United States
Department of
Agriculture

Soil
Conservation
Service

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

Soil Survey of Sioux County, Iowa

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How To Use This Soil Survey

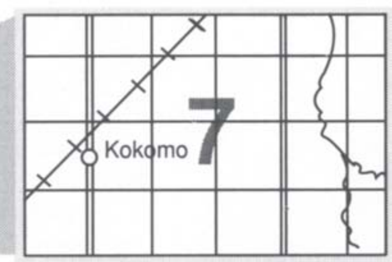
General Soil Map

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

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

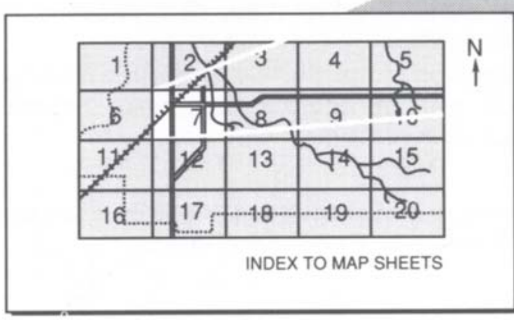
Detailed Soil Maps

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



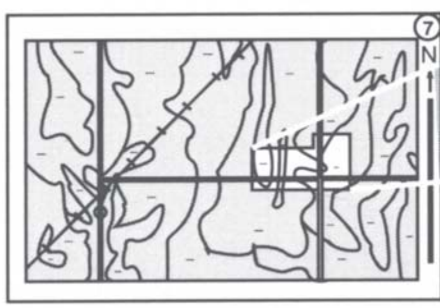
MAP SHEET

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

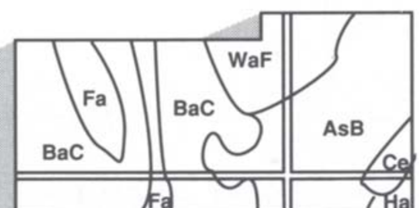


INDEX TO MAP SHEETS

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



MAP SHEET



AREA OF INTEREST

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

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

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed during the period 1981 to 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship. It is part of the technical assistance furnished to the Sioux County Soil and Water Conservation District. Funds appropriated by Sioux County were used to defray part of the cost of the survey.

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

Cover: Contour terraces in an area of Galva silty clay loam, 5 to 9 percent slopes, moderately eroded. The terraces help to control erosion.

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Issued June 1990

Index to Map Units

Summary of Tables

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Preface

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

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

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

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

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Soil Survey of
Sioux County, Iowa

By Thomas O'Connor, Soil Conservation Service

Fieldwork by Joseph M. Kristoff, Thomas O'Connor, Bruce D. Seelig, and
Robert W. Wilson, Soil Conservation Service

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

Sioux County is in the northwestern part of Iowa (fig. 1). It has an area of 490,240 acres, or 766 square miles. Orange City, the county seat, is in the southeastern part of the county, about 160 miles northwest of Des Moines, the state capital.

This survey updates the soil survey of Sioux County published in 1917 *(11)*. It provides additional information and larger maps, which show the soils in more detail.

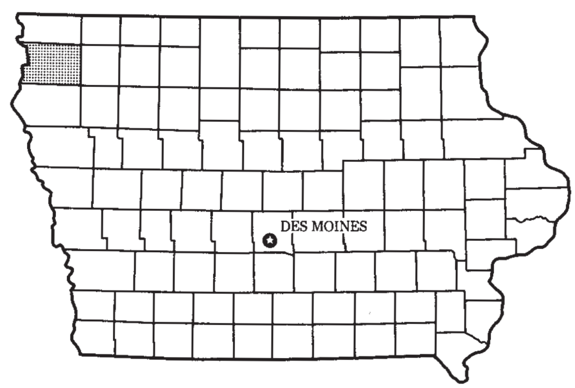

Figure 1.—Location of Sioux County in Iowa.

General Nature of the County

The history, farming, relief and drainage, transportation facilities, natural resources, and climate of the county are described in this section.

History

The first inhabitants of the area now known as Sioux County were Woodland Indians. They migrated into Iowa from Illinois and the Ohio Valley. The first Europeans, French traders and Christian missionaries, came into this area about 1700. The federal government acquired most of the land in Sioux County from the Indians through a treaty concluded on July 5, 1830. On December 28, 1846, Iowa became a state. On January 15, 1851, the Legislature of Iowa established 50 counties, including Sioux County. In 1860, the county was organized and Calliope was its county seat. In that year the population was 10.

In the spring of 1870, a colony of 40 Dutch families from Pella, in Marion County, settled in the southeastern part of Sioux County. The following summer they established the town of Orange City, which was made the county seat in 1872 . The first farmers in the county planted potatoes, wheat, rye, barley, and corn *(8)*.

By 1920, the population of Sioux County reached 26,450. In 1986, it was about 30,000.

Farming

Farming is the chief economic enterprise in Sioux County. In 1985, about 468,000 acres was farmland. Of this acreage, about 402,636 acres was used as cropland. Corn, soybeans, and oats are the main crops. The county ranks first in the state in the number of grain-fed cattle marketed. In 1985, about 652,000 hogs and 135,000 grain-fed cattle were marketed. In 1985, the number of laying hens was about 486,000 *(6)*.

In 1985, the average farm size was 234 acres in Sioux County and 303 acres in Iowa.

Relief and Drainage

Sioux County generally is on dissected uplands. It is drained by the Floyd River and its tributaries in the east, the Rock River in the northwest, and the Big Sioux River and its tributaries in the west.

The Floyd River enters the county 4 miles south of the northeast corner and crosses the county in a south-southwesterly direction. The West Branch of the Floyd River originates north of Boyden and almost parallels the Floyd River until it exits the county near the center of the southern boundary. Surface water in a small area in the northeastern part of the county drains into Otter Creek and then into the Rock River.

The Rock River enters the county about 14 miles east of the northwest corner. It flows southwest, joining the Big Sioux River about 12 miles south of the northwest corner.

The Big Sioux River marks the entire western boundary of the county. Six Mile Creek and Dry Creek begin in central Sioux County and enter the Big Sioux River near Hawarden. Indian Creek begins near Ireton and exits the county about 6 miles east of the western boundary. The surface water throughout the county eventually drains into the Missouri River.

The highest surface elevation in the county is about 1,490 feet above sea level in two areas. One area is southwest of Hull, and the other is in the northwestern part of the county, north of Fairview, South Dakota. The lowest elevation is about 1,150 feet above sea level in the southwest corner, along the Big Sioux River.

The soils in the county range from nearly level to very steep. In the eastern part, nearly level or gently sloping, broad upland divides are separated by moderately wide, nearly level drainageways. In the western part of the county, the upland divides and waterways are narrower and the side slopes are more sloping. Areas along the Floyd River, the West Branch of the Floyd River, the Rock River, and the Big Sioux River have extensive systems of terraces and bottom land that are 0.25 mile to more than 2.0 miles wide. Along the Big Sioux River, steep bluffs that support some stands of native trees mark the break between river terraces and uplands.

Transportation Facilities

U.S. Highway 75, running north and south, and U.S. Highway 18, running dominantly east and west, intersect in the north-central part of the county. State Highway 10, running east and west, intersects U.S. 75 in the south-central part of the county. State Highway 12, running north and south along the western border of the county, extends from its intersection with State Highway 10 to the southern boundary of the county. State Highway 60 runs generally north and south in the eastern part of the county. These routes are connected to all parts of the county by concrete, blacktop, or gravel roads.

Most farmsteads are along all-weather roads. Alton, Boyden, Chatsworth, Hawarden, Hospers, Hull, Maurice, Rock Valley, Sheldon, and Sioux Center are on mainline or branch railroads. There are small municipal airports at Hawarden, Orange City, Sheldon, and Sioux Center. Bus transportation is available along both north-south and east-west routes. Motor freight lines serve every trading center in the county.

Most of the county is rural. Many of the towns, however, have substantial industries. The major industries process meat and manufacture clothing, farm equipment, and paint. Most towns have grain elevators and farm equipment and supply outlets. Several towns have livestock auction markets or buying stations. In most areas of the county cattle feeding is important.

Natural Resources

Soil is the most important natural resource in the county. It is the growing medium for cultivated crops and for the pasture plants grazed by livestock. In most of the county, the water supply is adequate for domestic use and for watering livestock. Most of the rural areas are served by rural water districts. Most towns have municipal water systems.

In areas along the Floyd River, the West Branch of the Floyd River, the Rock River, and the Big Sioux River, the terraces that run parallel to the drainageways are good sources of sand and gravel.

Climate

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

Sioux County is cold in winter and is quite hot and has occasional cool spells in summer. Precipitation in winter frequently occurs as snowstorms. During the warmer months, when warm, moist air moves in from the south, the precipitation is chiefly showers, which are often heavy. The total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Hawarden, Iowa, in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 20 degrees F, and the average daily minimum temperature is 10 degrees. The lowest temperature on record, which occurred at Hawarden on January 14, 1982, is -30 degrees. In summer the average temperature is 73 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Hawarden on July 30, 1955, 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 27 inches. Of this, about 20 inches, or 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 15 inches. The heaviest 1-day rainfall during the period of record was 7.56 inches at Hawarden on June 7, 1953. Thunderstorms occur on about 44 days each year.

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

The average seasonal snowfall is about 35 inches. The greatest snow depth at any one time during the period of record was 26 inches. On the average, 44 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

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

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

General Soil Map Units

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

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

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

Soil Descriptions

1. Galva-Colo-Calco Association

Nearly level and gently sloping, well drained and poorly drained, silty soils formed in loess and alluvium; on bottom land and stream benches

This association consists of nearly level and undulating soils on benches and nearly level soils on bottom land. Slopes range from 0 to 5 percent.

This association makes up about 12 percent of the county. It is about 31 percent Galva soils, 30 percent Colo soils, 8 percent Calco soils, and 31 percent soils of minor extent (fig. 2).

The well drained Galva soils are on the nearly level and gently sloping parts of stream benches. The poorly drained Colo and Calco soils are on the nearly level bottom land.

Typically, the surface layer of Galva soils is black silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam. It is underlain by sand and gravel that in places have loamy strata.

Typically, the surface layer of Colo soils is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 15 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled silty clay loam.

Typically, the surface layer of Calco soils is black, calcareous silty clay loam about 6 inches thick. The subsurface layer also is black, calcareous silty clay loam. It is about 39 inches thick. The subsoil to a depth of about 60 inches is dark gray, calcareous silty clay loam.

The minor soils in this association are Allendorf, Estherville, Kennebec, and Spillville soils. Allendorf soils are well drained and formed in silty sediments on stream benches. Estherville soils are somewhat excessively drained and formed in loamy glacial outwash overlying calcareous sand and gravel. They are on outwash plains and stream terraces. Kennebec and Spillville soils are moderately well drained and somewhat poorly drained and are on level or nearly level flood plains. Kennebec soils formed in silty alluvium, and Spillville soils formed in loamy alluvium.

Most of this association is used for row crops, small grain, or hay. Areas that have meandering stream channels are used for pasture or as habitat for woodland wildlife. The main enterprise is growing cash-grain crops. The soils are generally well suited to cultivated crops if they are adequately drained and are protected from flooding where necessary. Corn, soybeans, oats, hay, and pasture plants grow well. Available water capacity is very high or high. The content of organic matter is moderate or high. The main management concerns are improving drainage, protecting the soil from floodwater, and maintaining

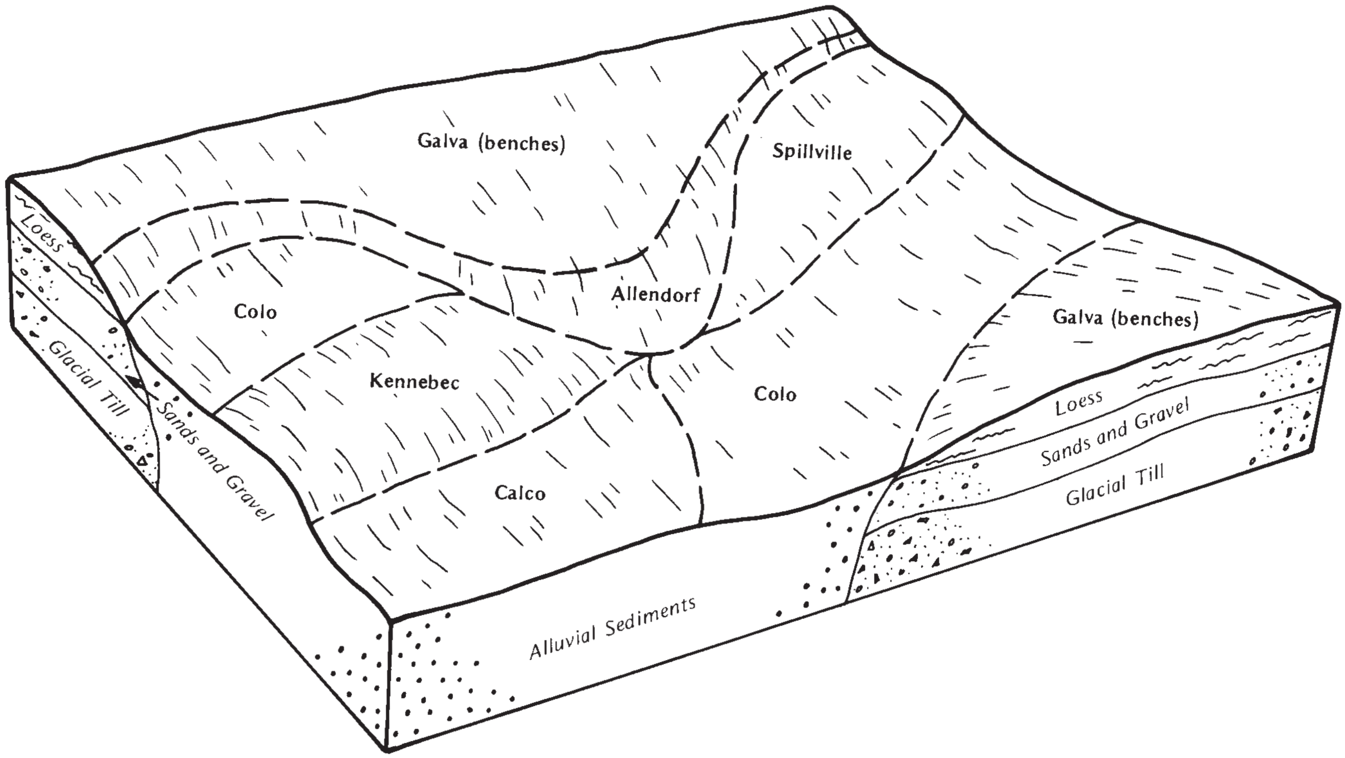

Figure 2.—Typical pattern of soils and parent material in the Galva-Colo-Calco association.

fertility. The soils can be drained by tile and surface drains if adequate outlets are available. Diversions, levees, and channel improvements help to control floodwater and runoff from the adjacent areas.

2. Galva-Primghar Association

Level to gently sloping, well drained and somewhat poorly drained, silty soils formed in loess; on uplands

This association consists of soils on nearly level, wide ridgetops and undulating, convex side slopes. Slopes range from 0 to 5 percent.

This association makes up about 43 percent of the county. It is about 57 percent Galva soils, 19 percent Primghar soils, and 24 percent soils of minor extent (fig. 3).

The well drained Galva soils are on the nearly level and gently sloping ridgetops and convex side slopes. The somewhat poorly drained Primghar soils are at slightly lower elevations than the Galva soils and are level to gently sloping.

Typically, the surface layer of Galva soils is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

Typically, the surface layer of Primghar soils is black silty clay loam about 11 inches thick. The subsurface layer is very dark gray silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is friable. The upper part is dark grayish brown silty clay loam, and the lower part is olive, calcareous silt loam. The substratum to a depth of about 60 inches is dark yellowish brown and light brownish gray, calcareous silt loam.

The minor soils in this association are Afton, Calco, Colo, and Marcus soils. The poorly drained Afton soils are in level areas and on the upper parts of drainageways. They formed in loess and local alluvium derived from loess. Marcus soils formed in loess, are poorly drained, and are in level areas and the lower

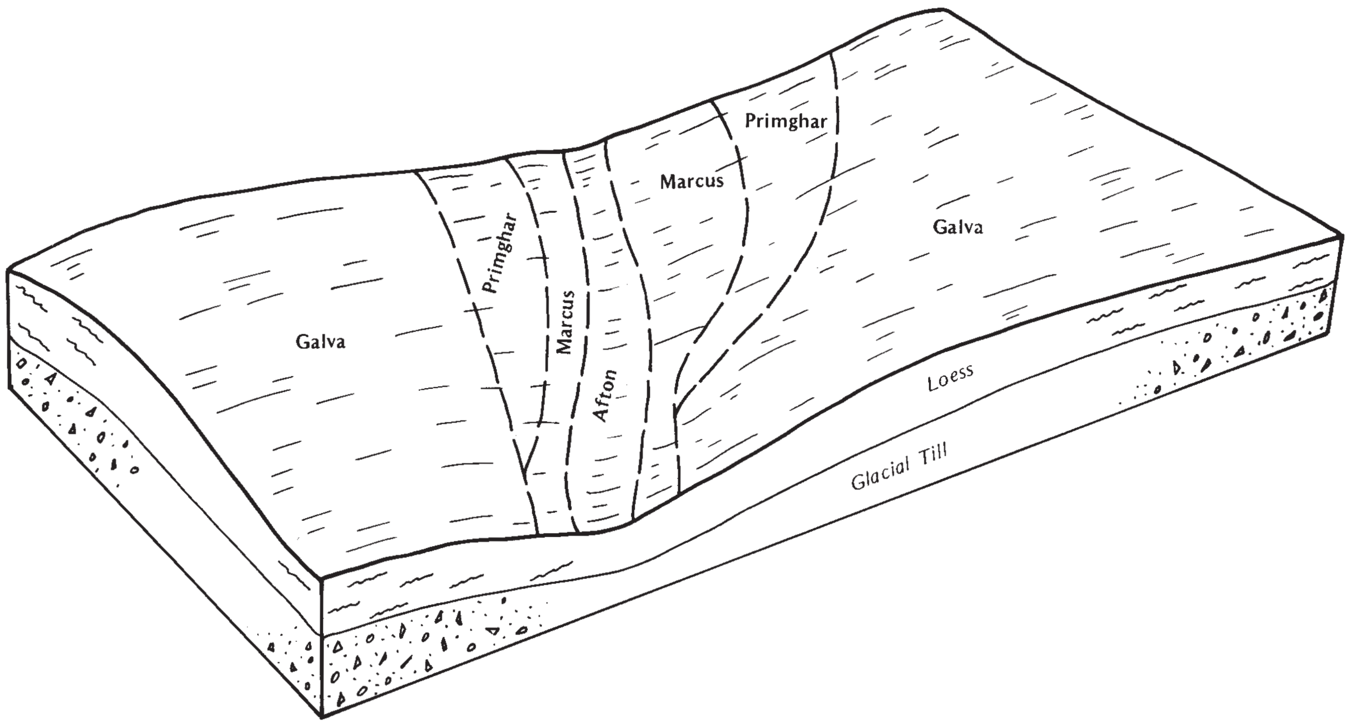

Figure 3.—Typical pattern of soils and parent material in the Galva-Primghar association.

parts of drainageways. Calco and Colo soils formed in alluvium and are on stream bottoms. Calco soils are calcareous throughout.

Most of this association is used for row crops, small grain, or hay. The main enterprises are growing cash crops and feeding livestock. The soils are well suited to corn, soybeans, oats, and hay. Most of the trees are in groves or windbreaks near farm buildings or along the major streams. Available water capacity is high, and the organic matter content is moderate or high. The main management concerns are controlling erosion and maintaining tilth and fertility. The gently sloping soils are subject to erosion. A subsurface drainage system is needed in the more poorly drained areas.

3. Primghar-Galva-Marcus Association

Nearly level and gently sloping, somewhat poorly drained, well drained, and poorly drained, silty soils formed in loess; on uplands

This association consists of soils in nearly level to undulating areas on broad drainage divides and in drainageways. Slopes range from 0 to 5 percent.

This association makes up about 4 percent of the county. It is about 50 percent Primghar soils, 27 percent Galva soils, 19 percent Marcus soils, and 4 percent soils of minor extent (fig. 4).

The somewhat poorly drained Primghar soils are on plane and convex drainage divides and concave side slopes. They are nearly level and gently sloping. The well drained Galva soils are on the nearly level ridgetops and gently sloping side slopes. The poorly drained Marcus soils are in nearly level areas on upland divides and in drainageways.

Typically, the surface layer of Primghar soils is black silty clay loam about 11 inches thick. The subsurface layer is very dark gray silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is friable. The upper part is dark grayish brown silty clay loam, and the lower part is olive, calcareous silt loam. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous silt loam.

