shelby-Adair							
95 Harps	95	36	76	6.6	4.0	3.3	5.0
107 Webster	110	42	88	7.3	4.4	4.2	6.6
133 Colo	104	40	78	7.0	4.2	4.2	5.5
135 Coland	110	42	83	7.6	4.6	4.1	6.0
138B Clarion	110	42	88	7.6	4.6	4.2	6.7
138C Clarion	105	40	84	7.3	4.4	3.8	6.3
138C2 Clarion	102	39	82	7.1	4.3	3.8	6.2
138D2 Clarion	93	35	74	6.5	3.9	3.7	5.5
168B Hayden	100	37	78	6.8	4.5	3.6	---
168C Hayden	93	35	74	6.5	3.9	3.6	---
168C2 Hayden	90	34	72	6.3	3.8	3.6	---
168D2 Hayden	81	31	65	5.6	3.4	3.3	---
168E Hayden	69	26	60	6.0	4.0	3.0	---
168F Hayden	---	---	---	4.5	3.0	3.0	---
169B Clarion	110	42	88	7.6	4.6	4.2	6.7
169C2 Clarion	102	39	82	7.1	4.3	3.8	6.2
175B Dickinson	81	31	60	5.0	3.0	2.7	4.8
175C Dickinson	76	29	57	4.6	2.8	2.5	4.5
179F Gara	---	---	---	2.5	1.5	1.3	---
201B Coland-Terril	112	43	86	7.9	4.7	4.0	6.4
203 Cylinder	103	39	82	7.1	4.3	3.8	6.2

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Bromegrass-alfalfa	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass
	Bu	Bu	Bu	AUM*	Ton	AUM*	AUM*
220 Nodaway	110	42	60	4.0	4.6	4.0	5.5
259 Biscay	100	38	80	6.6	4.0	3.8	---
308 Wadena	92	35	74	6.2	3.7	3.7	---
308B Wadena	90	34	72	6.0	3.6	3.7	---
325 Le Sueur	120	38	90	7.8	4.7	4.1	---
356G. Hayden-Storden							
368 Macksburg	121	46	67	8.5	5.1	4.5	8.4
370B Sharpsburg	113	43	62	7.8	4.7	4.2	6.7
370C2 Sharpsburg	108	40	58	7.3	4.4	4.0	6.5
370D2 Sharpsburg	96	36	53	6.6	4.0	3.8	5.7
419F Vanmeter	---	---	---	2.5	1.0	1.0	1.0
419G Vanmeter	---	---	---	---	---	1.0	---
485 Spillville	122	46	98	8.6	5.1	4.2	7.3
507 Canisteo	110	36	84	7.0	4.2	3.8	---
536 Hanlon	90	34	72	6.3	3.8	3.3	5.3
566B Moingona	110	42	88	7.6	4.6	4.1	5.5
638C2 Clarion-Storden	95	36	78	6.8	4.1	3.6	---
638D2 Clarion-Storden	87	33	70	6.1	3.7	3.5	---
736B Lester	105	40	83	7.3	4.5	3.8	---
736C2 Lester	92	35	74	6.5	4.3	3.6	---
822D2 Lamoni	61	23	33	4.3	2.6	2.1	3.7
823 Ridgeport	53	20	42	3.6	2.2	1.7	3.2
823B Ridgeport	51	19	41	3.5	2.1	1.5	3.1

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Bromegrass-alfalfa	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass
	Bu	Bu	Bu	AUM*	Ton	AUM*	AUM*
823C----------------------- Ridgeport	46	17	37	3.1	1.9	1.2	2.8
828B----------------------- Zenor	79	30	63	5.5	3.3	3.0	4.8
828C2---------------------- Zenor	72	27	58	5.0	3.0	2.7	4.3
829D2---------------------- Zenor-Storden	68	23	51	4.6	2.9	2.6	---
956------------------------ Harps-Okoboji	90	34	72	6.9	3.7	3.3	4.7
993D2---------------------- Gara-Armstrong	63	24	35	4.3	2.6	2.2	3.7
993E. Gara-Armstrong							
1220----------------------- Nodaway	---	---	---	4.0	3.0	4.0	5.5
1314----------------------- Hanlon-Spillville	---	---	---	---	---	3.5	---
1585----------------------- Spillville-Coland	---	---	---	---	---	3.4	---
5010**. Pits							
5040**. Orthents							
5060**. Pits							

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	46,670	---	---	---
II	226,385	109,915	111,670	4,800
III	64,640	61,260	2,990	390
IV	11,240	11,240	---	---
V	8,895	---	8,895	---
VI	6,550	6,550	---	---
VII	13,520	13,520	---	---
VIII	---	---	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
65G, Lindley	3r	Moderate	Moderate	Slight	Slight	White oak Post oak Blackjack oak Black oak	60 --- --- ---	White oak, green ash, yellow-poplar, black oak.
76B, 76C2, 76D2, Ladoga	1o	Slight	Slight	Slight	Slight	White oak Northern red oak	75 75	Eastern white pine, red pine, European larch, sugar maple, black walnut, white oak, northern red oak.
80B, 80C, 80C2, 80D2, Clinton	2o	Slight	Slight	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, red pine, European larch, black walnut, white oak, northern red oak.
168B, 168C, 168C2, 168D2, Hayden	2o	Slight	Slight	Slight	Slight	Northern red oak American basswood Sugar maple Black walnut Eastern white pine White oak	69 69 --- 62 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
168E, 168F, Hayden	2r	Moderate	Moderate	Slight	Slight	Northern red oak American basswood Sugar maple Black walnut Eastern white pine White oak	69 69 --- 62 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
179F, Gara	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine.
325, Le Sueur	2o	Slight	Slight	Slight	Slight	Sugar maple American basswood Black walnut Eastern cottonwood	60 70 55 85	Eastern cottonwood, American basswood.
356G*:								
Hayden	2r	Moderate	Moderate	Slight	Slight	Northern red oak American basswood Sugar maple Black walnut Eastern white pine White oak	69 69 --- 62 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
Storden.								
419F, 419G, Vanmeter	4c	Severe	Severe	Severe	Severe	White oak	45	Eastern white pine, red pine.
566B, Moingona	2o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 65	Eastern white pine, red pine, European larch, green ash, black walnut, white oak, northern red oak.