Typically, the surface layer of Galva soils is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous, mottled silt loam.

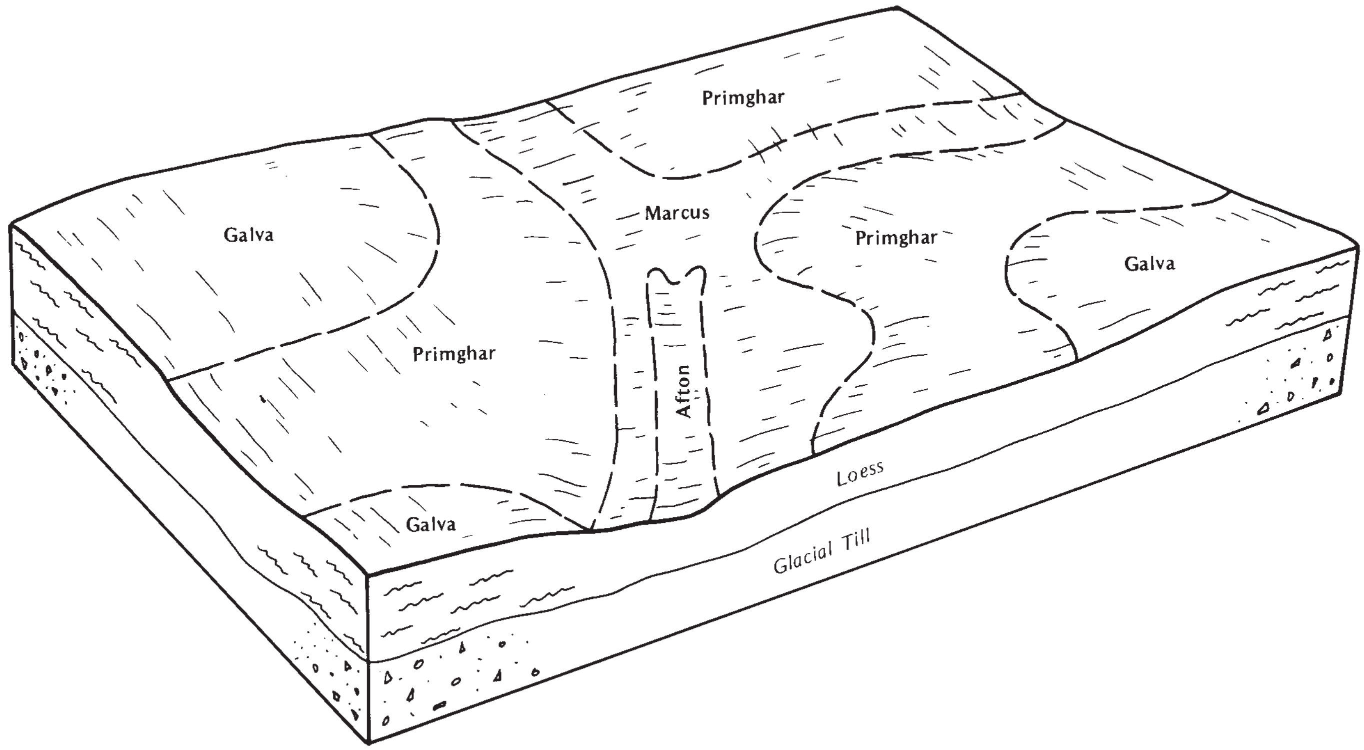

Figure 4.—Typical pattern of soils and parent material in the Primghar-Galva-Marcus association.

Typically, the surface layer of Marcus soils is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 10 inches thick. It is black in the upper part and very dark gray and olive in the lower part. The subsoil is mottled, friable silty clay loam about 22 inches thick. It is olive gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is mottled light olive gray and strong brown silt loam.

The minor soils in this association are Afton and Spicer soils. The poorly drained Afton soils formed in loess and local alluvium derived from loess. They are in upland drainageways. The poorly drained Spicer soils formed in calcareous loess and are in broad nearly level areas on uplands.

Most of this association is used for row crops, small grain, or hay. The main enterprises are growing cash crops and feeding livestock. The soils are well suited to corn, soybeans, oats, and hay. Most of the trees are in groves or windbreaks around farm buildings or along the major streams. Available water capacity is very high or high. The organic matter content is moderate or high. The main management concerns are controlling erosion, improving drainage, and maintaining tilth and fertility. The more sloping soils are subject to erosion. In the more poorly drained areas, a subsurface drainage system is needed.

4. Galva-Ida Association

Gently sloping to strongly sloping, well drained, silty soils formed in loess; on uplands

This association consists of soils on nearly level and undulating ridgetops and gently rolling to rolling, convex side slopes. The soils formed in loess. Slopes range from 0 to 14 percent.

This association makes up about 6 percent of the county. It is about 57 percent Galva soils, 10 percent Ida soils, and 33 percent soils of minor extent.

The well drained Galva soils are on the gently sloping ridgetops and moderately sloping side slopes. The well drained Ida soils are on the moderately sloping and strongly sloping side slopes.

Typically, the surface layer of Galva soils is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

Typically, the surface layer of Ida soils is very dark grayish brown, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is brown, dark yellowish brown, and yellowish brown, calcareous silt loam. It is mottled in the lower part.

The minor soils in this association are Judson, Primghar, Radford, and Rawles soils. Judson and Rawles soils formed in silty local alluvium. Judson soils are well drained and moderately well drained and are on foot slopes. Rawles soils are moderately well drained and are in upland drainageways. They are calcareous. Primghar soils formed in loess, are somewhat poorly drained, and are in level areas and on the upper parts of drainageways. Radford soils formed in alluvium on flood plains and alluvial fans. They are somewhat poorly drained.

Most of this association is used for row crops, small grain, or hay. The main enterprises are growing cash crops and feeding livestock. The soils are well suited to corn, soybeans, oats, and hay. Most of the trees are in groves or windbreaks near farm buildings or along the major streams. Available water capacity is very high. The content of organic matter is moderate or low. The main management concerns are controlling erosion and maintaining fertility. The gently sloping to strongly sloping soils are subject to erosion.

5. Galva-Radford Association

Nearly level to moderately sloping, well drained and somewhat poorly drained, silty soils formed in loess and alluvium; on uplands, bottom land, and alluvial fans

This association consists of soils on nearly level to gently rolling drainage divides and in nearly level upland drainageways. It has a well developed natural drainage system. Slopes range from 0 to 9 percent.

This association makes up about 25 percent of the county. It is about 58 percent Galva soils, 9 percent Radford soils, and 33 percent soils of minor extent.

The well drained Galva soils are on the nearly level ridgetops and moderately sloping side slopes. The somewhat poorly drained Radford soils are on bottom land and alluvial fans.

Typically, the surface layer of Galva soils is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

Typically, the surface layer of Radford soils is very dark gray silt loam about 8 inches thick. The subsurface layer is friable, very dark gray silt loam about 4 inches thick. The substratum is stratified silt loam about 19 inches thick. The upper part is very dark gray, and the lower part is black. Below this to a depth of about 60 inches is a buried soil of black silty clay loam.

The minor soils in this association are Ida, Judson, and Sac soils. The moderately well drained and well drained Judson soils are on foot slopes, and the well drained Ida and Sac soils are on side slopes. Ida soils are calcareous and formed in loess. Sac soils formed in loess and in the underlying glacial till.

Most of this association is used for cultivated crops. Most of the trees are in groves or windbreaks around farm buildings or along the major streams. The soils are well suited to all of the cultivated crops commonly grown in the county. The main enterprises are growing corn and soybeans as cash crops and feeding beef cattle. The main management concerns are controlling erosion and maintaining tilth and fertility.

6. Bolan-Dickman-Ocheyedan Association

Nearly level to strongly sloping, well drained, loamy soils formed in alluvium and eolian material; on uplands and stream terraces

This association consists of soils on nearly level ridgetops and gently rolling and rolling side slopes. Slopes range from 0 to 14 percent.

This association makes up about 3 percent of the county. It is about 42 percent Bolan soils, 12 percent Dickman soils, 11 percent Ocheyedan soils, and 35 percent soils of minor extent.

The Bolan soils are generally downslope from the Ocheyedan soils. The Dickman soils are generally downslope from the Bolan and Ocheyedan soils. The Ocheyedan soils are on convex ridgetops and hillsides.

Typically, the surface layer of Bolan soils is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, very friable loamy fine sand; and the lower part is dark yellowish brown and yellowish brown, very friable loamy sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand.

Typically, the surface layer of Dickman soils is very dark brown sandy loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable loamy sand about 18 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous sand.

Typically, the surface layer of Ocheyedan soils is very dark gray loam about 6 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 31 inches thick. It is friable. The upper part is brown loam, and the lower part is dark yellowish brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

The minor soils in this association are Galva, Steinauer, Terril, and Wadena soils. These soils are well drained or moderately well drained. Galva soils formed in loess and are on convex ridgetops and side slopes. Steinauer soils formed in glacial till and are on steep side slopes adjacent to the Rock River. Terril soils formed in local alluvium on foot slopes, on alluvial fans, and in upland drainageways. Wadena soils formed in loamy alluvial sediments and are underlain by calcareous sand and gravel.They are on stream terraces.

The main enterprises are growing cash crops and raising cow-calf herds. The more strongly sloping soils are generally used for permanent pasture, hay, or woodland. Many of these soils are too steep for cultivation or are droughty. The less sloping soils are suited to all of the cultivated crops commonly grown in the county. Available water capacity is high or moderate. The organic matter content is moderate or moderately low. The main management concerns are controlling erosion, preventing the formation of gullies, and maintaining fertility.

7. Moody Association

Nearly level to strongly sloping, well drained, silty soils formed in loess; on uplands

This association consists of soils on nearly level to undulating ridgetops and gently rolling and rolling side slopes. Slopes range from 0 to 14 percent.

This association makes up about 6 percent of the county. It is about 69 percent Moody soils and 31 percent soils of minor extent.

Typically, the surface layer of Moody soils is very dark gray silty clay loam about 8 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 22 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown, calcareous silt loam. It is mottled in the lower part.

The minor soils in this association are Crofton, Judson, Primghar, and Radford soils. Crofton soils formed in loess. They are calcareous throughout. They are well drained and are on the upper part of side slopes. Judson and Primghar soils are in upland drainageways. Judson soils formed in local alluvium and colluvium and are well drained and moderately well drained. Primghar soils formed in loess and are somewhat poorly drained. Radford soils formed in silty alluvium over a buried soil and are somewhat poorly drained. They are on bottom land and alluvial fans.

Most of this association is used for row crops, small grain, or hay and pasture. The main enterprises are growing cash crops and feeding livestock. The soils are well suited to corn, soybeans, oats, and hay. Most of the trees are in groves or windbreaks near farm buildings or along the major streams. Available water capacity is very high or high. The organic matter content is low or moderately low. The main management concerns are controlling erosion and maintaining tilth and fertility. The more sloping soils are subject to erosion.

8. Steinauer-Moody Association

Strongly sloping to very steep, well drained, loamy and silty soils formed in glacial till and loess; on uplands

This association consists of rolling to very steep soils on convex side slopes. Slopes range from 9 to 40 percent.

This association makes up about 1 percent of the county. It is about 50 percent Steinauer soils, 30 percent Moody soils, and 20 percent soils of minor extent (fig. 5).

The Steinauer soils are on the very steep parts of the side slopes. The Moody soils are on the strongly sloping parts.

Typically, the surface layer of Steinauer soils is very dark gray, calcareous clay loam about 5 inches thick. The next layer is calcareous, friable clay loam about 8 inches thick. It is olive brown and grayish brown and has mottles. The substratum to a depth of 60 inches is gray and olive brown, mottled, calcareous clay loam.

Typically, the surface layer of Moody soils is very dark gray silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 26 inches thick. It is brown in the upper part and dark yellowish brown in the lower part.

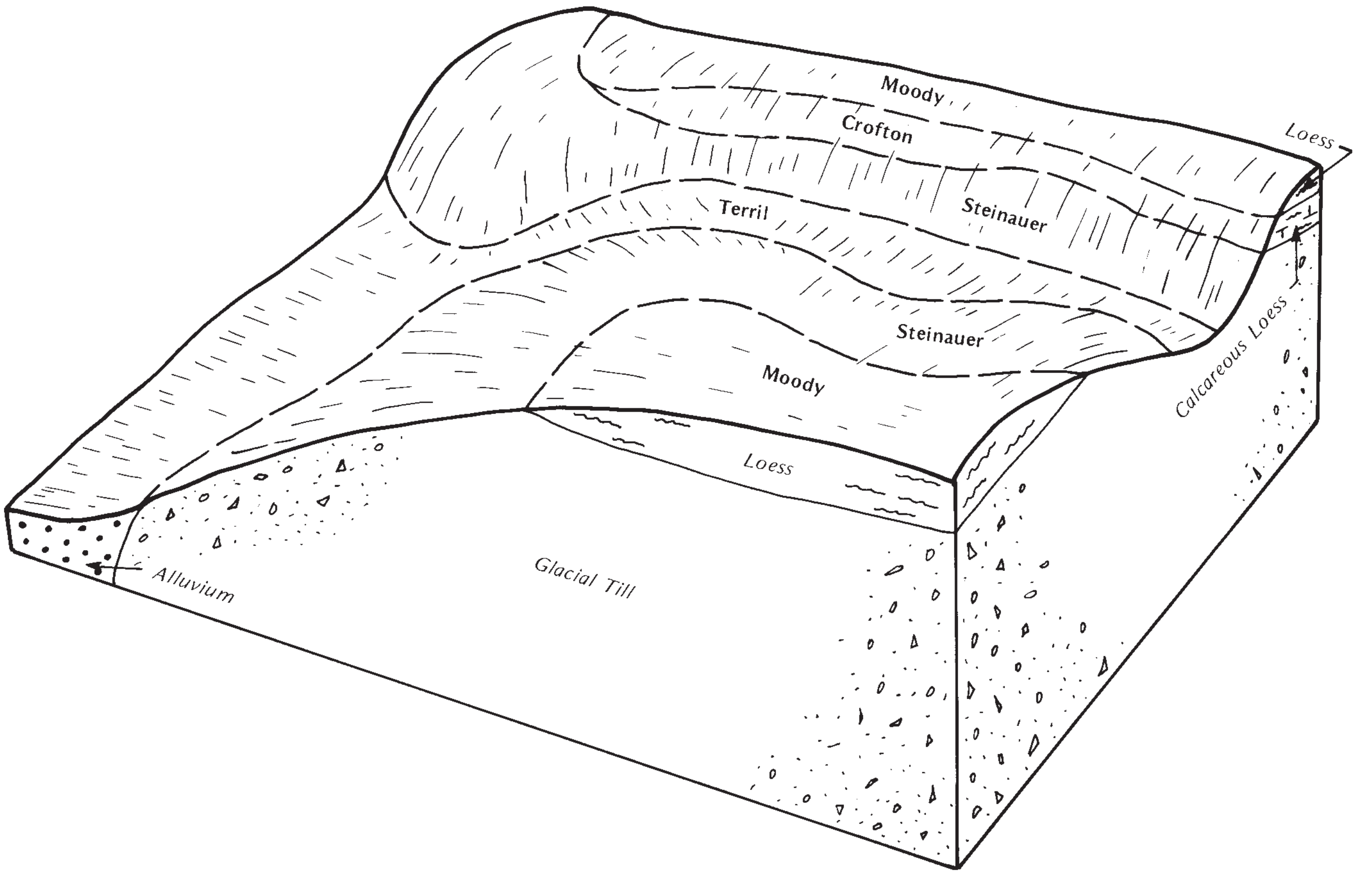

Figure 5.—Typical pattern of soils and parent material in the Steinauer-Moody association.

The substratum to a depth of about 60 inches is brown, calcareous silt loam. It has mottles in the lower part.

The minor soils in this association are Crofton and Terril soils. The well drained Crofton soils formed in loess, are calcareous throughout, and are on the upper part of the side slopes. The moderately well drained Terril soils formed in loamy local alluvium on foot slopes and in upland drainageways.

Most of this association is used as permanent pasture, woodland, or wildlife habitat. Many small ponds in the steep areas help to control erosion, prevent the formation of gullies, and provide water for livestock. A few large ponds provide habitat for aquatic life and waterfowl. The soils are well suited to woodland and to the development of wildlife habitat. The main management concerns are controlling water erosion, preventing the formation of gullies, and maintaining fertility.

Detailed Soil Map Units

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

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

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

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

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

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Radford-Judson complex, 0 to 5 percent slopes, is an example.

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

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

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

Soil Descriptions

1B3—Ida silt loam, 2 to 5 percent slopes, severely eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 3 to 12 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam about 8 inches thick. It has very dark grayish brown pockets. The substratum to a depth of about 60 inches is brown and dark yellowish brown, calcareous silt loam. It is mottled in the lower part. In some places the upper 24 inches is noncalcareous because of leaching. In other places the soil is moderately sloping. In some areas the surface soil is thicker.

Permeability is moderate, and runoff is medium. Available water capacity is very high. The content of organic matter is about 0.5 to 2.0 percent in the surface layer. The substratum generally 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 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. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in a calcareous soil results in the highest yields. Overgrazing causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIe.

1C3—Ida silt loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, well drained soil is on narrow, rounded ridgetops and the upper parts of side slopes in the uplands. Areas range from 5 to 15 acres in size and are narrow and irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam about 7 inches thick. It has very dark grayish brown pockets. The substratum to a depth of about 60 inches is brown, dark yellowish brown, and yellowish brown, calcareous silt loam. It is mottled in the lower part. In some places the surface layer is darker and is more than 7 inches thick. In other places the upper 24 inches is noncalcareous because of leaching.

Included with this soil in mapping are areas of Bolan Variant soils on side slopes and nose slopes. These soils have a loamy surface layer. They make up less than 10 percent of the unit.

Permeability in the Ida soil is moderate, and runoff is medium. Available water capacity is very high. The content of organic matter is about 0.5 to 2.0 percent in the surface layer.

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, erosion is a hazard. Contour farming, terraces, a conservation tillage system that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in a calcareous soil results in the highest yields. Overgrazing causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

1D3—Ida silt loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained soil is on ridgetops and side slopes in the uplands. Areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam about 5 inches thick. The substratum to a depth of 60 inches is yellowish brown, mottled, friable, calcareous silt loam. In places the surface layer is darker and is more than 5 inches thick. In some areas the upper 12 inches is noncalcareous because of leaching. In other areas the slope is more than 14 percent.

Included with this soil in mapping are areas of Bolan Variant soils on side slopes and nose slopes. These soils have a loamy surface layer. They make up less than 10 percent of the unit.

Permeability in the Ida soil is moderate, and runoff is rapid. Available water capacity is very high. The content of organic matter is about 0.5 to 2.0 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a low supply of available potassium. Tilth is good.

Most areas are used as cropland, but a few areas are pastured. This soil is 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. Contour farming, terraces, a conservation tillage system that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in calcareous soil results in the highest yields. Overgrazing causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

8B—Judson silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained and moderately well drained soil is on foot slopes and alluvial fans in upland drainageways. Areas range from 5 to 75 acres in size and are long and narrow.

Typically, the surface layer is very dark brown silty clay loam about 11 inches thick. The subsurface layer is friable silty clay loam about 19 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is friable silty clay loam. The upper part is brown, and the lower part is dark yellowish brown. In some places the dark surface soil is less than 24 inches thick. In other places the subsoil is mottled.

Included with this soil in mapping are some small areas of the somewhat poorly drained, stratified Radford soils. These soils are adjacent to the waterways that dissect the Judson soil. They make up less than 10 percent of the unit.

Permeability in the Judson soil is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil generally has a 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. In some areas runoff from soils upslope results in siltation and gullying. Diversion terraces help to control the runoff from the adjacent side slopes and help to prevent siltation. Grassed waterways help to remove excess water and prevent gullying. Good tilth generally can be easily maintained.

In pastured areas overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production.

The land capability subclass is IIe.

11B—Radford-Judson complex, 0 to 5 percent slopes. These nearly level and gently sloping soils are on foot slopes, alluvial fans, and narrow bottom land, mainly along small streams and waterways in the uplands. The somewhat poorly drained Radford soil is on flood plains. It is subject to flooding. The well drained and moderately well drained Judson soil is on foot slopes and alluvial fans. Areas range from about 5 to 100 acres in size and are long and narrow. They are about 60 percent Radford soil and about 30 percent Judson soil. The two soils occur as areas so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the Radford soil has a surface layer of very dark gray silt loam about 8 inches thick. The subsurface layer is friable, very dark gray silt loam about 4 inches thick. The substratum is stratified silt loam about 19 inches thick. The upper part is very dark gray, and the lower part is black. Below the substratum to a depth of about 60 inches is a buried soil of black silty clay loam. In places the subsurface layer is stratified.

Typically, the Judson soil has a surface layer of very dark brown silty clay loam about 11 inches thick. The subsurface layer is friable silty clay loam about 20 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is dark yellowish brown, friable silty clay loam.

Included with these soils in mapping are small areas of the somewhat poorly drained Ely soils on foot slopes and the poorly drained Colo soils along waterways. Included soils make up about 10 percent of the unit.

Permeability in the Radford and Judson soils is moderate. Runoff is slow on the Radford soil and medium on the Judson soil. Available water capacity is very high in both soils. The content of organic matter is about 5 to 7 percent in the surface layer. In the Radford soil, the seasonal high water table is at a depth of 1 to 3 feet. The substratum of the Radford soil has a medium supply of available phosphorus and a very low supply of available potassium. The subsoil of the Judson soil has a low supply of available phosphorus and potassium. Tilth is good in both soils.

Most areas are cultivated. Many small areas are cropped along with areas of the adjacent soils. Some areas are used for pasture. Some areas are in grassed waterways. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The wetness of the Radford soil is the main limitation. Some areas receive runoff from side slopes and are subject to siltation. Other areas near small streams are subject to flooding of short duration. Grassed waterways help to control erosion and to prevent gullying. A subsurface drainage system helps to improve the timeliness of fieldwork. Good tilth generally can be easily maintained in both soils.

In pastured areas overgrazing or grazing during wet periods causes surface compaction and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability subclass is IIw.

26—Kennebec silty clay loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on bottom land. It is subject to flooding. Areas range from 10 to 50 acres in size. They are long and narrow in drainageways and irregular in shape on bottom land.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black silty clay loam about 26 inches thick. The next layer is black silty clay loam about 12 inches thick. The substratum to a depth of about 60 inches is very dark gray silt loam that has very dark grayish brown and dark grayish brown mottles. In places the surface layer and subsurface layer are silt loam.

Included with this soil in mapping are some small areas of the poorly drained Colo soils and the somewhat poorly drained, loamy Spillville soils. Colo soils are on the lower parts of the landscape. Spillville soils are in landscape positions similar to those of Kennebec soil. Included soils make up less than 10 percent of the unit.

Permeability in the Kennebec soil is moderate, and runoff is slow. Available water capacity is very high. The substratum has a low supply of available phosphorus and a medium supply of available potassium. The soil has a seasonal high water table at a depth of 3 to 5 feet. Tilth is good.

Most areas are used for row crops. If flooding is controlled, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In areas dissected by old meander channels, cultivation is difficult. Good tilth can be easily maintained.

The land capability class is I.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes, on alluvial fans, and in upland drainageways. Areas range from 5 to 15 acres in size. Those on foot slopes and in drainageways are long and narrow, and those on alluvial fans are irregular in shape.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black loam about 18 inches thick. The subsoil is dark brown and dark yellowish brown, friable loam about 35 inches thick. In places the surface layer has more sand. In some areas the slope is more than 5 percent.

Included with this soil in mapping are some small areas of Judson and Spillville soils. Judson soils have less sand throughout than the Terrill soil. They are in landscape positions similar to those of Terril soil. Spillville soils are darker in the lower part than the Terril soil. Included soils make up less than 10 percent of the unit.

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

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Many narrow waterways are too small to be managed separately. If cultivated crops are grown, erosion and sedimentation are hazards unless the soil is protected from runoff from the higher adjacent soils. Terraces and diversions on the slopes above this soil help to control runoff. Contour farming and a conservation tillage system that leaves crop residue on the surface help to prevent excessive soil loss.

The land capability subclass is IIe.

28B—Dickman sandy loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops, side slopes, and knolls. Most areas range from 2 to 20 acres in size, but some are as large as 40 acres. The areas are generally longer than they are wide.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The subsurface layer is sandy loam about 10 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil is dark yellowish brown, friable loamy sand about 22 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous sand. In places the surface layer contains less sand. In some areas the surface layer is thinner and has some streaks and pockets of lighter colored subsoil material. In other areas the slope is more than 5 percent.

Included with this soil in mapping are small areas of Ocheyedan soils, which have a silty substratum. These soils are on the upper part of side slopes and on ridgetops. They make up about 5 percent of the unit.

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

This soil is suited to corn, soybeans, and small grain. It is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Also, the low available water capacity is a limitation. A conservation tillage system that leaves crop residue on the surface helps to control erosion and conserves moisture.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIIe.

28C2—Dickman sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on side slopes. Areas range from 5 to 30 acres in size. They are generally longer than they are wide.

Typically, the surface layer is very dark grayish brown sandy loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The subsoil is dark yellowish brown, friable loamy sand about 18 inches thick. The substratum to a depth of 60 inches is dark yellowish brown, calcareous sand. In some places the surface layer is loamy sand. In other places it is loam.

Included with this soil in mapping are small areas of Ocheyedan soils, which have a silty substratum. These soils are on the upper part of side slopes. They make up about 5 percent of the unit.

Permeability in the Dickman soil is moderately rapid. Runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

This soil is poorly suited to corn, soybeans, and small grain. It is suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Also, the low available water capacity is a limitation. A conservation tillage system that leaves crop residue on the surface, contour farming, stripcropping, and terraces help to control erosion. Returning crop residue to the soil or regularly adding other organic material helps to increase the rate of water infiltration.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IVe.

28D2—Dickman sandy loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on side slopes. Most areas range from 2 to 20 acres in size, but a few are as much as 50 acres. The areas are generally longer than they are wide.

Typically, the surface layer is very dark grayish brown sandy 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 loamy sand about 18 inches thick. The substratum to a depth of 60 inches is yellowish brown sand. In some places the surface layer is loamy sand. In other places it is loam. In some areas the soil is calcareous to the surface. In other areas the slope is less than 9 percent.

Included with this soil in mapping are small areas of Ocheyedan soils, which have a silty substratum. These soils are on the upper part of side slopes. They make up about 5 percent of the unit.

Permeability in the Dickman soil is moderately rapid. Runoff is rapid. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

This soil is poorly suited to corn, soybeans, and small grain. It is suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Also, the low available water capacity is a limitation. A conservation tillage system and contour farming help to control erosion. Returning crop residue to the soil or regularly adding other organic material helps to increase the rate of water infiltration.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IVe.

31—Afton silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in drainageways on uplands. It is subject to flooding. Areas range from 5 to 20 acres in size and are long and narrow.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black and very dark gray, mottled silty clay loam about 21 inches thick. The subsoil is dark grayish brown, mottled, friable silty clay loam about 13 inches thick. The substratum to a depth of about 60 inches is mottled yellowish brown and grayish brown silt loam. In a few areas the soil is darker colored in the lower part. In other areas it is calcareous.

Included with this soil in mapping are some areas of the somewhat poorly drained Primghar soils. These soils are in landscape positions similar to those of the Afton soil. They make up less than 10 percent of the unit.

Permeability in the Afton soil is moderately slow. Runoff is slow. Available water capacity is very high. The content of organic matter is about 6 to 7 percent in the surface layer. The shrink-swell potential is high. The subsoil generally has a very low supply of available phosphorus and potassium. The seasonal high water table is at a depth of 1 to 3 feet. Tilth is fair.

If drainage is improved, most areas are used for row crops. If drainage is adequate, the soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If drainage is not adequate on the soils higher on the landscape, overflow and siltation damage crops. Terraces, contour farming, and grassed waterways on the slopes above this soil help to reduce the hazards of overflow and siltation. The seasonal high water table is a limitation. Measures that reduce wetness improve the timeliness of fieldwork. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

The land capability subclass is IIw.

32—Spicer silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained, calcareous soil is in concave drainageways and in broad, nearly level areas on uplands. Areas range from about 3 to 40 acres in size. Those on uplands are irregular in shape, and those in drainageways are long and narrow.

Typically, the surface layer is black, calcareous silty clay loam about 9 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 9 inches thick. The subsoil is mottled silty clay loam about 20 inches thick. The upper part is dark grayish brown, and the lower part is olive gray. The substratum to a depth of about 60 inches is olive gray, mottled silt loam. In a few places the surface layer and subsurface layer are not calcareous. In some areas the dark colored surface soil is more than 30 inches thick and is not calcareous.

Included with this soil in mapping are small areas of soils in depressions. These soils have a dark colored surface layer that is thinner than that of the Spicer soil, have more clay in the subsoil, and are not calcareous. They make up about 5 to 10 percent of the unit.

Permeability in the Spicer soil is moderate, and runoff is slow. Available water capacity is high. The content of organic matter is about 6 to 7 percent in the surface layer. The seasonal high water table is at a depth of 1 to 3 feet. The subsoil has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are used for cultivated crops. If adequately drained, this soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Subsurface tile can drain this soil satisfactorily. Small areas are subject to ponding. Shallow surface drains or surface inlets to subsurface tile can remove excess surface water. In concave drainageways on uplands, overflow and siltation caused by runoff from the adjacent soils higher on the landscape damage crops. A conservation tillage system that leaves crop residue on the surface reduces the hazards of overflow and siltation. Excess lime in this soil reduces the availability of phosphorus and potassium to plants and interferes with the activity of some herbicides. Soybean varieties tolerant of excess lime are suited to this soil. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

The land capability subclass is IIw.

33C2—Steinauer clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, calcareous clay loam about 6 inches thick. The next layer is calcareous, friable clay loam about 8 inches thick. It is olive brown and grayish brown and has mottles. The substratum to a depth of 60 inches is gray and olive brown, calcareous clay loam that has mottles. In some places erosion has thinned the surface layer. In other places the surface layer is noncalcareous silty clay loam. In some areas it is silt loam.

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

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system and contour farming help to control erosion. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in a calcareous soil results in the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

33D2—Steinauer clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, calcareous clay loam about 6 inches thick. The next layer is calcareous, friable clay loam about 8 inches thick. It is olive brown and grayish brown and has mottles. The substratum to a depth of 60 inches is gray and olive brown, calcareous clay loam that has mottles. In some places the surface layer is thinner because of erosion. In other areas it is noncalcareous silty clay loam.

Permeability is moderately slow, and runoff is rapid. Available water capacity is high. The content of organic matter is about 2 to 3 percent. The substratum generally has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface, contour farming, and terraces help to control erosion. Returning crop residue to the soil or regularly adding organic material helps to maintain or improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in a calcareous soil results in the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IVe.

33E2—Steinauer clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 20 acres and are irregularly shaped.

Typically, the surface layer is very dark gray, calcareous clay loam about 6 inches thick. The next layer is calcareous, friable clay loam about 8 inches thick. It is olive brown and grayish brown and has mottles. The substratum to a depth of 60 inches is gray and olive brown, calcareous clay loam that has mottles. In some places erosion has thinned the surface layer. In other places the surface layer is noncalcareous silty clay loam. In some areas shale is at or near the surface.

Included with this soil in mapping are some small areas of Moody soils. These soils are in landscape positions similar to those of the Steinauer soil. They are noncalcareous and have a silty clay loam surface layer. They make up less than 5 percent of the unit.

Permeability in the Steinauer soil is moderately slow. Runoff is rapid. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are used for hay and pasture. Some areas have a cover of grasses and shrubs and are used as wildlife habitat. This soil is poorly suited to row crops but is suited to grasses and legumes for hay and pasture. In most areas farm machinery can be used. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

A cover of pasture plants or hay is effective in controlling erosion. Erosion is a hazard, however, if overgrazing reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IVe.

33G—Steinauer clay loam, 18 to 40 percent slopes. This steep and very steep, well drained soil is on convex side slopes in the uplands. Areas are irregularly shaped. Several are 200 to 400 acres in size. The rest are 5 to 20 acres in size.

Typically, the surface layer is very dark gray, calcareous clay loam about 5 inches thick. The next layer is calcareous, friable clay loam about 8 inches thick. It is olive brown and grayish brown and has mottles. The substratum to a depth of 60 inches is gray and olive brown, calcareous clay that has mottles. In some places erosion has thinned the surface layer. In some areas the surface layer is noncalcareous and contains less clay. In other areas shale is at or near the surface.

Included with this soil in mapping are small areas of Moody soils. These soils are in positions on the landscape similar to those of the Steinauer soil. They are noncalcareous and have a surface layer of silty clay loam. They make up less than 5 percent of the unit.

Permeability is moderately slow in the Steinauer soil, and runoff is very rapid. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and potassium.

Most areas are used for pasture. A few areas are used for timber. This soil is unsuited to corn, soybeans, and small grain, mainly because it is subject to erosion. It is poorly suited to legumes for hay but is suited to grasses for pasture. A cover of pasture plants is effective in controlling erosion. Overgrazing, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Most of the pastured areas support trees. Planting grass species that grow well in a calcareous soil and in shade results in the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is VIIe.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. It is subject to flooding. Areas range from 5 to 20 acres in size and are wide and irregularly shaped.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay about 17 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is about 23 inches thick. It is very dark gray, mottled, friable silty clay in the upper part and very dark gray, mottled silty clay loam in the lower part. The substratum to a depth of about 60 inches is very dark grayish brown and dark grayish brown silty clay loam. In some areas the subsoil contains less clay.

Included with this soil in mapping are some areas of Cylinder soils. These soils are slightly higher on the landscape than the Zook soil. They have sand and gravel within 40 inches of the surface. They make up less than 10 percent of the unit. Also included are small areas of Estherville soils on the higher parts of the landscape. These soils have more sand in the surface layer than the Zook soil and have sand and gravel within 20 inches of the surface.

The Zook soil is slowly permeable. It has a seasonal high water table within a depth of 3 feet. Runoff is slow. The shrink-swell potential is high. Available water capacity also is high. The content of organic matter is about 5 to 7 percent in the surface layer. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium. Tilth is poor.

Most areas are used for row crops. If adequately drained, this soil is suited to corn, soybeans, and small grain and to grasses for hay and pasture. A drainage system is needed to reduce wetness and to provide good aeration and a deep root zone for plants. Tile drains generally work satisfactorily only if they are closely spaced and if an adequate outlet is available. In some areas surface drains are needed to remove surface water. Returning crop residue to the soil or regularly adding other organic material helps to improve tilth.

In pastured areas overgrazing or grazing during wet periods causes surface compaction and poor tilth.

The land capability subclass is IIw.

72—Estherville loam, 0 to 2 percent slopes. This nearly level, well drained and somewhat excessively drained soil is on stream terraces. Most areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark brown loam about 7 inches thick. The subsoil is about 10 inches thick. The upper part is dark yellowish brown, friable coarse sandy loam, and the lower part is loose, dark yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is calcareous. The upper part is brown gravelly sand, and the lower part is light yellowish brown sandy loam. In some places the depth to sand and gravelly sediments is more than 20 inches. In other places the slope is more than 2 percent.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The low available water capacity and a shallow effective root zone are limitations. Also, wind erosion is a hazard in cultivated areas. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control erosion.

A few areas of this soil are used for pasture. Proper stocking rates and deferred grazing during dry periods help to keep the pasture in good condition.

The land capability subclass is IIs.

72B—Estherville loam, 2 to 5 percent slopes. This gently sloping, well drained and somewhat excessively drained soil is on stream terraces. Most areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark brown loam about 7 inches thick. The subsoil is about 10 inches thick. The upper part is dark yellowish brown coarse sandy loam, and the lower part is yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is calcareous. The upper part is brown gravelly sand, and the lower part is light yellowish brown gravelly sandy loam. In some places the depth to sandy and gravelly sediments is more than 20 inches. In other places the slope is less than 2 percent.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The low available water capacity and a shallow effective root zone are limitations. Also, wind erosion and water erosion are hazards in cultivated areas. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control erosion.

A few areas of this soil are used for pasture. Proper stocking rates and deferred grazing during dry periods help to keep the pasture in good condition.

The land capability subclass is IIIs.

72D2—Estherville loam, 5 to 12 percent slopes, moderately eroded. This moderately sloping and strongly sloping, well drained and somewhat excessively drained soil is on the side slopes of terraces adjacent to stream bottoms. Most areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. Streaks and pockets of lighter colored subsoil material are mixed into the surface layer. The subsoil is about 8 inches thick. The upper part is dark yellowish brown coarse sandy loam, and the lower part is yellowish brown gravelly loamy sand. The substratum to a depth of about 60 inches is calcareous. The upper part is brown gravelly sand, and the lower part is light yellowish brown gravelly coarse sand. In some places the surface layer is gravelly sandy loam. In other places the depth to sandy and gravelly sediments is more than 20 inches.

Permeability is moderately rapid, and runoff is medium. Available water capacity is low. The content of organic matter is about 1 to 2 percent in the surface layer. Tilth is good. The subsoil has a very low supply of available phosphorus and potassium.

Some areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. It is suited to grasses and legumes for hay and pasture. The low available water capacity and a shallow effective root zone are limitations. Also, further wind erosion and water erosion are hazards in cultivated areas. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control erosion.

Some areas of this soil are used for pasture. Proper stocking rates and deferred grazing during dry periods help to keep the pasture in good condition.

The land capability subclass is IVs.

78B2—Sac silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex side slopes in the uplands. Areas range from 3 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is about 26 inches thick. It is friable. The upper part is dark yellowish brown silty clay loam, the next part is dark yellowish brown silt loam, and the lower part is yellowish brown and light brownish gray clay loam. In places the surface layer is more than 10 inches thick and is not mixed with subsoil material. In some areas clay loam glacial till is at a depth of more than 40 inches.

Permeability is moderately slow, and runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 5 percent in the surface layer. The subsoil generally has a 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. If cultivated crops are grown, wind erosion and water erosion are hazards. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIe.

78C2—Sac silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 3 to 15 acres in size and are long and narrow.

Typically, the surface layer is very dark brown silty clay loam about 6 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is about 24 inches thick. It is friable. The upper part is dark yellowish brown silty loam, and the lower part is yellowish brown loam. The substratum to a depth of 60 inches is yellowish brown and light gray clay loam. In some places clay loam glacial till is at a depth of more than 40 inches. In other places the surface layer and the subsoil contain more sand.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIIe.

78D2—Sac silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Most areas range from 3 to 10 acres in size and are long and narrow, but a few are as large as 40 acres and are irregularly shaped.

Typically, the surface layer is very dark brown silty clay loam about 4 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown subsoil into the surface layer. The subsoil is about 22 inches thick. It is friable. The upper part is dark yellowish brown silty clay loam. The next part is dark yellowish brown silt loam, and the lower part is yellowish brown and light brownish gray clay loam. In places the surface layer and the subsoil contain more sand.

Included with this soil in mapping are small areas of the calcareous Steinauer soils on shoulder slopes. These soils have a surface layer of clay loam. They make up about 5 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, reduces the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIIe.

91—Primghar silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on broad, plane and convex divides and in drainageways on uplands. Most areas range from about 10 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is very dark gray silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is friable. The upper part is dark grayish brown silty clay loam, and the lower part is olive, calcareous silt loam. The substratum to a depth of about 60 inches is dark yellowish brown, calcareous silt loam. In places the soil has a browner subsoil and is better drained. In some areas the subsurface layer is thicker.

Included with this soil in mapping are scattered small areas of Galva soils. These soils have a subsoil that is browner than that of the Primghar soil. They are on slight rises. They make up about 2 percent of the unit. Also included are small areas of Marcus soils. These soils are lower on the landscape than the Primghar soil. Also, they have a more olive subsoil. They make up about 2 percent of the unit.

Permeability in the Primghar soil is moderate, and runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The seasonal high water table is at a depth of 3 to 5 feet. The shrink-swell potential is high. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated (fig. 6). A few areas are used for hay or pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A subsurface drainage system can lower the seasonal high water table and allow for timelier fieldwork. If tillage is deferred when the soil is wet, good tilth generally can be easily maintained. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth.

The land capability class is I.

91B—Primghar silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is in drainageways and on the lower side slopes in the uplands. Most areas range from about 5 to 30 acres

Figure 6.—Soybeans planted on the contour with a ridge-till planter in an area of Primghar silty clay loam, 0 to 2 percent slopes.

in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is very dark gray silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. It is friable. The upper part is dark grayish brown silty clay loam, and the lower part is olive, calcareous silt loam. The substratum to a depth of about 60 inches is light brownish gray, calcareous silt loam. In places the subsurface layer is thicker.

Included with this soil in mapping are scattered small areas of Marcus soils. These soils are lower on the landscape than the Primghar soil. Also, they have a more olive subsoil. They make up about 1 percent of the unit. Also included are small areas of Galva soils on slight rises. These soils have a subsoil that is browner than that of the Primghar soil. They make up about 2 percent of the unit.

Permeability in the Primghar soil is moderate, and runoff is medium. Available water capacity is high. The content of organic matter is about 5 to 6 percent in the surface layer. The seasonal high water table is at a depth of 3 to 5 feet. The shrink-swell potential is high. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. A few areas are used for pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Erosion, overflow, and siltation caused by runoff from the adjacent soils higher on the landscape damage crops. Establishing grassed waterways in areas of concentrated runoff helps to prevent crop damage. Subsurface drains can reduce wetness and allow for timelier fieldwork. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth, improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

A cover of pasture plants or hay reduces the runoff rate and helps to control erosion. Proper stocking rates, rotation grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability subclass is IIe.