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
736B, 736C2: Lester	2o	Slight	Slight	Slight	Slight	Northern red oak American basswood Black walnut Eastern cottonwood Eastern white pine White oak	69 69 62 92 64 62	Black walnut, northern red oak, American basswood, silver maple, white oak.
993D2*:								
Gara	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, white oak, northern red oak.
Armstrong	3c	Slight	Slight	Severe	Severe	White oak Northern red oak	55 55	Eastern white pine, red pine, European larch, sugar maple.
993E*:								
Gara	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, white oak, northern red oak.
Armstrong	3c	Moderate	Moderate	Severe	Severe	White oak Northern red oak	55 55	Eastern white pine, red pine, European larch, sugar maple, poplar.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--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 heights, in feet, of-- <8	8-15	16-25	26-35	>35
6 Okoboji	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
7 Wiota	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
8B Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
11B*:					
Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
Ely	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
24D2, 24E Shelby	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern white-cedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
27B, 27C Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
55 Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
62C2, 62D2, 62E, 62F Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
65G Lindley	---	Silky dogwood, Amur honeysuckle, Amur privet, American cranberrybush.	Washington hawthorn, northern white-cedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
76B, 76C2, 76D2--- Ladoga	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
80B, 80C, 80C2, 80D2------------- Clinton	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce, Austrian pine.	Eastern white pine, pin oak.
88---------------- Nevin	---	Silky dogwood, Amur privet, American cranberrybush, Amur honeysuckle.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
90---------------- Okoboji	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
93D2*, 93E*: Shelby-----------	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern white-cedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
Adair------------	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
95---------------- Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
107--------------- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
133--------------- Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
135--------------- Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
138B, 138C, 138C2, 138D2------------ Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
168B, 168C, 168C2, 168D2, 168E, 168F------------- Hayden	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian-olive, Amur maple, northern white-cedar, blue spruce.	Eastern white pine, green ash.	---
169B, 169C2-------- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
175B, 175C--------- Dickinson	Siberian peashrub, Tatarian honeysuckle, lilac.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, honeysuckle, bur oak, Russian-olive, jack pine, green ash.	---	---
179F--------------- Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern white-cedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
201B*:					
Coland------------	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
Terril------------	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
203---------------- Cylinder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, northern white-cedar, Amur maple, white spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
220---------------- Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce------	Eastern white pine, pin oak.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
259---------------- Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
308, 308B---------- Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, hackberry, Manchurian crabapple.	Jack pine, honeylocust, bur oak, Russian-olive, green ash, eastern white pine.	---	---
325---------------- Le Sueur	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
356G*: Hayden------------	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Hackberry, eastern redcedar, Russian-olive, Amur maple, northern white-cedar, blue spruce.	Eastern white pine, green ash.	---
Storden-----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
368---------------- Macksburg	---	American cranberrybush, Amur honeysuckle, Amur privet, silky dogwood.	Northern white-cedar, blue spruce, Washington hawthorn, white fir, Austrian pine.	Norway spruce-----	Eastern white pine, pin oak.
370B, 370C2, 370D2------------- Sharpsburg	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
419F, 419G--------- Vanmeter	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, osageorange, Russian-olive, jack pine, Washington hawthorn.	Northern catalpa, honeylocust.	---	---
485---------------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
507---------------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
536---------------- Hanlon	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
566B-------------- Moingona	---	Redosier dogwood, gray dogwood, lilac, Siberian peashrub.	Amur maple, blue spruce, Russian-olive, northern white-cedar, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
638C2*, 638D2*: Clarion-----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
736B, 736C2------- Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
822D2------------- Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
823, 823B, 823C--- Ridgeport	Tatarian honeysuckle, lilac, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, jack pine, honeylocust, Russian-olive, bur oak, green ash.	---	---
828B, 828C2------- Zenor	Siberian peashrub, Tatarian honeysuckle, lilac.	Hackberry, eastern redcedar, Manchurian crabapple.	Honeylocust, bur oak, jack pine, green ash, Russian-olive, eastern white pine.	---	---
829D2*: Zenor-------------	Siberian peashrub, Tatarian honeysuckle, lilac.	Hackberry, eastern redcedar, Manchurian crabapple.	Honeylocust, bur oak, jack pine, green ash, Russian-olive, eastern white pine.	---	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
829D2*:					
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
956*:					
Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Okoboji	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
993D2*, 993E*:					
Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern white-cedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
Armstrong	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Tatarian honeysuckle, Amur honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
1220 Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
1314*:					
Hanlon	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
1585*:					
Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
1585*:					
Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
5010*. Pits					
5040*. Orthents					
5060*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
6-------------------- Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, erodes easily.	Severe: ponding.
7-------------------- Wiota	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
8B------------------- Judson	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
11B*:					
Colo-----------------	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: flooding, wetness.	Severe: flooding.
Ely------------------	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight------------	Slight.
24D2----------------- Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight------------	Moderate: slope.
24E------------------ Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
27B------------------ Terril	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
27C------------------ Terril	Slight----------	Slight----------	Severe: slope.	Slight------------	Slight.
55------------------- Nicollet	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
62C2----------------- Storden	Slight----------	Slight----------	Severe: slope.	Slight------------	Slight.
62D2----------------- Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: slope.
62E------------------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
62F------------------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
65G------------------ Lindley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
76B------------------ Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight------------	Slight.
76C2----------------- Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight------------	Slight.
76D2----------------- Ladoga	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight------------	Moderate: slope.
80B------------------ Clinton	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Severe: erodes easily.	Slight.
80C, 80C2------------ Clinton	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Severe: erodes easily.	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
80D2 Clinton	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
88 Nevin	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
90 Okoboji	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus, erodes easily.	Severe: ponding.
93D2*:					
Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Adair	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
93E*:					
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Adair	Severe: slope, wetness.	Severe: slope.	Severe: slope, wetness.	Moderate: wetness, slope.	Severe: slope.
95 Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
133 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
135 Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
138B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
138C, 138C2 Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
138D2 Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
168B Hayden	Slight	Slight	Moderate: slope.	Slight	Slight.
168C, 168C2 Hayden	Slight	Slight	Severe: slope.	Slight	Slight.
168D2 Hayden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
168E, 168F Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
169B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
169C2 Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
175B Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
175C Dickinson	Slight	Slight	Severe: slope.	Slight	Slight.
179F Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
201B*:					
Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
203 Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
220 Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
259 Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
308 Wadena	Slight	Slight	Moderate: small stones.	Slight	Slight.
308B Wadena	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
325 Le Sueur	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
356G*:					
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
368 Macksburg	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Moderate: percs slowly, wetness.	Slight	Slight.
370B Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
370C2 Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
370D2 Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
419F Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: erodes easily.	Severe: slope.
419G Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, erodes easily.	Severe: slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
485 Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
507 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
536 Hanlon	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
566B Moingona	Slight	Slight	Moderate: slope.	Slight	Slight.
638C2*:					
Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
Storden	Slight	Slight	Severe: slope.	Slight	Slight.
638D2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
736B Lester	Slight	Slight	Moderate: slope.	Slight	Slight.
736C2 Lester	Slight	Slight	Severe: slope.	Slight	Slight.
822D2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
823 Ridgeport	Slight	Slight	Slight	Slight	Slight.
823B Ridgeport	Slight	Slight	Moderate: slope.	Slight	Slight.
823C Ridgeport	Slight	Slight	Severe: slope.	Slight	Slight.
828B Zenor	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
828C2 Zenor	Slight	Slight	Severe: slope.	Slight	Slight.
829D2*:					
Zenor	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
956*:					
Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, erodes easily.	Severe: ponding.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
993D2*:					
Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
993E*:					
Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Armstrong	Severe: slope, wetness.	Severe: slope.	Severe: slope, wetness.	Moderate: slope, wetness.	Severe: slope.
1220 Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
1314*:					
Hanlon	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Spillville	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
1585*:					
Spillville	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
5010*. Pits					
5040*. Orthents					
5060*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[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
6. Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
7. Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8B. Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B*:										
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
24D2. Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
24E. Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
27B. Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
27C. Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
55. Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62C2, 62D2, 62E. Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
62F. Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
65G. Lindley	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
76B. Ladoga	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
76C2, 76D2. Ladoga	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
80B. Clinton	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
80C, 80C2, 80D2. Clinton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
88. Nevin	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
90. Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
93D2*:										
Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
93E*:										
Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--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
93E*:										
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
95 Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107 Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
133 Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
135 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C, 138C2, 138D2 Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168B Hayden	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168C, 168C2, 168D2, 168E Hayden	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168F Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
169B Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
169C2 Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
175B Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
175C Dickinson	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
179F Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
201B*:										
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
203 Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
220 Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
259 Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
308, 308B Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
325 Le Sueur	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--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
356G*:										
Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
368 Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
370B Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
370C2, 370D2 Sharpsburg	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
419F, 419G Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
485 Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
507 Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
536 Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
566B Moingona	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
638C2*, 638D2*:										
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
736B Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
736C2 Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
822D2 Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
823, 823B, 823C Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828B Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828C2 Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
829D2*:										
Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
956*:										
Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--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
956*:										
Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
993D2*:										
Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
993E*:										
Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Armstrong	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
1220 Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
1314*:										
Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
1585*:										
Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
5010*. Pits										
5040*. Orthents										
5060*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--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
6: Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
7: Wiota	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
8B: Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
11B*:						
Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Severe: flooding.
Ely	Severe: wetness.	Severe: low strength.	Severe: low strength, wetness.	Severe: low strength.	Severe: frost action, low strength.	Slight.
24D2: Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
24E: Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
27B: Terril	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
27C: Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
55: Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
62C2: Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
62D2: Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
62E, 62F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
65G: Lindley	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
76B: Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
76C2: Ladoga	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
76D2: Ladoga	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.