92—Marcus silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on moderately wide divides and in drainageways on uplands. Areas range from about 3 to 50 acres in size. Those on divides are irregular in shape, and those in drainageways are long and narrow.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 10 inches thick. It is black in the upper part and very dark gray and olive gray in the lower part. The subsoil is mottled, friable silty clay loam about 22 inches thick. It is olive gray in the upper part and grayish brown in the lower part. The substratum to a depth of about 60 inches is mottled light olive gray and strong brown silt loam. In some small areas the surface soil is thicker. In places the soil is calcareous throughout.

Included with this soil in mapping are areas of the somewhat poorly drained Primghar soils. These soils are upslope from the Marcus soil. They make up less than 10 percent of the unit.

Permeability in the Marcus soil is moderately slow, and runoff is slow. Available water capacity is very high. The content of organic matter is about 6 to 7 percent in the surface layer. The seasonal high water table is at a depth of 1 to 3 feet. The shrink-swell potential is high. The subsoil has a very low supply of available phosphorus and potassium. Tilth is fair.

Most areas are used for cultivated crops (fig. 7). This soil is well suited to corn, soybeans, and small grain and to grasses for hay and pasture. Subsurface drains can reduce wetness and allow for timelier fieldwork. A conservation tillage system that leaves crop residue on the surface helps to control erosion. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

The land capability subclass is IIw.

108—Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is on stream terraces. Generally, areas are 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is brown, friable loam, and the lower part is brown and dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown and yellowish brown, calcareous gravelly sand. In some places loamy sand or sand and gravel are as shallow as 18 inches. In other places the lower part of the subsoil is sandy loam or loam.

Included with this soil in mapping are some areas of Graceville soils. These soils have a surface layer of silty clay loam and have sand and gravel below a depth of 45 inches. They are generally in the slightly lower landscape positions. They make up about 5 to 10 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the moderate available water capacity. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion and conserves moisture.

In pastured areas overgrazing reduces the extent of the protective plant cover and increases the hazard of wind erosion.

The land capability subclass is IIs.

108B—Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex slopes on stream terraces. Generally, areas are about 2 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark

Figure 7.—Soybeans in an area of Marcus silty clay loam, 0 to 2 percent slopes.

grayish brown loam about 8 inches thick. The subsoil is about 17 inches thick. The upper part is brown, friable loam, and the lower part is brown and dark yellowish brown, loose loamy sand. The substratum to a depth of about 60 inches is brown and yellowish brown gravelly sand. In places the lower part of the subsoil is sandy loam or loam.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, the soil is seasonally droughty because of the moderate available water capacity. A conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss.

In pastured areas overgrazing reduces the extent of the protective plant cover and increases the runoff rate and the hazard of erosion.

The land capability subclass is IIe.

116—Graceville silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on stream terraces and outwash plains. Areas range from about 10 to 80 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is friable silty clay loam about 29 inches thick. It is black in the upper part, very dark gray in the next part, and dark brown in the lower part. The subsoil is dark yellowish brown, friable loam about 7 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown gravelly sand. In some places the surface layer and the upper part of the subsurface layer are loam. In other places the subsoil contains more clay.

Included with this soil in mapping are areas of the loamy Wadena soils, which are underlain by sand and gravel at a depth of 32 to 40 inches. These soils are generally at the slightly higher elevations. They make up about 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Graceville soil and rapid in the substratum. Runoff is slow. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. 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. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion.

The land capability class is I.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land and in upland drainageways. It is subject to flooding. Areas are irregularly shaped on bottom land and long and narrow in upland drainageways. They generally range from 5 to 50 acres in size, but some are as large as 100 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 15 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled silty clay loam. In some places a gray subsoil is less than 36 inches from the surface. In other places recently deposited silt loam about 12 inches thick overlies the surface layer. In some areas the soil is calcareous.

Included with this soil in mapping are small areas of Zook silty clay and the moderately well drained Kennebec soils. These soils are in landscape positions similar to those of the Colo soil. They make up about 5 to 10 percent of the unit.

Permeability in the Colo soil is moderate, and runoff is slow. Available water capacity is high. The seasonal high water table is at a depth of 1 to 3 feet. The shrink-swell potential is high. The content of organic matter is about 5 to 7 percent in the surface layer. The substratum generally has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A drainage system helps to reduce wetness and provides good aeration and a deep root zone for plants. Tile drains work well if they are properly installed. In some areas adequate tile outlets are not readily available. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

Some areas along streams are used for pasture. Proper stocking rates, rotation grazing, and restricted grazing during wet periods help to keep the pasture in good condition.

The land 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 range from 3 to 50 acres in size. Most are irregularly shaped.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer also is black loam. It is about 13 inches thick. The subsoil is about 27 inches thick. It is calcareous. The upper part is dark grayish brown loam that has mottles. The lower part is dark yellowish brown gravelly sandy loam. The substratum is grayish brown sand. In some places the soil is well drained. In other places the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are some areas of Biscay soils. These soils have a subsoil that is grayer than that of the Cylinder soil. Also, they are lower on the landscape. They make up about 5 percent of the unit.

Permeability is moderate in the upper part of the subsoil in the Cylinder soil and very rapid in the substratum. Runoff is slow. The seasonal high water table is at a depth of 2 to 4 feet. Available water capacity is moderate. The content of organic matter is about 4 to 5 percent in the surface layer. Tilth is good. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A shallow effective root zone can be a limitation. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control wind erosion.

Some areas of this soil are used for pasture. Proper stocking rates and deferred grazing during wet periods help to keep the pasture in good condition.

The land capability subclass is IIs.

259—Biscay 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 range from 5 to 30 acres in size. Most are irregularly shaped.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black and very dark grayish brown, mottled loam about 10 inches thick. The subsoil is about 18 inches thick. It is mottled and friable. The upper part is dark grayish brown loam. The lower part is sandy loam. The substratum to a depth of about 60 inches is olive brown loamy sand that is about 5 percent gravel. In places the surface soil and the subsoil are clay loam.

Included with this soil in mapping are some areas of the somewhat poorly drained Cylinder soils. These soils are slightly higher on the landscape than the Biscay soil. They make up about 5 percent of the unit.

Permeability is moderate in the surface soil and subsoil of the Biscay soil and rapid in the substratum. Runoff is slow. The seasonal high water table is at a depth of 1 to 3 feet. Tilth is fair. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are used for cultivated crops. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Subsurface drains can reduce wetness and allow for timelier fieldwork. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion. Returning crop residue to the soil or regularly adding other organic material helps to maintain or improve tilth.

The land 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 2 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 17 inches thick. The substratum to a depth of about 60 inches is brown and yellowish brown, calcareous gravelly sand. In some places the lower part of the subsoil is loamy sand. In other places the upper part of the substratum is loam or sandy loam.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the moderate available water capacity. Good tilth generally can be easily maintained. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion.

In pastured areas overgrazing reduces the extent of the protective plant cover and increases the hazard of wind erosion.

The land 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 range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 7 inches thick. The subsoil is brown and dark yellowish brown, friable loam about 20 inches thick. The substratum to a depth of about 60 inches is brown and yellowish brown, calcareous gravelly sand. In some places the lower part of the subsoil is loamy sand. In other places the substratum is loam or sandy loam.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is seasonally droughty because of the moderate available water capacity. 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.

In pastured areas overgrazing causes surface compaction and increases the runoff rate. Proper stocking rates and pasture rotation help to keep the pasture in good condition.

The land capability subclass is IIe.

309—Allendorf silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on benches along the major rivers. Areas range from 3 to 80 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown and very dark gray silty clay loam about 7 inches thick. The subsurface layer is dark brown and very dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 20 inches thick. It is dark yellowish brown and brown, friable silty clay loam in the upper part and dark yellowish brown sandy loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown gravelly sand. In some places the surface soil and subsoil are loam. In other places the depth to gravelly sand is more than 40 inches.

Included with this soil in mapping are some small areas of Estherville soils. These soils are in landscape positions similar to those of the Allendorf soil. They have a loam surface soil about 20 inches thick. They make up about 5 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Crops are subject to damage by drought in some years. A conservation tillage system that leaves crop residue on the surface is effective in conserving water.

The land capability subclass is IIs.

309B—Allendorf silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches along the major rivers. Areas are from 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsurface layer is dark brown silty clay loam about 8 inches thick. The subsoil is about 20 inches of dark yellowish brown, friable silty clay loam and sandy loam. The substratum to a depth of about 60 inches is yellowish brown gravelly sand. In some places the dark surface soil is less than 10 inches thick, and has streaks and pockets of brown material. In other areas the depth to gravelly sand is more than 40 inches.

Included with this soil in mapping are some small areas of Estherville soils. These soils are in landscape positions similar to those of the Allendorf soil. They have a loam surface soil about 20 inches thick. They make up less than 10 percent of the unit.

Permeability is moderate in the surface layer, subsurface layer, and subsoil of the Allendorf soil and very rapid in the substratum. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 3 to 4 percent in the surface layer. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In some years crops are subject to damage by drought. In cultivated areas erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and contour farming are effective in controlling erosion and conserving water.

The land capability subclass is IIe.

309B2—Allendorf silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on benches along the major rivers. Areas are from 3 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is about 25 inches thick. It is dark yellowish brown and brown, friable silty clay loam in the upper part and dark yellowish brown sandy loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown gravelly sand. In places the surface layer and subsoil are loam.

Permeability is moderate in the surface layer, subsurface layer, and subsoil and very rapid in the substratum. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 2 to

3 percent in the surface layer. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In some years crops are subject to damage by drought. In cultivated areas erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and contour farming are effective in controlling erosion and conserving water.

The land capability subclass is IIe.

309C2—Allendorf silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on benches along the major rivers. Areas range from 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of dark yellowish brown subsoil material into the surface layer. The subsoil is about 25 inches thick. It is dark yellowish brown and brown, friable silty clay loam in the upper part and dark yellowish brown sandy loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown gravelly sand.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In some years crops are subject to damage by drought. In cultivated areas erosion is a hazard. A conservation tillage system that leaves crop residue on the surface, contour farming, and stripcropping are effective in controlling erosion and conserving water.

The land capability subclass is IIIe.

310—Galva silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad ridgetops and divides in the uplands. Most areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. In some areas the soil is somewhat poorly drained.

Permeability is moderate, and runoff is slow. Available water capacity is very high. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil has a very low supply of available potassium and phosphorus. 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. A conservation tillage system that leaves crop residue on the surface helps to maintain good tilth.

The land capability class is I.

310B—Galva silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on broad, convex ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from 5 to 150 acres in size. Some areas are as large as 400 acres.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In places the dark colored surface soil is less than 10 inches thick and has streaks and pockets of dark brown subsoil material. Some areas are moderately sloping.

Included with this soil in mapping are areas of the somewhat poorly drained Primghar soils along drainageways. These soils make up about 5 percent of the unit.

Permeability in the Galva soil is moderate. 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. The subsoil is slightly acid or neutral. The subsoil has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are used for cultivated crops. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In cultivated areas erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

The land capability subclass is IIe.

310B2—Galva silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. Plowing has mixed some of the subsoil with the surface layer. The subsoil is friable silty clay loam about 29 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. In places the dark colored surface soil is more than 10 inches thick. A few areas are moderately sloping.

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

Most areas are intensively used for cultivated crops. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In cultivated areas erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

The land capability subclass is IIe.

310C2—Galva silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on side slopes in the uplands. Most areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. Plowing has mixed some of the subsoil with the surface layer. The subsoil is friable silty clay loam about 30 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. In some areas along waterways, the dark colored surface layer is more than 10 inches thick. In a few areas the soil is gently sloping and has a surface layer as much as 10 inches thick.

Included with this soil in mapping are small areas of the calcareous Ida soils on shoulder slopes. These soils make up about 5 percent of the unit.

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

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. It is well suited to grasses and legumes for hay and pasture. In cultivated areas erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

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

The land capability subclass is IIIe.

310D2—Galva silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Most areas are irregularly shaped and range from 5 to 15 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 30 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. A few areas are moderately sloping. In places glacial till is within 40 inches of the surface.

Included with this soil in mapping are small areas of Ida and Judson soils. Ida soils are in landscape positions similar to those of the Galva soil. They are silt loam throughout and are calcareous to the surface. Judson soils are on foot slopes below the Galva soil. They have a thick, dark surface soil. Included soils make up about 5 percent of the unit.

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

In most areas this soil is used for cultivated crops. It is suited to corn, soybeans, and small grain. It is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

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

The land capability subclass is IIIe.

401B3—Crofton silt loam, 2 to 5 percent slopes, severely eroded. This gently sloping, well drained soil is on narrow, convex ridgetops and side slopes in the uplands. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam that has pockets of dark brown material. It is about 7 inches thick. The next layer is brown, friable, calcareous silt loam about 8 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. In some places the surface layer is darker and is more than 7 inches thick. In other places the upper 24 inches is noncalcareous because of leaching. A few areas are moderately sloping.

Permeability is moderate. Runoff is medium. Available water capacity is very high. The content of organic matter is about 1 to 2 percent in the surface layer. The substratum generally 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 suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. Returning crop residue to the soil or regularly adding other organic material helps to maintain tilth.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in a calcareous soil results in the highest yields. Overgrazing causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIe.

401C3—Crofton silt loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, well drained soil is on narrow, convex ridgetops and side slopes in the uplands. Areas range from 3 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam that has pockets of dark brown material. It is about 7 inches thick. The next layer is brown, friable, calcareous silt loam about 8 inches thick. The substratum to a depth of about 60 inches is mottled, calcareous silt loam. In some places the slope is more than 9 percent. In other places the upper 24 inches is noncalcareous because of leaching.

Permeability is moderate. Runoff is medium. Available water capacity is very high. The content of organic matter is about 1 to 2 percent in the surface layer. The substratum generally 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 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. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

The land capability subclass is IIIe.

401D3—Crofton silt loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained soil is on narrow, convex ridgetops and side slopes in the uplands. Areas range from about 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam that has pockets of substratum material. It is about 6 inches thick. The substratum to a depth of about 60 inches is friable, mottled, calcareous silt loam. In some places the upper 24 inches is noncalcareous because of leaching. In other places the slope is less than 9 percent.

Permeability is moderate. Runoff is rapid. Available water capacity is very high. The substratum generally has a very low supply of available phosphorus and a low supply of available potassium. Tilth is good.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

The land capability subclass is IIIe.

401E3—Crofton silt loam, 14 to 18 percent slopes, severely eroded. This moderately steep, well drained soil is on narrow, convex ridgetops and side slopes in the uplands. Areas range from about 3 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is brown, calcareous silt loam that has pockets of substratum material. It is about 6 inches thick. The substratum to a depth of about 60 inches is friable, mottled, calcareous silt loam. In some places the upper 24 inches is noncalcareous because of leaching. In other places the slope is less than 14 percent.

Permeability is moderate. Runoff is rapid. Available water capacity is very high. The content of organic matter is about 1 to 2 percent in the surface layer. The substratum generally has a very low supply of available phosphorus and a low supply of available potassium. Tilth is good.

Many areas are used for hay or pasture. Some areas are cultivated along with the adjacent soils. This soil is poorly suited to corn and soybeans but is suited to small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in a calcareous soil results in the highest yields. Overgrazing or grazing when the soil is wet causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IVe.

410—Moody silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad ridgetops. Most areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 22 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown, calcareous silt loam. In places the subsoil is gray and mottled.

Permeability is moderate. Runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil has a very low supply of available potassium and phosphorus. 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 (fig. 8). A conservation tillage system that leaves crop residue on the surface helps to maintain good tilth.

The land capability class is I.

410B—Moody silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on broad ridgetops in the uplands. Areas range from 4 to 100 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 29 inches thick. It is friable. The upper part is brown silty clay loam, the next part is dark yellowish brown silty clay loam, and the lower part is brown silt loam. The substratum to a depth of about 60 inches is brown, mottled, calcareous silt loam. In places the dark surface layer is less than 10 inches thick and is mixed with brown subsoil material. Some areas are moderately sloping.

Permeability is moderate. Runoff is medium. Available water capacity is high. 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. If the soil is cultivated, erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. Good tilth generally can be easily maintained.

The land capability subclass is IIe.

410B2—Moody silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from about 5 to 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. Plowing has mixed some of the subsoil with the plow layer. The subsoil is friable silty clay loam about 24 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown silt loam. In places the dark surface layer is more than 10 inches thick. A few areas are moderately sloping. In a few places the soil is underlain by clay loam glacial till.

Permeability is moderate. Runoff is medium. Available water capacity is high. The content of organic matter is about 2.5 to 3.5 percent in the surface layer. The subsoil 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

Figure 8.—Cattle grazing on an improved pasture in an area of Moody silty clay loam, 0 to 2 percent slopes.

legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

The land capability subclass is IIe.

410C2—Moody silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on narrow ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from about 5 to 40 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 26 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown silt loam. It has mottles in the lower part. In places the surface layer is more than 7 inches thick. In a few areas the soil is underlain by clay loam glacial till.

Included with this soil in mapping are small areas of the calcareous Crofton soils on shoulder slopes. These soils make up less than 10 percent of the unit.

Permeability in the Moody soil is moderate. Runoff is medium. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil has a very low supply of available potassium and phosphorus. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

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

The land capability subclass is IIIe.

410D2—Moody silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on narrow ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from about 3 to 10 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 25 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown, calcareous silt loam. It has mottles in the lower part. In places the substratum is clay loam glacial till. Some areas are moderately sloping.

Included with this soil in mapping are small areas of the calcareous Crofton soils on shoulder slopes and the moderately well drained Judson soils on foot slopes. Judson soils have a surface soil that is thicker and darker than that of the Moody soil. Included soils make up about 10 percent of the unit.

Permeability in the Moody soil is moderate. Runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil has a very low supply of available potassium and phosphorus. Tilth is good.

Many areas are cultivated along with the adjacent soils. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. It is subject to erosion when cultivated. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion.

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

The land capability subclass is IIIe.

428B—Ely silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is in upland drainageways and on foot slopes. Areas range from 5 to 15 acres in size and are long and narrow.

Typically, the surface layer is black silty clay loam about 14 inches thick. The subsurface layer is very dark gray, friable silty clay loam about 14 inches thick. The upper part is dark grayish brown, the next part is olive brown, and the lower part is mottled grayish brown, strong brown, and yellowish brown. The substratum to a depth of about 60 inches is grayish brown silt loam. In some places the soil is well drained or moderately well drained. In other places the dark surface soil is thicker.

Included with this soil in mapping are small areas of Radford soils. These soils formed in silt loam alluvium over a buried soil. They are adjacent to the waterways that dissect the Ely soil. They make up about 5 to 10 percent of the unit.

Permeability in the Ely soil is moderate, and runoff is medium. Available water capacity is very high. The content of organic matter is about 5 to 6 percent in the surface layer. This soil has a seasonal high water table at a depth of 2 to 4 feet. The subsoil generally has a 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. In some areas runoff from the soils upslope results in siltation and gullying. Diversion terraces help to control runoff from the adjacent side slopes and help to prevent siltation. Grassed waterways help to remove excess water and prevent gullying.

In pastured areas overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production.

The land capability subclass is IIe.

467—Radford silt loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on bottom land and alluvial fans along the smaller streams. It is subject to flooding. Areas range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is very dark gray, friable silt loam about 4 inches thick. The substratum is very dark gray and black silt loam about 19 inches thick. Below this to a depth of about 60 inches is a buried soil of black silty clay loam. In some places the substratum is thicker. In other places free carbonates are throughout the profile.

Included with this soil in mapping are areas of the nonstratified Colo soils. These soils have a surface layer of silty clay loam. They are in landscape positions similar to those of the Radford soil. They make up about 5 to 10 percent of the unit.

Permeability of the Radford soil is moderate. Runoff is slow. Available water capacity is very high. The content of organic matter is about 1 to 3 percent in the surface layer. This soil has a seasonal high water table at a depth of 1 to 3 feet. The substratum 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 suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Subsurface drains can reduce wetness and allow for timelier fieldwork. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion.

The land capability subclass is IIw.

474—Bolan loam, 0 to 2 percent slopes. This nearly level, well drained soil is on benches along the major streams. Areas range from 10 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is dark brown, friable loam about 10 inches thick. The subsoil is about 31 inches thick. The upper part is brown, mottled, friable loam; the next part is brown, mottled, friable fine sandy loam; and the lower part is brown and dark yellowish brown, very friable loamy fine sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand. In places the soil has a surface layer of fine sandy loam and is slightly droughty.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Runoff is slow. Available water capacity is moderate. The content of organic matter is about 1 to 2 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is droughty because the available water capacity is moderate. Also, wind erosion is a hazard if cultivated crops are grown. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control wind erosion.