See footnote at end of table.

TABLE 11.--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
80B----------------- Clinton	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
80C, 80C2---------- Clinton	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
80D2--------------- Clinton	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
88----------------- Nevin	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
90----------------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
93D2*:						
Shelby------------	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Adair-------------	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
93E*:						
Shelby------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Adair-------------	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: low strength, slope, frost action.	Severe: slope.
95----------------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
107---------------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
133---------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
135---------------- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
138B--------------- Clarion	Slight-----------	Slight-----------	Slight-----------	Slight-----------	Moderate: frost action.	Slight.
138C, 138C2-------- Clarion	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Moderate: frost action.	Slight.
138D2-------------- Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
168B--------------- Hayden	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 11.--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
168C, 168C2------- Hayden	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
168D2------------- Hayden	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
168E, 168F-------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
169B-------------- Clarion	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
169C2------------- Clarion	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
175B-------------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
175C-------------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
179F-------------- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
201B*:						
Coland-----------	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Severe: flooding.
Terril-----------	Slight---------	Slight---------	Slight---------	Slight---------	Severe: low strength.	Slight.
203--------------- Cylinder	Severe: cutbanks cave, wetness.	Moderate: shrink-swell, wetness.	Severe: wetness.	Moderate: shrink-swell, wetness.	Severe: frost action.	Slight.
220--------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
259--------------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
308, 308B--------- Wadena	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Slight.
325--------------- Le Sueur	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
356G*:						
Hayden-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
368--------------- Macksburg	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.

See footnote at end of table.