A cover of pasture plants or hay is effective in controlling erosion. Wind erosion is a hazard, however, if overgrazing reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIs.

474B—Bolan loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches and uplands along the major streams. Areas range from 5 to 20 acres in size and are irregular in shape.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, very friable loamy fine sand; and the lower part is dark yellowish brown and yellowish brown, very friable loamy sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand. In places the surface layer is fine sandy loam.

Included with this soil in mapping are some small areas of Estherville soils on shoulder slopes. These soils have a surface layer that is thinner than that of the Bolan soil and have more gravel in the substratum. They make up about 5 to 10 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses for hay and pasture and is well suited to legumes for hay and pasture. It is seasonally droughty, however, because of the moderate available water capacity. A conservation tillage system that leaves crop residue on the surface conserves moisture, helps to control wind erosion, and improves fertility.

A cover of pasture or hay is effective in controlling erosion. Wind erosion is a hazard, however, if overgrazing reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIe.

474B2—Bolan loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on benches and uplands. Areas are 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. Plowing has mixed some streaks and pockets of dark brown subsoil material into the surface layer. The subsoil is about 35 inches thick. The upper part is dark brown, friable loam; the next part is dark yellowish brown, very friable loamy fine sand; and the lower part is dark yellowish brown and yellowish brown, very friable loamy sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand. In some areas the surface layer and the upper part of the subsoil are sandy loam.

Included with this soil in mapping are small areas of Estherville soils on shoulder slopes. These soils have calcareous sand and gravel in the lower part. They make up less than 10 percent of the unit.

Permeability is moderate in the upper part of the Bolan soil and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses for hay and pasture. It is well suited to legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Also, crops commonly are damaged by drought unless summer rainfall is timely. A conservation tillage system that leaves crop residue on the surface conserves moisture and helps to control wind erosion and water erosion.

The land capability subclass is IIe.

474C2—Bolan loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on benches and uplands along the major streams. Areas range from 5 to 20 acres in size and are irregular in shape.

Typically, the surface layer is dark brown loam about 5 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 43 inches thick. The upper part is brown, friable loam; the next part is dark yellowish brown, very friable loamy fine sand; and the lower part is dark yellowish brown and yellowish brown loamy sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand. In some places the surface layer is fine sandy loam. In other places the slope is less than 5 percent. In some areas the substratum is silty.

Included with this soil in mapping are small areas of the finer textured Ocheyedan soils. These soils are in landscape positions similar to those of the Bolan soil. They make up less than 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Bolan soil and rapid in the lower part. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses for hay and pasture and is well suited to legumes for hay and pasture. It is seasonally droughty, however, because of the moderate available water capacity. A conservation tillage system that leaves crop residue on the surface improves fertility, helps to control wind erosion and water erosion, and conserves moisture.

A cover of pasture plants or hay is effective in controlling erosion. Wind erosion is a hazard, however, if overgrazing reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

474D2—Bolan loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on benches and uplands along the major streams. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is dark loam about 5 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 43 inches thick. The upper part is brown, friable loam; the next part is dark yellowish brown, very friable loamy sand; and the lower part is dark yellowish brown and yellowish brown loamy sand. The substratum to a depth of about 60 inches is multicolored, calcareous sand. In some places the surface layer is fine sandy loam. In other places the slope is less than 9 percent. In some areas the substratum is silt loam.

Included with this soil in mapping are some small areas of Ocheyedan soils. These soils are in landscape positions similar to those of the Bolan soil. They have a silt loam substratum. They make up about 5 to 10 percent of the unit.

Permeability is moderate in the upper part of the Bolan soil and rapid in the lower part. Runoff is rapid. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and a medium supply of available potassium. Tilth is good.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. It is seasonally droughty, however, because the available water capacity is moderate. A conservation tillage system that leaves crop residue on the surface improves fertility, helps to control wind erosion and water erosion, and conserves moisture.

A cover of pasture plants or hay is effective in controlling erosion. Wind erosion is a hazard, however, if overgrazing reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

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 range from 5 to 30 acres in size and are long and narrow.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer also is black loam. It is about 23 inches thick. The subsoil is very dark gray loam about 14 inches thick. The substratum to a depth of 60 inches is very dark grayish brown, mottled loam. In some places the soil is calcareous below the surface layer. In other places the surface layer is fine sandy loam.

Included with this soil in mapping are small areas of the well drained Kennebec soils. These soils are in landscape positions similar to those of the Spillville soil. They contain more clay and less sand than the Spillville soil. They make up about 4 percent of the unit.

Permeability in the Spillville soil is moderate, and runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The soil has a seasonal high water table at a depth of 3 to 5 feet. 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 intensive cropping of corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Unless protected, crops can be damaged by flooding. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Some areas are used for pasture or hay. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during the wet periods help to keep the pasture in good condition.

The land capability subclass is IIw.

486—Davis loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on second bottoms. It is subject to flooding. Areas range from 10 to 50 acres in size and are irregular in shape.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black loam about 10 inches thick. The subsoil is friable loam about 28 inches thick. The upper part is very dark brown, the next part is dark grayish brown, and the lower part is very dark brown. The substratum to a depth of about 60 inches is very dark grayish brown and dark brown loam. In places the surface layer and subsurface layer are silty clay loam. In some areas the lower part of the subsoil is loamy sand and has some gravel.

Included with this soil in mapping are areas of the somewhat poorly drained Spillville soils. These soils are in the slightly lower areas. They make up about 5 percent of the unit.

Permeability in the Davis soil is moderate, and runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. The subsoil generally has a low supply of available phosphorus and a very low supply of available potassium. Tilth 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. Special care is needed to maintain good tilth. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion.

In pastured areas overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production.

The land capability class is I.

615—Colo-Spillville complex, channeled, 0 to 2 percent slopes. These nearly level soils are on flood plains that generally are dissected by old stream channels. The soils are subject to flooding. Low areas are subject to ponding. The Colo soil is poorly drained, and the Spillville soil is somewhat poorly drained. Individual areas typically are irregularly shaped. They range from about 10 to 100 acres in size. They are about 50 percent Colo soil, 35 percent Spillville soil, and 15 percent soils of minor extent. The soils occur as areas so closely intermingled that it is not practical to separate them in mapping.

Typically, the surface layer of the Colo soil is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 15 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is very dark gray, mottled silty clay loam.

Typically, the surface layer of the Spillville soil is black loam about 8 inches thick. The subsurface layer also is black loam. It is about 23 inches thick. The subsoil is very dark gray loam about 14 inches thick. The substratum to a depth of 60 inches is very dark grayish brown, mottled loam.

Available water capacity is high in both soils, and permeability is moderate. The seasonal high water table is at a depth of 1 to 3 feet in the Colo soil and at a depth of 3 to 5 feet in the Spillville soil. The content of organic matter is about 4 to 6 percent in the surface layer of both soils. Runoff is slow. The subsoil of the Colo soil has a medium supply of available phosphorus and a very low supply of available potassium. The subsoil of the Spillville soil has a very low supply of available phosphorus and potassium.

Most areas are used as permanent pasture. Very few areas are cultivated. These soils are generally unsuited to cultivated crops. The channels generally cannot be crossed by ordinary farm machinery because they are too deep and wet. The soils are suited to pasture, but they are subject to periods of flooding and siltation. Grazing during these periods reduces the productivity of the pasture by increasing the extent of surface compaction and puddling. Pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

The land capability subclass is Vw.

670—Rawles silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is in upland drainageways and on bottom land. It is subject to flooding. Areas range from about 10 to more than 50 acres in size and are long and narrow.

Typically, the surface layer is very dark grayish brown, calcareous silt loam about 8 inches thick. The substratum is stratified very dark grayish brown, dark brown, and brown, calcareous silt loam about 16 inches thick. The next layer is dark brown and brown silt loam about 8 inches thick. Below this to a depth of about 60 inches is a buried soil of black, calcareous silty clay loam. In some places the surface layer is noncalcareous. In other places the soil is noncalcareous throughout. In some areas the thickness of the surface layer combined with that of the substratum is more than 40 inches.

Included with this soil in mapping are some small areas of the noncalcareous, poorly drained Colo soils. These soils do not have a stratified surface layer. They are slightly lower on the landscape than the Rawles soil. They make up less than 5 percent of the unit.

Permeability in the Rawles soil is moderate, and runoff is slow. Available water capacity is very high. The content of organic matter is about 1 to 3 percent in the surface layer. The subsoil generally 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. Because of runoff from the adjacent soils higher on the landscape, crops are damaged by erosion, overflow, and siltation. A conservation tillage system that leaves crop residue on the surface helps to control erosion. Grassed waterways channel overflow and help to control siltation.

The land capability subclass is IIw.

733—Calco silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land and along upland drainageways. It is subject to flooding. Areas range from 5 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is black, calcareous silty clay loam about 6 inches thick. The subsurface layer also is black, calcareous silty clay loam. It is about 39 inches thick. The subsoil to a depth of about 60 inches is dark gray, calcareous silty clay loam. In some places about 12 inches of recently deposited silt loam overlies the surface layer. In other places the soil is not calcareous.

Included with this soil in mapping are some small areas of the somewhat poorly drained or moderately well drained Spillco soils. These soils contain less clay and more sand than the Calco soil. Also, they are slightly higher on the landscape. They make up less than 10 percent of the unit.

Permeability in the Calco soil is moderate, and runoff is slow. Available water capacity is very high. The content of organic matter is about 5 to 7 percent in the surface layer. The shrink-swell potential is high. The seasonal high water table is at a depth of 1 to 3 feet. The subsoil generally has a medium supply of available phosphorus and a very low supply of available potassium. Tilth is fair.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses for hay and pasture. A drainage system can reduce the wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed. In some areas adequate tile outlets are not readily available. Returning crop residue to the soil or regularly adding other organic material and deferring tillage when the soil is wet help to maintain or improve tilth and fertility, prevent surface crusting, and increase the rate of water infiltration. Excess lime in this soil reduces the availability of phosphorus and potassium to plants and interferes with the activity of some herbicides. Soybean varieties that are tolerant of excess lime are suitable.

The land capability subclass is IIw.

785—Spillco loam, 0 to 2 percent slopes. This nearly level, moderately well drained and somewhat poorly drained soil is on bottom land. It is subject to flooding. Areas range from 10 to 100 acres in size and are irregularly shaped. The long axis of the areas is generally parallel to the stream channel.

Typically, the surface layer is black loam about 5 inches thick. The subsurface layer is black and very dark gray, friable, calcareous loam about 28 inches thick. The next layer is very dark gray loam about 11 inches thick. The substratum to a depth of about 60 inches is very dark gray, calcareous loam. In some places free carbonates are throughout the surface soil. In other places they have been leached from the entire profile.

Included with this soil in mapping are small areas of Colo and Kennebec soils. Colo soils have more clay and silt and less sand than the Spillco soil. They are poorly drained and are in depressions and channel fills on the flood plains. They make up about 2 percent of the unit. Kennebec soils have more silt and less sand than the Spillco soil. They are moderately well drained and are generally adjacent to the stream channels. They make up about 5 percent of the unit.

Permeability in the Spillco soil is moderate. Runoff is slow. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer.The seasonal high water table is at a depth of 3 to 5 feet. The subsurface layer 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 suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Flooding can damage crops unless it is controlled by a system of levees.

In pastured areas grazing during wet periods can result in surface compaction. Restricted grazing during these periods helps to prevent compaction.

The land capability subclass is IIw.

801B2—Bolan Variant loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on side slopes and ridgetops and on uplands and benches in a band paralleling the major streams in the western part of the county. Areas range from 5 to 30 acres in size and are irregular in shape.

Typically, the surface layer is very dark grayish brown, calcareous loam about 7 inches thick. In places plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 28 inches thick. It is brown, friable, and calcareous. It is sandy loam in the upper part and loamy sand in the lower part. The upper part of the substratum is yellowish brown, calcareous, stratified loam and fine sandy loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous clay loam. In some places the surface soil is sandy loam. In other places the surface soil and subsoil are leached. Some areas are moderately sloping.

Included with this soil in mapping are some small areas of the silty Ida soils. These soils are in landscape positions similar to those of the Bolan Variant soil. They have a very high available water capacity. They make up about 5 percent of the unit.

Permeability of the Bolan Variant soil is moderately rapid. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

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, wind erosion and water erosion are hazards. Also, the soil can be droughty because of the moderate available water capacity. Windblown sand grains from small areas where the surface layer is loamy sand can injure young plants.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, decreases the runoff rate, and helps to control wind erosion and water erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIe.

801C2—Bolan Variant loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on side slopes and shoulder slopes on uplands and benches in a band paralleling the major streams. Areas range from 5 to 30 acres in size and are irregular in shape.

Typically, the surface layer is very dark grayish brown, calcareous loam about 6 inches thick. The subsoil is about 28 inches thick. It is brown, calcareous, and friable. It is loam in the upper part and loamy sand in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous, stratified loam and fine sandy loam. In some places the surface soil is sandy loam. In other places the surface soil and subsoil are leached.

Included with this soil in mapping are some small areas of the silty Ida soils. These soils are in landscape positions similar to those of the Bolan Variant soil. They have a very high available water capacity. Also included are small areas of loamy sand. Windblown sand grains from these small areas can injure young plants on this soil. Included soils make up about 5 percent of the unit.

Permeability in the Bolan Variant soil is moderately rapid. Runoff is medium. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain. It is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Also, the soil can be droughty because of the moderate available water capacity.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, decreases the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIIe.

801D2—Bolan Variant loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on side slopes and shoulder slopes on uplands and benches in a band paralleling the major streams. Areas range from 5 to 40 acres in size and are irregular in shape.

Typically, the surface layer is very dark grayish brown, calcareous loam about 5 inches thick. In places plowing has mixed streaks and pockets of brown subsoil material into the surface layer. The subsoil is about 24 inches thick. It is brown, friable, and calcareous. It is sandy loam in the upper part and loamy sand in the lower part. The upper part of the substratum is yellowish brown, calcareous, stratified loam and fine sandy loam. The lower part to a depth of about 60 inches is yellowish brown, calcareous clay loam. In some places the surface soil is sandy loam. In other places the surface soil and subsoil are leached.

Permeability is moderately rapid. Runoff is rapid. Available water capacity is moderate. The content of organic matter is about 2 to 3 percent in the surface layer. The subsoil generally has a very low supply of available phosphorus and potassium.

Many areas are cultivated. This soil is suited to corn, soybeans, and small grain. It is well suited to grasses and legumes for hay and pasture. If cultivated crops are grown, wind erosion and water erosion are hazards. Also, the soil can be droughty because of the moderate available water capacity. Windblown sand grains from small areas where the surface layer is loamy sand can injure young plants.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, decreases the runoff rate, and helps to control water erosion and wind erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is IIIe.

801F—Bolan Variant loam, 14 to 25 percent slopes, bouldery. This moderately steep and steep soil is on convex slopes on uplands that are near the confluence of the Rock and Big Sioux Rivers. Boulders are on the surface at intervals throughout the unit. Most areas are 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, calcareous loam about 10 inches thick. The subsoil is brown, calcareous sandy loam about 25 inches thick. It has pockets of sandy loam in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous, stratified loam and fine loamy sand. In places the upper part of the soil is leached.

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

This soil is poorly suited to grasses and legumes for hay and pasture. The boulders on the surface and the low available water capacity limit crop production. Also, wind erosion and water erosion are hazards in cultivated areas. A conservation tillage system that leaves crop residue on the surface helps to control erosion and conserves moisture.

Growing grasses and legumes for hay and pasture increases the rate of water infiltration, decreases the runoff rate, and helps to control erosion. Proper stocking rates and deferred grazing during droughty periods help to keep the pasture in good condition.

The land capability subclass is VIe.

810—Galva silty clay loam, benches, 0 to 2 percent slopes. This nearly level, well drained soil is on loess-covered benches. Most areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam. It is underlain by sand and gravel that in places have loamy strata. In some areas the sand and gravel are at a depth as shallow as 36 inches.

Permeability is moderate. Runoff is slow. Available water capacity is very high. The content of organic matter is about 4 to 5 percent in the surface layer. 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. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion. In some areas crops grown on this Galva soil are more adversely affected by drought than those grown on Galva soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability class is I.

810B—Galva silty clay loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on loess-covered benches. Most areas are irregular in shape and range from about 5 to 50 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is friable silty clay loam about 30 inches thick. It is dark brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam. It is underlain by sand and gravel that in places has loamy strata. In some areas the sand and gravel are at a depth as shallow as 36 inches. In other areas the dark surface layer is less than 8 inches thick and is mixed with some streaks and pockets of subsoil material.

Permeability is moderate. Available water capacity is high. Runoff is medium. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. 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 subject to erosion if it is cultivated. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. In some areas crops grown on this Galva soil are more adversely affected by drought than those grown on Galva soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability subclass is IIe.

810B2—Galva silty clay loam, benches, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on loess-covered benches. Most areas are irregular in shape and range from about 5 to 50 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. Plowing has mixed some streaks and pockets of brown subsoil material into the surface layer. The subsoil is friable silty clay loam about 29 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam. It is underlain by sand and gravel that in places has loamy strata. In some areas the dark colored surface layer is more than 10 inches thick. In other areas sand and gravel are at a depth as shallow as 36 inches.

Permeability is moderate. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. Runoff is medium. 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 subject to erosion if it is cultivated. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. In some areas crops grown on this Galva soil are more adversely affected by drought than those grown on Galva soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability subclass is IIe.

812—Moody silty clay loam, benches, 0 to 2 percent slopes. This nearly level, well drained soil is on loess-covered benches. Areas are irregular in shape and range from about 5 to more than 80 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 22 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown, calcareous silt loam. It is underlain by sand and gravel. In places calcareous sand and gravel are at a depth of about 36 to 60 inches.

Permeability is moderate. Available water capacity is high. The content of organic matter is about 4 to 5 percent in the surface layer. Runoff is slow. The subsoil has a very low supply of available potassium and phosphorus. 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. A conservation tillage system that leaves crop residue on the surface helps to control wind erosion. In some areas crops grown on this Moody soil are more adversely affected by drought than those grown on other Moody soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability class is I.

812B—Moody silty clay loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on loess-covered stream benches. Areas are irregular in shape and range from about 5 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is friable silty clay loam about 22 inches thick. It is brown in the upper part and dark yellowish brown in the lower part. The substratum to a depth of about 60 inches is brown, calcareous silt loam. It is underlain by calcareous sand and gravel. In some places the depth to calcareous sand and gravel is about 36 to 60 inches. In other places the dark colored surface layer is less than 10 inches thick.

Permeability is moderate. Available water capacity is high. Runoff is medium. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The subsoil has a very low supply of available potassium and phosphorus. 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 subject to erosion if it is cultivated. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. In some areas crops grown on this Moody soil are more adversely affected by drought than those grown on Moody soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability subclass is IIe.

812B2—Moody silty clay loam, benches, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on loess-covered stream benches. Most areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 7 inches thick. Plowing has mixed some of the subsoil with the surface layer. The subsoil is friable silty clay loam about 24 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is brown, calcareous silt loam. It is underlain by calcareous sand and gravel. In some places the depth to calcareous sand and gravel is about 36 to 60 inches. In other places the dark colored surface layer is more than 10 inches thick.

Permeability is moderate. Available water capacity is high. Runoff is medium. The content of organic matter is about 3 to 4 percent in the surface layer. 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 subject to erosion if it is cultivated. Applying a conservation tillage system that leaves crop residue on the surface, tilling on the contour, stripcropping, and terracing help to control erosion. In some areas crops grown on this Moody soil are more adversely affected by drought than those grown on Moody soils that do not have sand or gravel at a depth of 5 to 10 feet.

The land capability subclass is IIe.

878B—Ocheyedan loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 36 inches thick. It is friable. The upper part is brown loam, and the lower part is dark yellowish brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some places the subsoil is loamy sand. In other places the surface soil is silt loam.

Included with this soil in mapping are small areas of Dickman soils. These soils have a sandy loam surface layer and subsurface layer and a sandy substratum. Also included are small areas of soils that are calcareous in the surface layer and that do not have a silty substratum. Included soils are in landscape positions similar to those of the Ocheyedan soil. They make up less than 10 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In cultivated areas the soil is subject to wind erosion and water erosion. A conservation tillage system that leaves crop residue on the surface helps to control erosion. Contour farming, stripcropping, and terraces also help to control erosion.

A few areas of this soil are used for pasture. Proper stocking rates and rotation grazing help to keep the pasture in good condition.

The land capability subclass is IIe.