TABLE 11.--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
370B Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
370C2 Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
370D2 Sharpsburg	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
419F, 419G Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
485 Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
507 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
536 Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
566B Moingona	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
638C2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
638D2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
736B Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
736C2 Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
822D2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
823, 823B Ridgeport	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
823C Ridgeport	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
828B Zenor	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 11.--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
828C2: Zenor	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
829D2*:						
Zenor	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
956*:						
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
993D2*:						
Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
993E*:						
Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Armstrong	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: slope, wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action, slope.	Severe: slope.
1220: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
1314*:						
Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
1585*:						
Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Severe: flooding.
5010*. Pits						
5040*. Orthents						

See footnote at end of table.

TABLE 11.--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
5060*. Pits						

*See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--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
6: Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
7: Wiota	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
8B: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
11B*:					
Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
24D2: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
24E: Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
27B: Terril	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
27C: Terril	Slight	Severe: slope.	Slight	Slight	Good.
55: Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62C2: Storden	Slight	Severe: slope.	Slight	Slight	Good.
62D2: Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
62E, 62F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
65G: Lindley	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
76B: Ladoga	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
76C2: Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
76D2: Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 12.--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
80B Clinton	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
80C, 80C2 Clinton	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
80D2 Clinton	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
88 Nevin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
90 Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
93D2*:					
Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
93E*:					
Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Adair	Severe: percs slowly, slope, wetness.	Severe: slope, wetness.	Severe: wetness, slope.	Severe: wetness, slope.	Poor: slope, wetness.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
107 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
133 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
135 Coland	Severe: flooding, wetness.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
138B Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
138C, 138C2 Clarion	Slight	Severe: slope.	Slight	Slight	Good.
138D2 Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
168B Hayden	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnote at end of table.

TABLE 12.--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
168C, 168C2---------- Hayden	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
168D2---------------- Hayden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
168E, 168F---------- Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
169B---------------- Clarion	Slight-----------	Moderate: slope, seepage.	Slight-----------	Slight-----------	Good.
169C2--------------- Clarion	Slight-----------	Severe: slope.	Slight-----------	Slight-----------	Good.
175B---------------- Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
175C---------------- Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
179F---------------- Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
201B*:					
Coland--------------	Severe: flooding, wetness.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
Terril--------------	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
203----------------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
220----------------- Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
259----------------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, wetness, too sandy, small stones.
308, 308B----------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
325----------------- Le Sueur	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
356G*:					
Hayden--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Storden-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 12.--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
368 Macksburg	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
370B Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
370C2 Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
370D2 Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
419F, 419G Vanmeter	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, hard to pack, slope.
485 Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
507 Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
536 Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
566B Moingona	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
638C2*:					
Clarion	Slight	Severe: slope.	Slight	Slight	Good.
Storden	Slight	Severe: slope.	Slight	Slight	Good.
638D2*:					
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
736B Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
736C2 Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
822D2 Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
823, 823B Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

See footnote at end of table.

TABLE 12.--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
823C: Ridgeport	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
828B: Zenor	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
828C2: Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
829D2*:					
Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
956*:					
Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
993D2*:					
Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
993E*:					
Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Armstrong	Severe: percs slowly, slope, wetness.	Severe: slope.	Severe: slope, wetness.	Severe: wetness, slope.	Poor: slope, wetness.
1220: Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
1314*:					
Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
1585*:					
Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1585*:					
Coland	Severe: flooding, wetness.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
5010*. Pits					
5040*. Orthents					
5060*. Pits					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--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
6: Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
7: Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
8B: Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11B*:				
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
24D2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
24E: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
27B, 27C: Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
55: Nicollet	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
62C2: Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
62D2: Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
62E, 62F: Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
65G: Lindley	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
76B, 76C2, 76D2: Ladoga	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
80B, 80C, 80C2, 80D2: Clinton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
88: Nevin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
90: Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
93D2*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
93D2*:				
Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
93E*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
95 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
107 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
133 Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
135 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
138B, 138C, 138C2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
138D2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
168B, 168C, 168C2 Hayden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
168D2 Hayden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
168E, 168F Hayden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
169B, 169C2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
175B, 175C Dickinson	Good	Probable	Improbable: too sandy.	Good.
179F Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
201B*:				
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
203 Cylinder	Fair: wetness.	Probable	Improbable: too sandy.	Fair: area reclaim, small stones, thin layer.
220 Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
259 Biscay	Fair: wetness.	Probable	Probable	Poor: area reclaim.
308, 308B Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
325 Le Sueur	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
356G*:				
Hayden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
368 Macksburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
370B, 370C2, 370D2 Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
419F Vanmeter	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
419G Vanmeter	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
485 Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
507 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
536 Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
566B Moingona	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
638C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
638D2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
736B, 736C2 Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
822D2 Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
823, 823B, 823C Ridgeport	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
828B, 828C2 Zenor	Good	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
829D2*:				
Zenor	Good	Probable	Improbable: too sandy.	Fair: small stones, thin layer, slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
956*:				
Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
993D2*:				
Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
993E*:				
Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope, thin layer.
1220 Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1314*:				
Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1585*:				
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
5010*. Pits				
5040*. Orthents				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
5060*. Pits				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--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
6 Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
7 Wiota	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
8B Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
11B*:						
Colo	Moderate: seepage, slope.	Severe: wetness.	Flooding, frost action, slope.	Wetness, slope, flooding.	Wetness	Wetness.
Ely	Moderate: slope, seepage.	Moderate: wetness.	Slope, frost action.	Slope, wetness.	Erodes easily, wetness.	Erodes easily.
24D2, 24E Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
27B, 27C Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
55 Nicollet	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
62C2 Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
62D2, 62E, 62F Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
65G Lindley	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
76B, 76C2 Ladoga	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
76D2 Ladoga	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
80B, 80C, 80C2 Clinton	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
80D2 Clinton	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
88 Nevin	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
90 Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
93D2*, 93E*:						
Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Adair	Severe: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Slope, wetness.	Wetness, slope.

See footnote at end of table.