878B2—Ocheyedan loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Most areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 34 inches thick. It is friable. The upper part is brown loam, and the lower part is dark yellowish brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. In some places the subsoil is loamy sand. In other places the surface soil is silt loam.

Included with this soil in mapping are small areas of Dickman soils. These soils have a sandy loam surface layer and subsurface layer and a sandy substratum. Also included are small areas of soils that are calcareous in the surface layer and that do not have a silty substratum. Included soils are in landscape positions similar to those of the Ocheyedan soil. They make up less than 10 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In cultivated areas the soil is subject to further wind erosion and water erosion. A conservation tillage system that leaves crop residue on the surface helps to control erosion. Contour farming, stripcropping, and terraces also help to control erosion.

A few areas of this soil are used for pasture. Proper stocking rates and rotation grazing help to keep the pasture in good condition.

The land capability subclass is IIe.

878C2—Ocheyedan loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Most areas are long and narrow and range from 5 to 20 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 31 inches thick. It is friable. The upper part is brown loam, and the lower part is dark yellowish brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous silt loam that has mottles. In some places the subsoil is loamy sand. In other places the surface soil is silty loam.

Included with this soil in mapping are small areas of Dickman soils. These soils have a sandy loam surface layer and subsurface layer and a sandy substratum. Also included are small areas of soils that are calcareous in the surface layer and that do not have a silty substratum. Included soils are in landscape positions similar to those of the Ocheyedan soil. They make up less than 5 percent of the unit.

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

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and is well suited to grasses and legumes for hay and pasture. In cultivated areas it is subject to further wind erosion and water erosion. A conservation tillage system that leaves crop residue on the surface helps to control erosion. Contour farming, stripcropping, and terraces also help to control erosion.

A few areas of this soil are used for pasture. Proper stocking rates and rotation grazing help to keep the pasture in good condition.

The land capability subclass is IIIe.

5010—Pits, sand and gravel. This map unit is dominantly on stream terraces. It includes both active and inactive pits. Active pits are mined; inactive pits are no longer mined. The pits range from less than 1 acre to more than 40 acres in size and commonly are square or rectangular.

Typically, available water capacity is low or very low in the soil material. As a result, the material tends to be droughty during much of the growing season. In most areas it has a seasonal high water table. Low areas are ponded during wet periods. Stones and cobbles are commonly on the surface. The content of organic matter in the surface layer is less than 1 percent. Reaction typically is moderately alkaline.

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

No land capability class has been assigned.

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

Typically, the upper 60 inches is brown and yellowish brown, friable silt loam and silty clay loam. In places the texture is loam or clay loam. The surface color ranges from very dark gray to dark brown.

Included with these soils in mapping are small areas of former dumps or landfills that have been covered.

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

These soils are better suited to small grain and to grasses and legumes for hay and pasture than to row crops. Areas where topsoil has been redistributed are suited to row crops. In these areas corn and soybeans are grown. If cultivated crops are grown, erosion is a moderate or severe hazard in the more sloping areas. A conservation tillage system that turns over as little soil as possible and leaves crop residue on the surface helps to control erosion and stabilize the soils.

No land capability class has been assigned.

5044—Fluvaquents, 0 to 2 percent slopes. These nearly level, poorly drained soils are on flood plains adjacent to the major streams in the county. They are subject to flooding. Many areas have old stream channels and oxbows. Most areas are elongated and range from about 5 to several hundred acres in size.

These soils formed in recently deposited alluvial sediments on bottom land. These sediments range in age from a few years to several hundred years. Typically, they occur as calcareous strata of loam, silty clay loam, silt loam, loamy fine sand, fine sand, loamy sand, or sand. The fine textured strata are generally black or very dark gray. The coarse textured strata have many colors, including dark grayish brown, grayish brown, and pale brown. In some places the upper part of the profile is not stratified. In other places some strata are noncalcareous.

Permeability is moderate to rapid. Runoff is slow. Available water capacity is low to moderate. Generally, the content of organic matter and fertility are low. The soils have a seasonal high water table.

Most areas are covered with brush and trees. Some areas have been cleared and are cropped. These soils are poorly suited to corn, soybeans, and small grain. They are better suited to woodland and to permanent pasture. The main limitations are frequent flooding and the seasonal high water table. The height of the water table is often controlled by the water level in the nearby river. Most areas are well suited to use as wildlife habitat.

The land capability subclass is Vw.

Prime Farmland

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

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

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

About 417,000 acres in the survey area, or nearly 85 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are throughout the county, mainly in associations 1 through 7, which are described under the heading "General Soil Map Units." About 400,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for much of the county's total agricultural income each year.

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

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

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

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Use and Management of the Soils

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

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

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

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

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

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

Crops and Pasture

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

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

In 1985, according to the 1986 Iowa Agricultural Statistics, 402,636 acres in Sioux County was used as cropland and about 50,000 acres was used as pasture. Corn, soybeans, and oats are the main crops. In this section the management concerns that affect the use of the soils for crops and pasture are described.

Water erosion is the major problem on about 75 percent of the cropland in the county. It is a hazard on slopes of more than 2 percent. Loss of the surface layer through erosion reduces the productivity of soils and results in the sedimentation of streams. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the surface layer. Loss of the surface layer is especially damaging on soils where fertility is very low in the subsoil, such as Galva and Moody soils. Erosion also reduces the productivity of soils that tend to be droughty, such as Dickman soils. Control of erosion helps to maintain soil productivity and, by minimizing the sedimentation of streams, improves the quality of water for municipal use, recreation, and fish and wildlife.

Measures that control erosion provide a protective plant cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods can hold soil losses to a level that will not reduce the productive capacity of the soils. On livestock farms where part of the acreage is hayland, including grasses and legumes in the cropping system not only provides nitrogen and improves tilth but also helps to control erosion on the more sloping soils. Management practices that help to prevent surface compaction and gully erosion are especially important on the steep soils, such as Steinauer and Ida soils.

A conservation tillage system that leaves crop residue on the surface is effective in controlling erosion. Examples of the major kinds of conservation tillage are no-till, till-plant, and chisel-disk. No-till is a system in which the seedbed is prepared and the seed is planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the surface. Till-plant also is a system in which the seedbed is prepared and the seed is planted in one operation. Tillage is limited to a strip not wider than one-third of the row. A protective cover of crop residue is left on two-thirds of the surface. Chisel-disk is a system in which the soil is loosened throughout the field and part of the crop residue is incorporated into the soil. Preparing the seedbed and planting generally are one operation but can be separate operations. A conservation tillage system is effective only if the amount of crop residue left on the surface after planting is adequate to control erosion.

Terraces and diversions reduce the length of slopes and thus the runoff rate and the hazard of erosion. They are most practical on deep, well drained soils that have long, uniform slopes. In many areas Crofton, Galva, Ida, Moody, and Sac soils are well suited to terracing. Other soils are not so well suited to terraces or diversions because slopes are irregular or too steep or root-limiting layers are within a depth of 40 inches. Terracing is not practical on Dickman and other soils that have short slopes and are moderately coarse textured. On these soils a cropping system that provides a substantial plant cover and a conservation tillage system that leaves crop residue on the surface are effective in controlling erosion.

Contour farming and stripcropping can help to control erosion. They are most effective in areas where slopes are smooth and uniform, including most areas of Galva and Moody soils.

Wind erosion is a hazard on most of the soils in the county that are not protected by a plant cover or crop residue. It is most severe in areas that have been used for soybeans and fall tilled. It can damage plants on some soils, such as Dickman soils. Windblown sand grains damage plants through abrasion. Maintaining a plant cover or applying a conservation tillage system that leaves crop residue on the surface helps to control wind erosion. Windbreaks of suitable trees and shrubs 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, which is available in local offices of the Soil Conservation Service.

A drainage system is needed on about 10 percent of the acreage used for crops and pasture in the county. Unless a drainage system is installed, poorly drained soils are so wet that plants are damaged or fieldwork is complicated in most years. Examples of poorly drained soils are Afton, Marcus, and Spicer soils. In somewhat poorly drained soils, a drainage system allows for timelier fieldwork.

The design of drainage systems varies with the kind of soil. A tile drainage system is generally adequate in areas of poorly drained soils. Drains should be more closely spaced in slowly permeable soils than in more rapidly permeable soils.

Soil fertility is affected by the supply of available phosphorus and potassium in the subsoil, by reaction, and by the content of organic matter. The supply of available phosphorus and potassium in the subsoil is low or very low in most of the soils in the county.

In most of the well drained soils on uplands, such as Galva and Moody soils, the content of organic matter is about 4 or 5 percent in the surface layer. In the eroded soils, however, it is about 1.5 to 3.5 percent in the surface layer. In the poorly drained soils on uplands or bottom land, such as Marcus and Colo soils, the content of organic matter is typically 5 to 7 percent in the surface layer.

Most of the soils in the county are neutral or mildly alkaline. Ida, Crofton, and Spicer soils, for example, are moderately alkaline and have free carbonates in the surface layer. A high pH level or alkaline conditions reduce the content of available phosphorus and micronutrients. Sampling for fertility tests is an important part of cropland management. Samples from soils that have similar properties, such as Galva and Primghar soils, may be combined for testing, especially if the soils are likely to be managed in the same manner. Samples from soils that have different properties, such as Marcus and Spicer soils, should not be combined even if the same general management is planned. A separate analysis of the samples from each soil or group of similar soils results in the best estimate of the fertility status of a field. Samples of soils of minor extent in a field are needed only if the soil properties are so different from those of the other soils that different management is needed. More specific information about soil sampling for fertility tests is available in the local office of the Cooperative Extension Service.

Soil tilth is an important factor affecting the germination of seeds and in the infiltration of water into the soil. Soils with good tilth generally are high in content of organic matter and are granular and porous.

In most of the soils in the county, tilth is good. Practices that maintain or increase the content of organic matter improve tilth and soil structure. If silty soils are cultivated when wet, they tend to become cloddy when dry. Timely cultivation or minimum tillage helps to prevent cloddiness. Returning crop residue to the soil and regularly adding manure and other organic material improve soil structure and help to prevent surface crusting.

Applications of herbicide can control weeds in some areas used for crops and pasture. The organic matter content, the pH level, the depth to carbonates, and soil texture affect the need for herbicides and the rate of application.

Most of the permanent pastures in the county support bluegrass, but some of them support a grass-legume mixture, such as alfalfa and bromegrass. Management practices can improve forage production. The management needed on established stands includes applications of fertilizer, control of weeds and brush, rotation grazing 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, a conservation tillage system that leaves crop residue on the surface, contour farming, and grassed waterways help to prevent excessive soil loss. Interseeding grasses and legumes into the existing sod eliminates the need for destroying the plant cover during seedbed preparation.

Yields Per Acre

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

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

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

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

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

Land Capability Classification

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

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

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

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

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

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

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

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

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

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

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

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

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

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow (fig. 9). They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

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

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

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

Recreation

Most of the larger towns in the county have at least one local park. The county also has several other recreational areas. One of these is Oak Grove Park, a 160-acre area managed by the Sioux County Conservation Board. It provides opportunities for camping, fishing, hiking, and winter sports. Access areas are along the Big Sioux and Rock Rivers.

In rural areas opportunities for hunting and fishing are available along creeks and rivers and in upland game areas. Permission from the landowner is needed on private lands. White-tailed deer, pheasant, and partridge are plentiful and are hunted throughout the county.

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

In table 8, the degree of soil limitation is expressed

Figure 9.—A renovated farmstead windbreak in an area of Galva silty clay loam, 0 to 2 percent slopes.

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

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

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

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

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

Wildlife Habitat

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

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

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

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

Building Site Development

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

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

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of calcium carbonate affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

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

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

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

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

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

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

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

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

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

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

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

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

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

Construction Materials

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

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

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

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

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and bedrock.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

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

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

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

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

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

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

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

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

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

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

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

Soil Properties

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

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

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

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

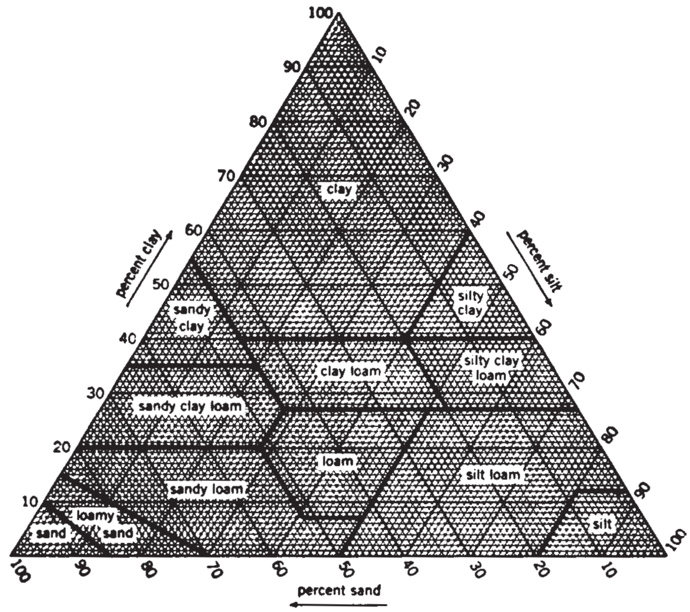

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

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

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

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

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

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

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

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

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

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

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

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

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

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

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

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

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

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

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

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

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

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

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility to wind erosion. 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 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

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

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

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

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

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

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

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

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

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

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

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. Only saturated zones within a depth of about 6 feet are indicated.

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.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(14)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

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

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

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

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (13)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (14)*. 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."

Afton Series

The Afton series consists of poorly drained, moderately slowly permeable soils in upland drainageways. These soils formed in loess and silty alluvium. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Afton silty clay loam, 0 to 2 percent slopes, in an area of cropland; 210 feet east and 1,360 feet north of the southwest corner of sec. 23, T. 95 N., R. 43 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; abrupt smooth boundary.

A—10 to 23 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

AB—23 to 31 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; black (5Y 2/1) coatings on faces of peds; few fine prominent yellowish red (5YR 5/8) and common fine distinct dark grayish brown (2.5Y 4/2) mottles; moderate fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bg—31 to 44 inches; dark grayish brown (2.5Y 4/2) silty clay loam; gray (5Y 5/1) coatings on faces of peds; common fine distinct yellowish brown (10YR 5/6) and few fine prominent yellowish red (5YR 5/8) mottles; weak fine prismatic structure parting to weak fine subangular blocky; friable; few medium very dark gray (10YR 3/1) krotovinas; neutral; gradual smooth boundary.

Cg—44 to 60 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) silt loam; weak medium prismatic structure; friable; neutral.

The solum ranges from 40 to 55 inches in thickness. The mollic epipedon ranges from 24 to 32 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 0 or 1. The Bg horizon has value of 3 to 5 and chroma of 2 or less. The Cg horizon has value of 3 to 5 and chroma of 1 to 6.

Allendorf Series

The Allendorf series consists of well drained soils on benches. These soils formed in silty sediments overlying sandy sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. The native vegetation was mixed prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Allendorf silty clay loam, 2 to 5 percent slopes, in a cultivated field; 840 feet west and 600 feet south of the northeast corner of sec. 17, T. 95 N., R. 43 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

AB—7 to 15 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw—15 to 30 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on faces of peds; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; neutral; gradual smooth boundary.

BC—30 to 35 inches; dark yellowish brown (10YR 4/4) sandy loam; very weak medium prismatic structure; friable; neutral; clear smooth boundary.

2C—35 to 60 inches; yellowish brown (10YR 5/6) gravelly sand; single grained; loose; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from about 30 to 40 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is silty clay loam or silt loam. The 2C horizon has value of 5 or 6 and chroma of 3 to 6. It is gravelly sand, very gravelly loamy coarse sand, or sand.

Allendorf silty clay loam, 2 to 5 percent slopes, moderately eroded, and Allendorf silty clay loam, 5 to 9 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Biscay Series

The Biscay series consists of poorly drained soils on stream terraces. These soils formed in glacial sediments consisting of a loamy mantle underlain by calcareous sand and gravel. Permeability is moderate in the upper part of the profile and rapid in the lower part. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Biscay series because they do not have contrasting textures and have a lower content of gravel in the 2BCg and 2C horizons than is defined as the range for the series.

Typical pedon of Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 1,360 feet west and 366 feet south of the northeast corner of sec. 18, T. 97 N., R. 43 W.

Ap—0 to 7 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; common fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; friable; few fine roots; mildly alkaline; abrupt smooth boundary.

A—7 to 12 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) in the lower part; very dark gray (10YR 3/1) dry; very few fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; friable; few fine roots; mildly alkaline; gradual smooth boundary.

AB—12 to 17 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; black (10YR 2/1) coatings on faces of peds; common fine distinct dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; few fine roots; mildly alkaline; gradual smooth boundary.

Bg—17 to 25 inches; dark grayish brown (2.5Y 4/2) clay loam; very dark grayish brown (10YR 3/2) discontinuous coatings on faces of peds; common medium distinct olive brown (2.5Y 4/4) mottles; weak fine prismatic structure parting to weak fine subangular blocky; friable; mildly alkaline; gradual smooth boundary.

2BCg—25 to 35 inches; mottled dark grayish brown (2.5Y 4/2), olive brown (2.5Y 4/4), and light olive brown (2.5Y 5/6) sandy loam; weak fine prismatic structure; friable; moderately alkaline; gradual smooth boundary.

2C—35 to 60 inches; olive brown (2.5Y 4/4) loamy sand; about 5 percent gravel; single grained; loose; strong effervescence; moderately alkaline.

The solum and the loamy mantle are 30 to 40 inches thick. The depth to free carbonates is 10 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 30 inches.

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

Bolan Series

The Bolan series consists of well drained soils on upland benches. These soils formed in loamy eolian material. Permeability is moderate in the upper part of the profile and rapid in the lower part. The native vegetation was mixed prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Bolan loam, 2 to 5 percent slopes, in a cultivated field; 480 feet south and 1,680 feet west of the northeast corner of sec. 23, T. 96 N., R. 43 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—9 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

Bw1—17 to 27 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

2Bw2—27 to 35 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

2BC—35 to 50 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loamy sand; few thin bands of silty clay loam; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

2C—50 to 60 inches; variegated pale brown (10YR 6/3), brown (10YR 5/3), light yellowish brown (10YR 6/4), and yellowish brown (10YR 5/4) sand; loose; very friable; strong effervescence; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. Free carbonates are at a depth of 48 to 60 inches or more.

The A horizon is dominantly loam, but the range includes silt loam. The C horizon is loamy sand or sand.

Bolan loam, 2 to 5 percent slopes, moderately eroded, Bolan loam, 5 to 9 percent slopes, moderately eroded, and Bolan loam, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Bolan Variant

The Bolan Variant consists of well drained, moderately rapidly permeable soils on uplands and benches. These soils formed in calcareous, loamy and sandy eolian material. The native vegetation was mixed prairie grasses. Slopes range from 2 to 25 percent.

Typical pedon of Bolan Variant loam, 5 to 9 percent slopes, moderately eroded, in an area of cropland; 1,500 feet east and 100 feet north of the southwest corner of sec. 5, T. 94 N., R. 47 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few accumulations of calcium carbonate; strong effervescence; moderately alkaline; abrupt smooth boundary.

Bw1—7 to 20 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

Bw2—20 to 35 inches; brown (10YR 4/3) loamy sand that has pockets of sandy loam; weak medium prismatic structure; friable; slight effervescence; moderately alkaline; clear smooth boundary.

C—35 to 60 inches; yellowish brown (10YR 5/4), stratified loam and fine sandy loam; massive; friable; slight effervescence; moderately alkaline.

The solum ranges from 15 to 35 inches in thickness. The dark colored surface layer typically is 6 to 10 inches thick. Free carbonates generally are throughout the profile, but in some pedons they are below a depth of 18 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is sandy loam, silt loam, or loam. The B horizon has value of 4 or 5 and chroma of 3 to 6. It is sandy loam, loam, or loamy sand. The C horizon has value of 4 to 6 and chroma of 2 to 6. In some pedons it is loamy sand or sand. Some pedons have a 2C horizon, which is clay loam.

Calco Series

The Calco series consists of poorly drained, moderately permeable soils on bottom land and in upland drainageways. These soils formed in calcareous, silty alluvium. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Calco silty clay loam, 0 to 2 percent slopes, in a pasture; 2,440 feet east and 95 feet north of the southwest corner of sec. 29, T. 96 N., R. 43 W.

A1—0 to 6 inches; black (5Y 2.5/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine granular structure; friable; common fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

A2—6 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine roots; disseminated lime; strong effervescence; mildly alkaline; gradual smooth boundary.

A3—16 to 31 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; disseminated lime; strong effervescence; mildly alkaline; gradual smooth boundary.

A4—31 to 45 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; disseminated lime; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg—45 to 60 inches; dark gray (5Y 4/1) silty clay loam; weak fine subangular blocky structure; friable; few soft accumulations of calcium carbonate; strong effervescence; mildly alkaline.