TABLE 14.--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
95 Harps	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
107 Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
133 Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
135 Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
138B, 138C, 138C2- Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
138D2 Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
168B, 168C, 168C2- Hayden	Moderate: seepage, slope.	Slight	Deep to water	Slope	Favorable	Favorable.
168D2, 168E, 168F- Hayden	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
169B, 169C2 Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
175B, 175C Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
179F Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
201B*:						
Coland	Moderate: seepage, slope.	Severe: wetness.	Flooding, frost action, slope.	Wetness, slope, flooding.	Wetness	Wetness.
Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
203 Cylinder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Favorable.
220 Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
259 Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
308 Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable	Too sandy	Favorable.
308B Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope	Too sandy	Favorable.
325 Le Sueur	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Wetness	Favorable.
356G*:						
Hayden	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.

See footnote at end of table.

TABLE 14.--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
356G*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
368 Macksburg	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
370B, 370C2 Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
370D2 Sharpsburg	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
419F, 419G Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
485 Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
507 Canisteo	Severe: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
536 Hanlon	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing	Favorable.
566B Moingona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Rooting depth, slope.	Favorable	Rooting depth.
638C2*:						
Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
638D2*:						
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
736B, 736C2 Lester	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Erodes easily	Erodes easily.
822D2 Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
823 Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth.	Soil blowing	Rooting depth.
823B, 823C Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth, slope.	Soil blowing	Rooting depth.
828B, 828C2 Zenor	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.

See footnote at end of table.

TABLE 14.--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
829D2*:						
Zenor	Severe: seepage, slope.	Severe: seepage.	Deep to water	Soil blowing, slope.	Slope, too sandy, soil blowing.	Slope.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
956*:						
Harps	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
993D2*, 993E*:						
Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Armstrong	Severe: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.
1220 Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
1314*:						
Hanlon	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing	Favorable.
Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
1585*:						
Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
5010*. Pits						
5040*. Orthents						
5060*. Pits						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
6----------------- Okoboji	0-26	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	26-49	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	49-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	41-55	20-30
7----------------- Wiota	0-18	Silt loam--------	CL	A-6	0	100	100	100	90-95	30-40	11-20
	18-26	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	41-50	15-25
	26-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	41-50	20-30
8B--------------- Judson	0-32	Silty clay loam	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	32-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
11B*:											
Colo-------------	0-34	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	41-60	15-30
	34-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	41-55	20-30
Ely--------------	0-27	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	11-25
	27-60	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	11-25
24D2-------------- Shelby	0-8	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-38	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	38-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
24E--------------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	11-20
	7-41	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	41-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
27B, 27C---------- Terril	0-30	Loam-------------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	11-20
	30-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	11-20
55---------------- Nicollet	0-21	Loam-------------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	11-25
	21-48	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	48-60	Loam-------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
62C2, 62D2, 62E, 62F-------------- 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
65G--------------- Lindley	0-10	Loam, silt loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	50-65	15-30	5-15
	10-50	Clay loam, loam	CL	A-6, A-7	0	95-100	90-100	85-95	55-75	30-45	15-25
	50-60	Loam, clay loam	CL	A-6	0	95-100	90-100	85-95	50-70	30-40	15-25
76B--------------- Ladoga	0-12	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	12-36	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	36-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
76C2, 76D2-------- Ladoga	0-8	Silty clay loam	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	8-42	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	42-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
80B, 80C--------- Clinton	0-11	Silt loam--------	ML	A-4	0	100	100	100	95-100	30-40	5-10
	11-48	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	48-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
80C2, 80D2------- Clinton	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
	7-53	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	53-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25
88--------------- Nevin	0-24	Silty clay loam	CL, OL	A-6, A-7	0	100	100	100	90-95	35-45	11-20
	24-55	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	41-50	20-30
	55-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	41-50	20-30
90--------------- Okoboji	0-12	Mucky silt loam	OH, MH	A-7	0	100	100	95-100	90-95	60-95	11-30
	12-51	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	51-60	Silty clay loam	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
93D2*:											
Shelby-----------	0-8	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-38	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	38-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair-----------	0-6	Clay loam--------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	11-20
	6-44	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	41-55	20-30
	44-60	Clay loam--------	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-50	15-25
93E*:											
Shelby-----------	0-11	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	11-20
	11-41	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	41-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair-----------	0-8	Clay loam--------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	11-20
	8-56	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	41-55	20-30
	56-60	Clay loam--------	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-50	15-25
95--------------- Harps	0-20	Loam-------------	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	20-33	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	33-60	Loam-------------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	11-25
107-------------- Webster	0-17	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	17-29	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
	29-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	11-20
133-------------- Colo	0-34	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	41-60	15-30
	34-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	41-55	20-30
135-------------- Coland	0-44	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30

See footnote at end of table.

TABLE 15.--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	
138B, 138C, 138C2, 138D2----- Clarion	0-18	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	18-37	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	37-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
168B, 168C, 168C2, 168D2, 168E, 168F------ Hayden	0-11	Loam--------------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	11-38	Clay loam, loam	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	38-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-35	8-15
169B, 169C2------ Clarion	0-18	Loam--------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	18-50	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	50-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
175B, 175C-------- Dickinson	0-15	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	15-25	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	25-42	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	<20	NP-5
	42-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
179F-------------- Gara	0-10	Loam--------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-43	Clay loam---------	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	43-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
201B*:											
Coland-----------	0-36	Clay loam---------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	36-60	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
Terril-----------	0-30	Loam--------------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	11-20
	30-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	11-20
203--------------- Cylinder	0-23	Loam--------------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	11-25
	23-35	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	11-20
	35-60	Gravelly coarse sand, loamy sand, sandy loam.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
220--------------- Nodaway	0-60	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
259--------------- Biscay	0-22	Clay loam---------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	11-25
	22-32	Loam, clay loam	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	11-20
	32-60	Stratified sandy loam to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
308, 308B-------- Wadena	0-18	Loam--------------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	18-36	Loam, sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	36-60	Sand, gravel, loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
325--------------- Le Sueur	0-14	Loam, silt loam	CL, ML, CL-ML	A-6, A-4	0	95-100	95-100	90-100	70-85	20-40	5-15
	14-36	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	95-100	95-100	85-100	60-80	35-50	15-25
	36-60	Loam--------------	CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	55-75	20-40	5-20