The solum ranges from 30 to more than 60 inches in thickness. The mollic epipedon ranges from 30 to 50 inches in thickness. Some pedons do not have free carbonates below a depth of 24 inches.

The A horizon has value of 2, 2.5, or 3 and chroma of 0 or 1. In some pedons it has snail shell fragments. The Bg horizon has value of 3 to 6 and chroma of 0 to 2. In some pedons this horizon is mottled. It typically is silty clay loam but in some pedons is silt loam or loam.

Colo Series

The Colo series consists of poorly drained, moderately permeable soils on bottom land and along upland drainageways. These soils formed in silty alluvium. The native vegetation was mixed wetland prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,050 feet south and 72 feet west of the northeast corner of sec. 34, T. 96 N., R. 43 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—9 to 24 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

ACg—24 to 38 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on faces of peds; few fine prominent strong brown (7.5YR 4/6) mottles; weak fine prismatic structure parting to moderate fine and medium subangular blocky; friable; few very fine roots; few soft dark concretions of iron and manganese oxide; neutral; gradual smooth boundary.

Cg—38 to 60 inches; very dark gray (5Y 3/1) silty clay loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; neutral.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon is 36 or more inches thick.

The A horizon has value of 2 or 3 and chroma of 0 or 1. The Cg horizon has value of 3 to 5 and chroma of 1 or 2. It has mottles that have value of 5 to 8 and chroma of 4 to 8. It is silty clay loam or silt loam.

Crofton Series

The Crofton series consists of well drained, moderately permeable, calcareous soils on ridgetops and side slopes in the uplands. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 2 to 18 percent.

Typical pedon of Crofton silt loam, 5 to 9 percent slopes, severely eroded, in a cultivated field; 264 feet east and 2,060 feet north of the southwest corner of sec. 22, T. 97 N., R. 47 W.

Ap—0 to 7 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; few dark brown (10YR 3/3) pockets; weak fine subangular blocky structure; friable; few fine roots; few fine rounded masses of calcium carbonate; violent effervescence; mildly alkaline; clear smooth boundary.

AC—7 to 15 inches; brown (10YR 4/3) silt loam; dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; friable; few fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C1—15 to 26 inches; yellowish brown (10YR 5/4) silt loam; few fine distinct light brownish gray (10YR 6/2) mottles; weak medium prismatic structure; friable; few very fine roots; few light soft accumulations and filaments of calcium carbonate; violent effervescence; mildly alkaline; gradual smooth boundary.

2C—26 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine distinct light brownish gray (10YR 6/2) mottles; massive; few light soft accumulations and filaments of calcium carbonate; violent effervescence; mildly alkaline.

The Ap or A horizon is less than 10 inches thick. In some pedons it is leached. It has value of 3 to 5 and chroma of 2 or 3. The C horizon has value of 4 or 5 and chroma of 3 to 6.

Cylinder Series

The Cylinder series consists of somewhat poorly drained soils on stream terraces. These soils formed in glacial sediments 32 to 40 inches deep over sand and gravel. Permeability is moderate in the upper part of the profile and very rapid in the sand and gravel. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Cylinder series because they do not have contrasting textures and have a lower content of gravel in the 2BC and 2C horizons than is defined as the range for the series.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field; 2,220 feet west and 66 feet south of the northeast corner of sec. 2, T. 97 N., R. 44 W.

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

A1—7 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; neutral; clear smooth boundary.

A2—13 to 20 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

BA—20 to 26 inches; dark grayish brown (10YR 4/2) loam; very dark gray (10YR 3/1) coatings on faces of peds; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.

Bw—26 to 35 inches; dark grayish brown (10YR 4/2) loam; few fine very dark gray (10YR 3/1) filled worm channels and few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; violent effervescence; mildly alkaline; clear smooth boundary.

2BC—35 to 47 inches; dark grayish brown (10YR 4/2) gravelly sandy loam; very weak medium subangular blocky structure; loose; strong effervescence; mildly alkaline; abrupt smooth boundary.

2C—47 to 60 inches; grayish brown (2.5Y 5/2) sand mixed with variegated sand grains; about 5 percent gravel; single grained; loose; strong effervescence; mildly alkaline.

The solum ranges from 24 to 35 inches in thickness. The mollic epipedon is 10 to 24 inches thick. Free carbonates are as shallow as 13 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5. The 2BC horizon is loam to sand and gravel. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8.

Davis Series

The Davis series consists of moderately well drained, moderately permeable soils on second bottoms. These soils formed in loamy alluvial sediments. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Davis loam, 0 to 2 percent slopes, in a cultivated field; 170 feet east and 570 feet south of the center of sec. 16, T. 96 N., R. 47 W.

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

A—8 to 18 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; few fine roots; neutral; gradual smooth boundary.

BA—18 to 27 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; black (10YR 2/1) coatings on faces of peds; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine roots; mildly alkaline; gradual smooth boundary.

Bw—27 to 36 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; very dark brown (10YR 2/2) coatings on faces of peds; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine roots; mildly alkaline; gradual smooth boundary.

BC—36 to 46 inches; dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) dry; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine prismatic structure; friable; few dark concretions of iron oxide; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) loam, grayish brown (10YR 5/2) dry; massive; friable; mildly alkaline.

The thickness of the solum ranges from 24 to more than 60 inches. In some pedons free carbonates are as high in the solum as 22 inches. The mollic epipedon is 20 or more inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes silt loam. The Bw horizon has value of 2 to 4 and chroma of 1 to 3. It is loam or clay loam. The C horizon has value of 3 to 6 and chroma of 2 to 6. It is loam, silt loam, or clay loam.

Dickman Series

The Dickman series consists of well drained, moderately rapidly permeable soils on ridgetops, side slopes, and knolls on uplands and outwash plains. These soils formed in loamy and sandy eolian material. The native vegetation was mixed prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Dickman sandy loam, 2 to 5 percent slopes, in a cultivated field; 168 feet north and 650 feet west of the center of sec. 30, T. 96 N., R. 47 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; common fine roots; neutral; clear smooth boundary.

A1—7 to 11 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; mixed with very dark grayish brown (10YR 3/2) material in the lower part; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; neutral; clear smooth boundary.

A2—11 to 17 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) sandy loam, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; mixed with dark yellowish brown (10YR 3/4) material in the lower part; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

Bw1—17 to 26 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

Bw2—26 to 39 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; few fine roots; neutral; gradual smooth boundary.

C1—39 to 52 inches; yellowish brown (10YR 5/4) sand; single grained; loose; few fine roots in the upper part; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—52 to 60 inches; yellowish brown (10YR 5/4) sand; single grained; loose; violent effervescence; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The depth to free carbonates is 30 inches or more. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 to 5 and chroma of 3 or 4. It is loamy sand, fine sandy loam, or sandy loam. The BC and C horizons have value of 5 or 6 and chroma of 3 or 4. They are loamy sand or sand.

Dickman sandy loam, 5 to 9 percent slopes, moderately eroded, and Dickman sandy loam, 9 to 14 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Ely Series

The Ely series consists of somewhat poorly drained, moderately permeable soils on concave foot slopes and along upland drainageways. These soils formed in silty local alluvium or colluvium. The native vegetation was mixed prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Ely silty clay loam, 2 to 5 percent slopes, in a meadow; 840 feet east and 550 feet south of the northwest corner of sec. 16, T. 96 N., R. 46 W.

A1—0 to 14 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

A2—14 to 28 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; few fine faint dark yellowish brown (10YR 3/6) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

BA—28 to 34 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; few fine roots; neutral; gradual smooth boundary.

Bw1—34 to 49 inches; olive brown (2.5Y 4/4) silty clay loam; grayish brown (2.5Y 5/2) coatings on faces of peds; weak fine prismatic structure parting to moderate fine subangular blocky; friable; neutral; gradual smooth boundary.

Bw2—49 to 56 inches; mottled grayish brown (2.5Y 5/2), strong brown (7.5YR 4/6), and yellowish brown (10YR 5/6) silty clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; few dark concretions of iron and manganese oxide; neutral; gradual smooth boundary.

C—56 to 60 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct strong brown (7.5Y 4.6) mottles; massive; friable; few dark soft accumulations of calcium carbonate; neutral.

The solum ranges from about 40 to 65 inches in thickness. The mollic epipedon ranges from 24 to 36 inches in thickness.

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

Estherville Series

The Estherville series consists of well drained or somewhat excessively drained, moderately rapidly permeable soils on stream terraces. These soils formed in glacial outwash. The native vegetation was mixed prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Estherville loam, 0 to 2 percent slopes, in an area of cropland; 600 feet west and 210 feet south of the northeast corner of sec. 2, T. 97 N., R. 46 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

A—7 to 14 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10 YR 3/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

Bw—14 to 18 inches; dark yellowish brown (10YR 4/4) coarse sandy loam; mixed with dark brown (10YR 3/3) material in the upper part; weak fine granular structure; friable; few fine roots; about 10 percent gravel; neutral; abrupt smooth boundary.

2BC—18 to 24 inches; dark yellowish brown (10YR 4/4) gravelly loamy sand; single grained; loose; mildly alkaline; clear smooth boundary.

2C1—24 to 35 inches; brown (10YR 5/3) gravelly sand; single grained; loose; strong effervescence; moderately alkaline; clear smooth boundary.

2C2—35 to 60 inches; light yellowish brown (10YR 6/4) gravelly coarse sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 30 inches. The loamy mantle and the mollic epipedon are 10 to 20 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value and chroma of 3 or 4. The A and B horizons are sandy loam or loam. The 2BC horizon has chroma of 2 to 5. It is gravelly loamy sand or sandy loam. The 2C horizon has value of 4 to 6 and chroma of 3 to 5. It is sand, gravelly sand, or gravelly coarse sand.

Estherville loam, 5 to 12 percent slopes, moderately eroded, is a taxadjunct to the series because it does not have a mollic epipedon.

Galva Series

The Galva series consists of well drained, moderately permeable soils on ridgetops and side slopes on uplands and on benches. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Galva silty clay loam, 2 to 5 percent slopes, in an area of cropland; 2,050 feet east and 80 feet south of the northwest corner of sec. 36, T. 97 N., R. 44 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine roots; slightly acid; abrupt smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 4/3) dry; black (10YR 2/1) coatings on faces of peds; weak fine granular and subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

BA—14 to 21 inches; dark brown (10YR 4/3) silty clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw—21 to 43 inches; dark yellowish brown (10YR 4/4) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds in the upper part; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

C—43 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; massive; friable; few fine accumulations of calcium carbonate; few fine dark concretions of manganese oxide; strong effervescence; mildly alkaline.

The solum generally ranges from 35 to 50 inches in thickness. In areas on stream benches where the underlying material is sandy loam or gravelly sand, however, the solum commonly is 55 or more inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 to 5 and chroma of 3 or 4. The higher values are in the lower part of the horizon. Areas on stream benches are underlain by stratified sandy loam or gravelly sand at a depth of 5 to 15 feet.

Galva silty clay loam, 2 to 5 percent slopes, moderately eroded, Galva silty clay loam, 5 to 7 percent slopes, moderately eroded, Galva silty clay loam, 9 to 14 percent slopes, moderately eroded, and Galva silty clay loam, benches, 2 to 5 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Graceville Series

The Graceville series consists of well drained soils on stream terraces and outwash plains. These soils formed in silty alluvial sediments overlying sand and gravel. Permeability is moderate in the solum and rapid in the substratum. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

These soils are taxadjuncts to the Graceville series because they have slightly more sand in the particle-size control section than is defined as the range for the series.

Typical pedon of Graceville silty clay loam, 0 to 2 percent slopes, in an area of cropland; 184 feet east and 2,440 feet north of the southwest corner of sec. 22, T. 97 N., R. 46 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few fine roots; a few sand grains visible on faces of peds; neutral; abrupt smooth boundary.

A1—9 to 20 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—20 to 31 inches; very dark gray (10YR 3/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—31 to 38 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—38 to 45 inches; dark yellowish brown (10YR 4/4) loam; discontinuous brown (10YR 4/3) coatings on faces of peds; moderate fine prismatic structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

2C—45 to 60 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grained; loose; about 15 percent gravel; neutral.

The solum ranges from 32 to 60 inches in thickness. The depth to sand and gravel ranges from 40 to 60 inches. The mollic epipedon ranges from 20 to 48 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silty clay loam or silt loam. The Bw horizon has hue of 10YR or 2.5Y and value and chroma of 3 or 4. It is loam, silt loam, or silty clay loam. The C horizon is gravelly sand, gravelly loamy sand, or very gravelly sand.

Ida Series

The Ida series consists of well drained, moderately permeable, calcareous soils on convex ridgetops and side slopes in the uplands. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Ida silt loam, 9 to 14 percent slopes, severely eroded, in an area of cropland; 460 feet south and 120 feet west of the northeast corner of sec. 20, T. 95 N., R. 46 W.

Ap—0 to 5 inches; brown (10YR 4/3) silt loam, dark yellowish brown (10YR 4/4) dry; weak fine subangular blocky structure; friable; few fine roots; few accumulations of calcium carbonate; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—5 to 28 inches; yellowish brown (10YR 5/4) silt loam; weak medium prismatic structure parting to very weak fine subangular blocky; friable; few fine roots; few light accumulations, filaments, and concretions of calcium carbonate; violent effervescence; mildly alkaline; clear smooth boundary.

C2—28 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine distinct light brownish gray (10YR 6/2) and few fine faint yellowish brown (10YR 5/6) mottles; massive; friable; few light accumulations, filaments, and concretions of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum is less than 10 inches. It is the same as the thickness of the Ap or A horizon. In some pedons the Ap or A horizon is not calcareous. It has value of 3 to 5 and chroma of 2 or 3. The C horizon has value of 4 or 5 and chroma of 3 to 6.

Judson Series

The Judson series consists of well drained and moderately well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in silty local alluvium and colluvium. The native vegetation was mixed prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Judson silty clay loam, 2 to 5 percent slopes, in a pasture; 330 feet east and 1,240 feet north of the southwest corner of sec. 9, T. 95 N., R. 47 W.

A1—0 to 11 inches; very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) dry; black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

A2—11 to 20 inches; very dark brown (10YR 2/2) silty clay loam, brown (10YR 4/3) dry; black (10YR 2/1) coatings on faces of peds; weak fine granular structure; friable; common fine roots; neutral; gradual smooth boundary.

AB—20 to 30 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure; friable; common fine roots; neutral; gradual smooth boundary.

Bw—30 to 46 inches; brown (10YR 4/3) silty clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds in the upper part; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; neutral; gradual smooth boundary.

BC—46 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium prismatic structure; friable; neutral.

The solum ranges from 40 to more than 60 inches in thickness. The mollic epipedon ranges from 24 to 36 inches in thickness. The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value and chroma of 3 or 4.

Kennebec Series

The Kennebec series consists of moderately well drained, moderately permeable soils on bottom land.

These soils formed in silty alluvium. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Kennebec silty clay loam, 0 to 2 percent slopes, in an area of cropland; 790 feet west and 210 feet north of the southeast corner of sec. 22, T. 96 N., R. 43 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few very fine roots; neutral; abrupt smooth boundary.

A1—9 to 18 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few very fine roots; neutral; gradual smooth boundary.

A2—18 to 35 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; few sand grains visible on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AC—35 to 47 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

C—47 to 60 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; few fine faint dark brown (7.5YR 3/2) and dark grayish brown (10YR 4/2) mottles; massive; friable; neutral.

The solum and the mollic epipedon are more than 30 inches thick. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The AC horizon has value of 2 to 4 and chroma of 1 to 4. The C horizon has value of 3 to 5 and chroma of 1 to 3. It is silt loam or silty clay loam.

Marcus Series

The Marcus series consists of poorly drained, moderately slowly permeable soils on wide upland divides and in upland drainageways. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Marcus silty clay loam, 0 to 2 percent slopes, in an area of cropland; 660 feet west and 400 feet south of the northeast corner of sec. 31, T. 97 N., R. 43 W.

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

A—9 to 13 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few very fine roots; neutral; clear smooth boundary.

AB—13 to 19 inches; very dark gray (5Y 3/1) and olive gray (5Y 4/2) silty clay loam, dark gray (5Y 4/1) and olive gray (5Y 5/2) dry; weak fine subangular blocky structure; friable; few very fine roots; mildly alkaline; gradual smooth boundary.

Bg1—19 to 28 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few medium very dark gray (10YR 3/1) krotovinas; few fine dark concretions of manganese oxide; mildly alkaline; clear smooth boundary.

Bg2—28 to 41 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—41 to 60 inches; mottled light olive gray (5Y 6/2) and strong brown (7.5YR 5/6) silt loam; massive; friable; few fine dark concretions of manganese oxide; slight effervescence; moderately alkaline.

The solum typically is 30 to 48 inches thick but ranges to as much as 60 inches thick. The A horizon has value of 2 or 3 and chroma of 0 to 2. The B horizon has value of 4 or 5 and chroma mainly of 1 or 2. It has chroma of 3 in some pedons where hue is 5Y. The Cg horizon has value of 5 or 6 and chroma of 1 or 2. It is silt loam or silty clay loam.

Moody Series

The Moody series consists of well drained, moderately permeable soils on ridgetops and side slopes on uplands and benches. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Moody silty clay loam, 2 to 5 percent slopes, in an area of cropland; 1,240 feet west and 588 feet south of the northeast corner of sec. 3, T. 97 N., R. 46 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—10 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; mixed with some dark brown (10YR 3/3) material in the lower part; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

Bw1—17 to 29 inches; brown (10YR 4/3) silty clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw2—29 to 39 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fine roots in the upper part; neutral; abrupt smooth boundary.

Bk—39 to 46 inches; brown (10YR 5/3) silt loam; weak medium prismatic structure; friable; few fine light soft filaments and accumulations of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; brown (10YR 5/3) silt loam; few fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; few fine light soft filaments and accumulations of calcium carbonate; few fine dark concretions of iron and manganese oxide; strong effervescence; mildly alkaline.

The solum ranges from about 30 to 60 inches in thickness. The mollic epipedon is 10 to 20 inches thick.

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

Moody silty clay loam, 2 to 5 percent slopes, moderately eroded, Moody silty clay loam, 5 to 9 percent slopes, moderately eroded, Moody silty clay loam, 9 to 14 percent slopes, moderately eroded, and Moody silty clay loam, benches, 2 to 5 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Ocheyedan Series

The Ocheyedan series consists of well drained, moderately permeable soils on ridgetops and side slopes in the uplands. These soils formed in loamy glacial sediments. The native vegetation was mixed prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Ocheyedan loam, 2 to 5 percent slopes, in an area of cropland; 210 feet south and 1,300 feet west of the northeast corner of sec. 6, T. 97 N., R. 45 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

AB—7 to 11 inches; loam, very dark grayish brown (10YR 3/2) kneaded, brown (10YR 5/3) dry; weak fine granular structure; friable; few fine roots; neutral; clear smooth boundary.

Bw1—11 to 20 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on faces of peds; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

Bw2—20 to 26 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

Bw3—26 to 40 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; clear smooth boundary.

BC—40 to 47 inches; dark yellowish brown (10YR 4/4) sandy loam; gray (10YR 5/1) and grayish brown (10YR 5/2) silt pockets 0.25 to 0.5 inch in diameter; weak fine prismatic structure; friable; neutral; abrupt smooth boundary.

2C—47 to 60 inches; yellowish brown (10YR 5/6) silt loam; few fine distinct strong brown (7.5YR 4/6) and common fine distinct gray (10YR 6/1) mottles; massive; friable; common fine dark accumulations of iron and manganese oxide; very slight effervescence; mildly alkaline.

The solum ranges from 35 to 50 inches in thickness. The mollic epipedon is 10 to 20 inches thick. The depth to free carbonates ranges from 20 to 50 inches.

The A horizon has chroma of 1 or 2. Some pedons do not have an AB horizon. The B horizon has chroma of 3 or 4. It is loam or sandy loam. The 2C horizon has value of 4 to 6 and chroma of 1 to 6. It is silt loam or sandy clay loam.

Ocheyedan loam, 2 to 5 percent slopes, moderately eroded, and Ocheyedan loam, 5 to 9 percent slopes, moderately eroded, are taxadjuncts to the series because they do not have a mollic epipedon.

Primghar Series

The Primghar series consists of somewhat poorly drained, moderately permeable soils on broad divides and in drainageways on uplands. These soils formed in loess. The native vegetation was mixed prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Primghar silty clay loam, 0 to 2 percent slopes, in an area of cropland; 100 feet east and 2,400 feet south of the northwest corner of sec. 36, T. 97 N., R. 44 W.

Ap—0 to 11 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—11 to 20 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; gradual smooth boundary.

BA—20 to 27 inches; dark grayish brown (2.5Y 4/2) silty clay loam; very dark grayish brown (2.5Y 3/2) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; neutral; clear smooth boundary.