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
356G*:											
Hayden	0-5	Loam	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	5-25	Clay loam, loam	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	25-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-35	8-15
Storden	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
368 Macksburg	0-23	Silty clay loam	ML, OL, MH, OH	A-7	0	100	100	100	95-100	41-55	15-25
	23-43	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	41-60	20-35
	43-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
370B, 370C2, 370D2 Sharpsburg	0-14	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	14-44	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	41-60	20-35
	44-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
419F, 419G Vanmeter	0-6	Silt loam	CL, CL-ML	A-4, A-6	0-5	90-100	95-100	90-100	70-100	25-40	5-15
	6-30	Silty clay loam, silty clay, clay.	CH	A-7	0-5	90-100	95-100	95-100	85-100	41-65	40-50
	30-60	Weathered bedrock	CH	A-7	0-5	90-100	95-100	95-100	85-100	65-80	50-60
485 Spillville	0-44	Loam	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	44-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
507 Canisteo	0-22	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	22-33	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	33-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
536 Hanlon	0-30	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	30-45	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
	45-60	Loam, sandy loam, loamy sand.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	80-90	20-60	15-35	5-15
566B Moingona	0-18	Loam	CL	A-4, A-6	0-2	95-100	95-100	80-90	50-65	25-40	8-15
	18-60	Sandy clay loam, loam, clay loam.	CL	A-6	0-2	95-100	95-100	80-90	50-60	25-40	11-20
638C2*, 638D2*:											
Clarion	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	7-30	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	30-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden	0-7	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

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
736B, 736C2------ Lester	0-8	Loam-------------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	8-31	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	31-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
822D2------------ Lamoni	0-7	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	7-48	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	48-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
823, 823B, 823C-- Ridgeport	0-13	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	13-28	Sandy loam, gravelly sandy loam, gravelly loamy sand.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	28-60	Gravelly loamy sand, gravelly sand, sand.	SW, SP, SW-SM, SP-SM	A-1	0-5	80-95	75-95	35-50	2-10	<25	NP-6
828B, 828C2------ Zenor	0-11	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	15-25	5-10
	11-34	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	15-25	5-10
	34-60	Gravelly loamy sand, gravelly sand, loamy sand, gravelly sandy loam.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
829D2*: Zenor-----------	0-7	Sandy loam-------	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	60-70	25-40	15-25	5-10
	7-27	Sandy loam, loam	SM-SC, SC	A-2, A-4	0-5	85-95	80-95	50-70	25-40	15-25	5-10
	27-60	Gravelly loamy sand, gravelly coarse sand, loamy sand.	SW, SP, SP-SM	A-1	0-5	85-95	80-90	20-40	3-12	<20	NP-5
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
956*: Harps-----------	0-20	Loam-------------	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	20-33	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	33-60	Loam-------------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	11-25
Okoboji---------	0-26	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	26-49	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	49-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	41-55	20-30
993D2*: Gara------------	0-8	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	8-46	Clay loam--------	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	46-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
Armstrong-------	0-7	Clay loam, silt loam.	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
	7-30	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	30-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
993E*: Gara------------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-34	Clay loam--------	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	34-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
Armstrong-------	0-8	Loam, silt loam	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
	8-35	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	35-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1220------------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
1314*:											
Hanlon----------	0-30	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	30-45	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
	45-60	Loam, sandy loam, loamy sand.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	80-90	20-60	15-35	5-15
Spillville------	0-44	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	44-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
1585*:											
Spillville------	0-44	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	11-20
	44-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
Coland----------	0-36	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	36-60	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
5010*. Pits											
5040*. Orthents											
5060*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
6----------------	0-26	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High----------	0.37	5	4	9-11
Okoboji	26-49	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37			
	49-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate------	0.28			
7----------------	0-18	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7	3-4
Wiota	18-26	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate------	0.43			
	26-60	28-34	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate------	0.43			
8B---------------	0-32	25-32	1.30-1.35	0.6-2.0	0.21-0.23	6.1-7.3	Moderate------	0.28	5	7	3-5
Judson	32-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.3	Moderate------	0.43			
11B*:											
Colo-------------	0-34	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	7	6-7
	34-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High----------	0.28			
Ely--------------	0-27	25-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7	5-6
	27-60	28-32	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate------	0.43			
24D2-------------	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate------	0.28	4	6	1-2
Shelby	8-38	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28			
	38-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37			
24E--------------	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.28	5	6	1-3
Shelby	7-41	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28			
	41-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37			
27B, 27C---------	0-30	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6	4-6
Terril	30-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32			
55---------------	0-21	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6	5-6
Nicollet	21-48	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32			
	48-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32			
62C2, 62D2, 62E, 62F-------------	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	.5-2
Storden	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
65G--------------	0-10	18-27	1.20-1.40	0.6-2.0	0.16-0.18	4.5-7.3	Low-----------	0.32	5	6	.5-1
Lindley	10-50	25-35	1.35-1.55	0.2-0.6	0.14-0.18	4.5-6.5	Moderate------	0.32			
	50-60	18-32	1.40-1.60	0.2-0.6	0.12-0.16	6.1-7.8	Moderate------	0.32			
76B--------------	0-12	18-27	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low-----------	0.32	5	6	2-3
Ladoga	12-36	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate------	0.43			
	36-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate------	0.43			
76C2, 76D2-------	0-8	27-34	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low-----------	0.32	5	6	.5-2
Ladoga	8-42	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate------	0.43			
	42-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate------	0.43			
80B, 80C---------	0-11	16-26	1.30-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.37	5	6	1-3
Clinton	11-48	36-42	1.35-1.45	0.2-0.6	0.16-0.20	5.1-6.0	Moderate------	0.37			
	48-60	24-35	1.40-1.55	0.6-2.0	0.18-0.20	6.1-6.5	Moderate------	0.37			

See footnote at end of table.

TABLE 16.--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
80C2, 80D2-------Clinton	0-7	27-34	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.37	4	7	.5-1
	7-53	36-42	1.35-1.45	0.2-0.6	0.16-0.20	5.1-6.0	Moderate-----	0.37			
	53-60	24-35	1.40-1.55	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.37			
88---------------Nevin	0-24	26-29	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	4-6
	24-55	30-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
	55-60	25-36	1.40-1.45	0.6-2.0	0.18-0.20	6.6-7.3	Moderate-----	0.43			
90---------------Okoboji	0-12	20-26	1.20-1.25	0.6-2.0	0.24-0.26	6.6-7.8	High---------	0.37	5	4	9-18
	12-51	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37			
	51-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37			
93D2*:											
Shelby-----------	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate-----	0.28	4	6	1-3
	8-38	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	38-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
Adair------------	0-6	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.32	2	6	1-3
	6-44	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High---------	0.32			
	44-60	30-38	1.60-1.85	0.2-0.6	0.14-0.16	5.6-7.8	Moderate-----	0.32			
93E*:											
Shelby-----------	0-11	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	2-3
	11-41	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	Moderate-----	0.28			
	41-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
Adair------------	0-8	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.32	2	6	2-3
	8-56	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High---------	0.32			
	56-60	30-38	1.60-1.85	0.2-0.6	0.14-0.16	5.6-7.8	Moderate-----	0.32			
95---------------Harps	0-20	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate-----	0.24	5	4L	4-6
	20-33	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32			
	33-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.32			
107--------------Webster	0-17	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
	17-29	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	29-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
133--------------Colo	0-34	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	6-7
	34-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
135--------------Coland	0-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7	5-7
	44-60	20-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-8.4	High---------	0.28			
138B, 138C, 138C2, 138D2----Clarion	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6	1-4
	18-37	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37			
	37-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
168B, 168C, 168C2, 168D2, 168E, 168F------Hayden	0-11	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	6	.5-3
	11-38	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	38-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
169B, 169C2------Clarion	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6	2-4
	18-50	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37			
	50-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
175B, 175C-------Dickinson	0-15	12-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3	1-2
	15-25	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low----------	0.20			
	25-42	5-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low----------	0.20			
	42-60	5-10	1.60-1.70	6.0-20	0.02-0.04	5.6-6.5	Low----------	0.15			
179F-------------Gara	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	<.5
	10-43	30-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	43-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-7.8	Moderate-----	0.37			

See footnote at end of table.

TABLE 16.--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
201B*:											
Coland----------	0-36	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7	5-7
	36-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28			
Terril----------	0-30	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	4-6
	30-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32			
203--------------	0-23	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6	4-5
Cylinder	23-35	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate-----	0.32			
	35-60	2-12	1.60-1.70	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
220--------------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	1-2
Nodaway											
259--------------	0-22	18-35	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6	6-8
Biscay	22-32	18-35	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28			
	32-60	1-16	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
308, 308B--------	0-18	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	3-4
Wadena	18-36	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32			
	36-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
325--------------	0-14	20-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	Low----------	0.24	5	6	2-4
Le Sueur	14-36	24-35	1.30-1.45	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.32			
	36-60	20-27	1.50-1.65	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32			
356G*:											
Hayden----------	0-5	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	6	<0.5
	5-25	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	25-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
Storden---------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	.5-1
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
368--------------	0-23	25-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	6	4-6
Macksburg	23-43	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	High---------	0.43			
	43-60	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43			
370B-------------	0-14	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	3-5
Sharpsburg	14-44	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	44-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
370C2, 370D2-----	0-8	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	1-3
Sharpsburg	8-38	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	38-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
419F, 419G-------	0-6	18-24	1.30-1.40	0.2-0.6	0.18-0.20	7.4-8.4	Low----------	0.43	3	6	.5-1
Vanmeter	6-30	40-60	1.50-1.60	<0.06	0.12-0.14	7.4-8.4	High---------	0.32			
	30-60	40-75	1.70-1.90	<0.06	0.08-0.10	7.4-8.4	High---------	----			
485--------------	0-44	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
Spillville	44-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
507--------------	0-22	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L	6-7
Canisteo	22-33	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate-----	0.32			
	33-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32			
536--------------	0-30	12-15	1.50-1.70	2.0-6.0	0.16-0.18	6.6-7.3	Low----------	0.20	5	3	2-3
Hanlon	30-45	5-10	1.70-1.75	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20			
	45-60	2-18	1.75-1.85	2.0-6.0	0.12-0.19	5.6-7.8	Low----------	0.20			
566B-------------	0-18	18-20	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	5	3-4
Moingona	18-60	21-30	1.45-1.65	0.6-2.0	0.16-0.18	5.6-7.3	Low----------	0.28			

See footnote at end of table.

TABLE 16.--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
638C2*, 638D2*:											
Clarion----------	0-7	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6	2-3
	7-30	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37			
	30-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
Storden----------	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
	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
736B, 736C2------ Lester	0-8	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Low-----------	0.28	5	6	2-4
	8-31	20-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	Moderate------	0.28			
	31-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	Low-----------	0.37			
822D2------------ Lamoni	0-7	27-38	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate------	0.32	2	7	1-3
	7-48	38-50	1.55-1.75	<0.2	0.13-0.17	5.1-6.5	High----------	0.32			
	48-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	6.1-6.5	High----------	0.32			
823, 823B, 823C-- Ridgeport	0-13	10-18	1.50-1.55	2.0-6.0	0.14-0.17	5.6-7.3	Low-----------	0.24	4	3	1-3
	13-28	10-18	1.55-1.60	2.0-6.0	0.10-0.14	5.6-7.3	Low-----------	0.24			
	28-60	2-8	1.60-1.75	>20	0.03-0.05	7.4-8.4	Low-----------	0.10			
828B, 828C2------ Zenor	0-11	14-18	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low-----------	0.20	4	3	1-3
	11-34	14-18	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low-----------	0.20			
	34-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Low-----------	0.10			
829D2*:											
Zenor------------	0-11	14-18	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low-----------	0.20	4	3	.5-2
	11-34	14-18	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low-----------	0.20			
	34-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Low-----------	0.10			
Storden----------	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	.5-2
	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
956*:											
Harps------------	0-20	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L	4-6
	20-33	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
	33-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
Okoboji----------	0-26	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High----------	0.37	5	4	9-11
	26-49	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37			
	49-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate------	0.28			
993D2*:											
Gara-------------	0-8	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.28	5	6	.5-2
	8-46	30-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate------	0.28			
	46-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-7.8	Moderate------	0.37			
Armstrong--------	0-7	27-38	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate------	0.32	2	6	.5-2
	7-30	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High----------	0.32			
	30-60	30-42	1.55-1.75	0.2-0.6	0.14-0.16	5.1-6.5	Moderate------	0.32			
993E*:											
Gara-------------	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.28	5	6	1-2
	10-34	30-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate------	0.28			
	34-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-7.8	Moderate------	0.37			
Armstrong--------	0-8	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.32	3	6	1-2
	8-35	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High----------	0.32			
	35-60	30-42	1.55-1.75	0.2-0.6	0.14-0.16	5.1-6.5	Moderate------	0.32			
1220------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	6	2-3

See footnote at end of table.

TABLE 16.--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
1314*:											
Hanlon----------	0-30	12-15	1.50-1.70	2.0-6.0	0.16-0.18	6.6-7.3	Low----------	0.20	5	3	2-3
	30-45	5-10	1.70-1.75	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20			
	45-60	2-18	1.75-1.85	2.0-6.0	0.12-0.19	5.6-7.8	Low----------	0.20			
Spillville------	0-44	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	44-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
1585*:											
Spillville------	0-44	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	44-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
Coland----------	0-36	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7	5-7
	36-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28			
5010*. Pits											
5040*. Orthents											
5060*. Pits											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--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]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
6 Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	High	High	Low.
7 Wiota	B	None	---	---	>6.0	---	---	High	Moderate	Moderate.
8B Judson	B	None	---	---	>6.0	---	---	High	Moderate	Low.
11B*:										
Colo	B/D	Frequent	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
Ely	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	High	High	Moderate.
24D2, 24E Shelby	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
27B, 27C Terril	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
55 Nicollet	B	None	---	---	2.5-5.0	Apparent	Apr-May	High	High	Low.
62C2, 62D2, 62E, 62F Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
65G Lindley	C	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
76B, 76C2, 76D2 Ladoga	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
80B, 80C, 80C2, 80D2 Clinton	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
88 Nevin	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	High	High	Low.
90 Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	High	High	Low.
93D2*, 93E*:										
Shelby	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Adair	D	None	---	---	1.0-3.0	Perched	Nov-Jul	High	High	Moderate.
95 Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	High	High	Low.
107 Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	High	High	Low.
133 Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
135 Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
138B, 138C, 138C2, 138D2 Clarion	B	None	---	---	>6.0	---	---	Moderate	Low	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
168B, 168C-------- Hayden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
168C2, 168D2------ Hayden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
168E-------------- Hayden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
168F-------------- Hayden	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
169B, 169C2------- Clarion	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
175B, 175C-------- Dickinson	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
179F-------------- Gara	C	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
201B*:										
Coland-----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Terril-----------	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
203--------------- Cylinder	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	Moderate	Low.
220--------------- Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	High-----	Moderate	Low.
259--------------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	High-----	Moderate	Low.
308, 308B--------- Wadena	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
325--------------- Le Sueur	B	None--------	---	---	2.0-5.0	Apparent	Nov-May	High-----	High-----	Low.
356G*:										
Hayden-----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
Storden----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
368--------------- Macksburg	B	None--------	---	---	2.0-4.0	Apparent	Apr-Jul	High-----	High-----	Moderate.
370B, 370C2, 370D2------------ Sharpsburg	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
419F, 419G-------- Vanmeter	C	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
485--------------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High------	Moderate.
507--------------- Canisteo	C/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	High-----	High------	Low.
536--------------- Hanlon	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	Moderate	Moderate	Low.
566B-------------- Moingona	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
638C2*, 638D2*:										
Clarion----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
736B, 736C2------- Lester	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
822D2------------- Lamoni	D	None--------	---	---	1.0-3.0	Perched	Nov-Jul	Moderate	High-----	Moderate.
823, 823B, 823C--- Ridgeport	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
828B, 828C2------- Zenor	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
829D2*:										
Zenor------------	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
956*:										
Harps------------	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	High-----	High-----	Low.
Okoboji----------	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
993D2*:										
Gara-------------	C	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Armstrong--------	D	None--------	---	---	1.0-3.0	Perched	Nov-Jul	High-----	High-----	Moderate.
993E*:										
Gara-------------	C	None--------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Armstrong--------	D	None--------	---	---	1.0-3.0	Perched	Nov-Jul	High-----	High-----	Moderate.
1220-------------- Nodaway	B	Frequent----	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	High-----	Moderate	Low.
1314*:										
Hanlon-----------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	Moderate	Moderate	Low.
Spillville-------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
1585*:										
Spillville-------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
Coland-----------	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
5010*. Pits										
5040*. Orthents										
5060*. Pits										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Clinton	Fine, montmorillonitic, mesic Typic Hapludalfs
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
*Le Sueur	Fine-loamy, mixed, mesic Aquic Argiudolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Lindley	Fine-loamy, mixed, mesic Typic Hapludalfs
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Moingona	Fine-loamy, mixed, mesic Typic Argiudolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Typic Udorthents
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zenor	Coarse-loamy, mixed, mesic Typic Hapludolls

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