Bw—27 to 33 inches; dark grayish brown (2.5Y 4/2) silty clay loam; very dark grayish brown (2.5Y 3/2) coatings on faces of peds; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; neutral; clear smooth boundary.

BC—33 to 45 inches; olive (5Y 5/3) silt loam; weak medium prismatic structure; friable; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

C—45 to 60 inches; light brownish gray (10YR 6/2) silt loam; common fine distinct dark yellowish brown (10YR 4/6) mottles; massive; few dark concretions of iron and manganese oxide; few soft accumulations of calcium carbonate; strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. Free carbonates are at a depth of 24 to 50 inches.

The A horizon is 16 to 24 inches thick. It has value of 2 or 3 and chroma of 1 or 2. The upper part of the B horizon has hue of 10YR or 2.5Y and value of 4 or 5. The C horizon is silt loam or silty clay loam.

Radford Series

The Radford series consists of somewhat poorly drained, moderately permeable soils on bottom land and alluvial fans. These soils formed in stratified alluvium that is 20 to 40 inches deep over a buried soil. The native vegetation was mixed prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Radford silt loam, 0 to 2 percent slopes, in an area of cropland; 500 feet east and 440 feet north of the southwest corner of sec. 13, T. 95 N., R. 47 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—8 to 12 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; clear smooth boundary.

C1—12 to 21 inches; very dark gray (10YR 3/1) silt loam; thin discontinuous dark grayish brown (10YR 4/2) strata; weak medium platy structure; friable; few fine roots; neutral; gradual smooth boundary.

C2—21 to 31 inches; black (10YR 2/1) silt loam; thin discontinuous dark grayish brown (10YR 4/2) strata; weak medium platy structure; friable; few fine roots; neutral; clear smooth boundary.

2Ab1—31 to 45 inches; black (N 2/0) silty clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; abrupt smooth boundary.

2Ab2—45 to 60 inches; black (N 2/0) silty clay loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral.

The solum and the mollic epipedon range from 10 to 22 inches in thickness. Depth to the 2Ab horizon ranges from 20 to 40 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The C horizon has value of 2 to 5 and chroma of 1 or 2. The higher value colors commonly are those of thin strata. The buried soil has value of 2 or 3 and chroma of 0 or 1. It typically is silty clay loam, but in some pedons it is silt loam or clay loam.

Rawles Series

The Rawles series consists of moderately well drained, moderately permeable soils in upland drainageways and on bottom land. These soils formed in calcareous, silty alluvium. The native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Rawles silt loam, 0 to 2 percent slopes, in a drainageway in a cultivated field; 700 feet north and 66 feet west of the southeast corner of sec. 24, T. 94 N., R. 48 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

C—8 to 24 inches; stratified very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), and brown (10YR 4/3) silt loam; massive; friable; slight effervescence; mildly alkaline; clear smooth boundary.

C/A—24 to 32 inches; dark brown (10YR 3/3) and brown (10YR 4/3) silt loam (C); very dark grayish brown (10YR 3/2) material with weak fine subangular blocky structure (A); friable; slight effervescence; mildly alkaline; clear smooth boundary.

2Ab1—32 to 51 inches; black (10YR 2/1) silty clay loam; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

2Ab2—51 to 60 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; friable; slight effervescence; mildly alkaline.

The A horizon is 6 to 10 inches thick. The C horizon has value of 3 to 5 and chroma of 2 or 3. Depth to the 2Ab horizon ranges from 20 to 36 inches. This horizon is silt loam or silty clay loam. It has value of 2 or 3 and chroma of 1 or 2.

Sac Series

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

These soils are taxadjuncts to the Sac series because they do not have a mollic epipedon.

Typical pedon of Sac silty clay loam, 2 to 5 percent slopes, moderately eroded, in an area of cropland; 168 feet west and 1,080 feet north of the southeast corner of sec. 26, T. 96 N., R. 43 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; mixed with some dark yellowish brown (10YR 4/4) material in the lower part; black (10YR 2/1) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; few fine roots; medium acid; abrupt smooth boundary.

Bw1—8 to 20 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak fine subangular blocky structure; friable; black (10YR 2/1) filled worm channels; few fine roots; slightly acid; gradual smooth boundary.

Bw2—20 to 28 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; neutral; abrupt smooth boundary.

2BC—28 to 34 inches; yellowish brown (10YR 5/4) loam; few fine distinct light brownish gray (10YR 6/2) mottles; weak fine prismatic structure; friable; few soft accumulations of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

2C—34 to 60 inches; mixed yellowish brown (10YR 5/6 and 5/4) and light brownish gray (10YR 6/2) clay loam; massive; firm; few dark concretions of iron and manganese oxide; few soft accumulations of calcium carbonate; strong effervescence; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. Carbonates are within a few inches of the top of the glacial till. The loess ranges from 22 to 40 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 to 3. The Bw horizon is silt loam or silty clay loam. It has value of 4 or 5 and chroma of 3 or 4. Some pedons do not have a 2BC horizon. This horizon is loam or clay loam. It has value and chroma of 3 to 5. The 2C horizon has value of 5 or 6 and chroma of 2 to 8.

Spicer Series

The Spicer series consists of poorly drained, moderately permeable soils in drainageways and in broad nearly level areas on uplands. These soils formed in calcareous loess. The native vegetation was wetland prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, 0 to 2 percent slopes, in an area of cropland; 2,500 feet east and 189 feet north of the southwest corner of sec. 6, T. 96 N., R. 43 W.

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

A—9 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; mixed with some dark grayish brown (2.5Y 4/2) subsoil material; weak fine granular structure; friable; few fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

BAg—18 to 26 inches; dark grayish brown (2.5Y 4/2) silty clay loam; dark gray (10YR 4/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Bg—26 to 38 inches; olive gray (5Y 5/2) silty clay loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak fine subangular blocky; friable; few soft accumulations of calcium carbonate; slight effervescence; mildly alkaline; gradual smooth boundary.

C—38 to 60 inches; olive gray (5Y 5/2) silt loam; many medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few dark concretions of manganese oxide; slight effervescence; moderately alkaline.

The solum ranges from 22 to 48 inches in thickness. The mollic epipedon is 12 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 0 or 1. The Bg and C horizons are silty clay loam or silt loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2.

Spillco Series

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

Typical pedon of Spillco loam, 0 to 2 percent slopes, in a pasture; 300 feet north and 900 feet west of the southeast corner of sec. 25, T. 97 N., R. 43 W.

A1—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; continuous black (N 2/0) coatings on faces of peds; weak fine granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

A2—5 to 19 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; black (N 2/0) coatings on faces of peds, continuous in the upper part, discontinuous in the lower part; weak fine granular structure; friable; few fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

A3—19 to 33 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

AC—33 to 44 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to weak fine subangular blocky; friable; few strata of loamy fine sand about 0.25 inch thick; slight effervescence; mildly alkaline; gradual smooth boundary.

C—44 to 60 inches; very dark gray (10YR 3/1) loam; massive; friable; few pebbles; few strata of loamy fine sand about 0.25 inch thick; slight effervescence; mildly alkaline.

The solum ranges from 36 to 50 inches in thickness. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. Colors that have value of 3 or less and chroma of 2 or less extend to a depth of more than 40 inches. Some pedons have mottles below a depth of 36 inches.

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 mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spillville loam, 0 to 2 percent slopes, in an area of cropland; 2,360 feet east and 900 feet south of the northwest corner of sec. 2, T. 94 N., R. 44 W.

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

A1—8 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; very few fine roots; neutral; gradual smooth boundary.

A2—16 to 31 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—31 to 45 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium prismatic structure; friable; neutral; gradual smooth boundary.

C—45 to 60 inches; very dark grayish brown (10YR 3/2) loam; few fine faint brown (10YR 4/3) mottles; massive; friable; neutral.

The solum ranges from 35 to 55 inches in thickness. Free carbonates are at a depth of 48 to 60 inches or more. The mollic epipedon is 36 to 60 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The C horizon is dominantly loam, but the range includes sandy loam and sandy clay loam.

Steinauer Series

The Steinauer series consists of well drained, moderately slowly permeable soils on convex side slopes in the uplands. These soils formed in calcareous glacial till. The native vegetation was mixed prairie grasses. Slopes range from 5 to 40 percent.

Typical pedon of Steinauer clay loam, 14 to 18 percent slopes, moderately eroded, in a cultivated field; 1,620 feet north and 200 feet east of the southwest corner of sec. 19, T. 95 N., R. 46 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) clay loam (25 percent sand), dark grayish brown (10YR 4/2) dry; streaks and pockets of dark yellowish brown (10YR 4/4) material; weak fine subangular blocky structure; friable; few fine roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

AC—6 to 14 inches; olive brown (2.5Y 4/4) and grayish brown (2.5Y 5/2) clay loam; few fine distinct gray (10YR 5/1) mottles; weak fine subangular blocky structure; friable; few fine roots; few light soft accumulations of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

C1—14 to 28 inches; olive brown (2.5Y 4/4) and gray (10YR 5/1) clay loam; very weak medium prismatic structure; firm; few fine roots; many light accumulations and concretions of calcium carbonate; violent effervescence; moderately alkaline; clear smooth boundary.

C2—28 to 43 inches; olive brown (2.5Y 4/4) and gray (10YR 5/1) clay loam; massive; firm; few dark concretions of iron oxide; many soft accumulations and concretions of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

C3—43 to 60 inches; olive brown (2.5Y 4/4) and gray (10YR 5/1) clay loam; massive; firm; few dark concretions of manganese oxide; slight effervescence; moderately alkaline.

The solum ranges from 4 to 20 inches in thickness. Free carbonates are within a depth of about 11 inches.

The A horizon has chroma of 1 to 3. It commonly is clay loam but in some pedons is loam. The AC horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon is clay loam or loam. It has value of 4 or 5 and chroma of 2 to 4. The low-chroma colors are relict.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on foot slopes, on alluvial fans, and in upland drainageways. These soils formed in loamy local alluvium. The native vegetation was mixed prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Terril loam, 2 to 5 percent slopes, in an area of cropland; 1,070 feet north and 267 feet west of the southeast corner of sec. 1, T. 97 N., R. 46 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A1—7 to 16 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

A2—16 to 25 inches; black (10YR 2/1) loam, brown (10YR 4/3) dry; some dark brown (10YR 3/3) material in the lower part; weak fine prismatic structure parting to weak fine subangular blocky; friable; few fine roots; neutral; gradual smooth boundary.

BA—25 to 33 inches; dark brown (10YR 3/3) loam, dark yellowish brown (10YR 4/4) dry; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

Bw1—33 to 46 inches; dark yellowish brown (10YR 3/4), dark brown (10YR 3/3), and brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—46 to 60 inches; dark yellowish brown (10YR 3/4) and dark brown (10YR 3/3) loam; weak medium prismatic structure; friable; neutral.

The solum ranges from about 36 to 60 inches in thickness. The mollic epipedon ranges from 20 to 36 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is dominantly loam but in some pedons is silt loam high in content of sand. The Bw horizon has value of 3 or 4 and chroma of 2 to 4. It is loam, clay loam, or sandy loam.

Wadena Series

The Wadena series consists of well drained soils on stream terraces. These soils formed in loamy and sandy-skeletal glacial sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. The native vegetation was mixed prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in a pasture; 2,400 feet west and 140 feet south of the northeast corner of sec. 26, T. 97 N., R. 47 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; few fine roots; neutral; abrupt smooth boundary.

A—9 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw—17 to 27 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on faces of peds in the upper part; weak fine subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

2BC—27 to 34 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loamy sand; single grained; loose; about 5 percent gravel; neutral; abrupt smooth boundary.

2C—34 to 60 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) gravelly sand; single grained; loose; about 30 percent gravel; strong effervescence; mildly alkaline.

The solum and loamy mantle range from 24 to 40 inches in thickness. The depth to free carbonates is 30 to 50 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. It is loam, sandy loam, or sandy 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.

Zook Series

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

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,550 feet north of the center of sec. 10, T. 94 N., R. 48 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

A1—9 to 15 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; weak fine granular structure; friable; sheen on faces of peds; few fine roots; neutral; gradual smooth boundary.

A2—15 to 26 inches; very dark gray (2.5Y 3/1) silty clay, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; friable; sheen on faces of peds; few fine roots; neutral; gradual smooth boundary.

Bg—26 to 38 inches; very dark gray (10YR 3/1) silty clay; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine prismatic structure parting to weak fine subangular blocky; friable; sheen on faces of peds; few fine roots; neutral; gradual smooth boundary.

BCg—38 to 49 inches; very dark gray (10YR 3/1) silty clay loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine prismatic structure; friable; few dark concretions of manganese oxide; neutral; gradual smooth boundary.

C—49 to 60 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) silty clay loam; massive; friable; neutral.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon ranges from 36 to 50 inches in thickness. The depth to calcium carbonates is 50 or more inches.

The A horizon has chroma of 0 or 1. It is dominantly silty clay loam, but the range includes silty clay. The B and C horizons have value of 3 to 5. They are silty clay, silty clay loam, or silt loam.

Formation of the Soils

In this section, the factors of soil formation are related to the soils in Sioux County and the processes that result in the formation of soil horizons are described.

Factors of Soil Formation

Soil forms through processes acting on deposited or accumulated geologic material. Several factors determine the characteristics of the soil at any given point on the landscape. They are the physical and mineralogical composition of the parent material, the climate under which the soil material accumulated and has 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 *(7)*. Human activities also affect soil formation.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. These factors act on unconsolidated organic and mineral parent material and slowly change it into a natural body that has genetically related horizons. Relief conditions the effects of climate and plant and animal life. The parent material affects the kind of soil that forms and the rate at which it forms. In extreme cases it almost entirely determines profile formation. Finally, time is needed for the transformation of the parent material into a soil. A long period generally is needed for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

The principal parent materials in Sioux County are loess, alluvium, glacial drift, and sandy eolian material.

Loess is silty, wind-deposited material that consists mainly of silt particles and smaller amounts of clay and sand. It covers about 75 percent of the county. It ranges in depth from more than 20 feet on stable ridgetops in the western part of the county to about 6 feet in the eastern part. It overlies glacial till and glacial outwash. The base of the Wisconsinan-age loess in Iowa is 16,500 to 29,000 years old *(9)*. The wind probably carried most of the loess from the flood plain along the Missouri River, the Big Sioux River, and other glacial outwash streams *(5)*. Crofton, Galva, Ida, Marcus, Moody, and Primghar soils formed in loess more than 60 inches thick. Sac soils formed in less than 40 inches of loess and in the underlying glacial till.

Alluvium is sediment deposited by water along the major and minor streams and drainageways. The texture of alluvium varies widely because the sources of the material and the manner in which it was deposited differ from area to area. In Sioux County the main sources of alluvium are loess and outwash deposited by glacial meltwater. The most extensive areas where the soils formed in alluvium are along the Big Sioux, Rock, and Floyd Rivers and their tributaries.

Much of the alluvium in the county washed from loess-covered slopes in the uplands. These alluvial sediments commonly are silty and low in content of sand. Colo and Kennebec soils formed in silty alluvium. Spillville and Terril soils formed in loamy alluvium. They contain more sand than the silty soils.

Textural differences among soils that formed in alluvium are accompanied by some variations in the chemical and mineralogical composition of the soils. Some soils formed in calcareous alluvium. Examples are Calco and Spillco soils. The other alluvial soils do not have free carbonates and are neutral or slightly acid.

Some alluvial material on foot slopes has been transported only a short distance. This local alluvium is similar to the material on the slopes from which it was eroded. Judson soils formed in this type of material. They are on alluvial fans and foot slopes directly below loess-covered slopes.

The soils on terraces also formed in alluvium. They are above the flood plain and generally are not subject to flooding. Most of these soils are underlain by coarser textured material within a depth of 2 to 6 feet. The texture differs among these soils. Graceville soils formed in silty alluvium, and Davis soils formed in loamy alluvium. Biscay, Cylinder, and Wadena soils formed in loamy alluvium overlying coarse sand and gravel.

Glacial drift is the rock material transported or deposited by glacial ice. It also is material of dominantly glacial origin deposited in the sea or in bodies of glacial meltwater. It includes glacial till, which is unsorted material ranging in size from clay to boulders.

Historically, four glaciations have been recognized in the United States. In order of increasing age, these glaciations are the Wisconsinan, Illinoian, Kansan, and Nebraskan. Recent evidence indicates that Kansan and Nebraskan sediments in Iowa are actually a complex association of several glacial deposits *(3)*. On the basis of this evidence, these deposits would be better represented as pre-Illinoian. Glacial drifts belonging to the Wisconsinan and pre-Illinoian Glaciations have been identified in Sioux County. Tazewell glacial drift was deposited during a substage of the Wisconsinan Glaciation. It is of very minor extent in the northeastern part of the county. The entire county is underlain by pre-Illinoian drift.

Glacial till is not an extensive parent material in Sioux County because most of the till is buried beneath a layer of loess about 6 to more than 20 feet thick. The most extensive exposures of glacial till are in the more sloping areas near the Big Sioux River in the northwestern part of the county. In these areas geologic erosion has removed the loess from the surface. Of the soils mapped in the county, only Steinauer soils formed entirely in glacial till.

Sandy eolian material is not extensive in Sioux County. It is along the southeastern side of the major streams. Deposits of this material are higher in content of sand than loess deposits. Wind-deposited sandy material is mainly fine and very fine quartz that is highly resistant to weathering. Since deposition it has not been appreciably altered. Dickman soils formed in wind-deposited loamy sand. Bolan soils formed in wind-deposited loamy material overlying wind-deposited sand.

Beneath the loess and glacial till are rock strata. These strata consist mainly of cretaceous shale that periodically crops out on very steep side slopes near the Big Sioux River *(16)*. Some soils formed entirely or partly in material weathered from these rocks, but it is impractical to map them because of their very small extent. Special spot symbols are used to identify the minor areas of bedrock on the soil maps.

Climate

The soils of Sioux County formed under the influence of a changing climate. Just after the Wisconsinan Glaciation, about 13,000 to 10,500 years before present (Y.B.P.), the climate was quite cool. A warming trend began between 10,500 and 8,000 Y.B.P. This trend eventually led to a drier climate. About 3,000 Y.B.P., the climate became more humid, similar to the subhumid, midcontinental climate of today.

The climate is generally uniform throughout the county, although the amount of rainfall increases slightly from west to east and temperature rises from north to south. The climate of the county is marked by wide seasonal extremes in temperature.

Climate is a major factor in determining what soils form in the various parent materials. It affects the rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil. Temperature, rainfall, relative humidity, and length of the frost-free period influence the kind of vegetation that grows on the soil.

Local conditions somewhat modify the effect of the general climate. South-facing slopes generally are slightly warmer and less humid than north-facing slopes. Low-lying, poorly drained areas have a slightly cooler and more humid microclimate than the higher adjacent areas. These contrasts account for some of the differences among soils within the same general climatic region.

Plant and Animal Life

Living organisms are important in soil formation. Differences in the kind of vegetation commonly cause marked differences among soils. Burrowing animals, worms, crayfish, and micro-organisms also influence soil properties.

The soils in Sioux County formed mainly under prairie grasses. Herbaceous prairie vegetation probably replaced forest vegetation about 3,000 years ago *(12)*. Because grasses have many roots and tops that decay, the surface layer of soils that formed under prairie vegetation typically is thicker and darker than the surface layer of soils that formed under trees. The organic matter in soils that formed under trees is derived mainly from fallen leaves. Soils that formed under grasses generally are less acid than soils that formed under trees and have had less net downward movement of bases and clay minerals.

Although native trees grow on the steep soils along the Big Sioux River, soils that show the influence of trees were not observed during the survey of the county. On Steinauer soils trees caused changes that are too slight to be significant or easily identified.

Large burrowing animals, such as badgers, foxes, and pocket gophers, drastically rearrange soil materials in small areas. Small animals, such as earthworms and ants, also have a widespread influence on soil formation. Earthworms move up and down in soils with changes in the moisture status. In most soil profiles examined in the county, earthworms have moved material from one soil horizon to another.

Relief

Relief is an important factor of soil formation because of its effect on drainage, runoff, depth to the water table, and erosion. In Sioux County slope ranges from nearly level to very steep. Differences in relief account for the differing properties among some soils in the county.

Slope affects erosion and the amount of water that runs off the surface or percolates through the soil. In this way, it affects the thickness and color of the A horizon and the thickness of the solum. For example, Ida, Galva, and Primghar soils formed in similar kinds of parent material. The thickness and color of the A horizon of these soils are related to the slope. The thickness of the A horizon increases and the color darkens as the slope decreases. Generally, Ida soils are strongly sloping to steep, Galva soils are gently sloping or moderately sloping, and Primghar soils are nearly level. The solum of Ida soils is thinner than that of Galva and Primghar soils. Also, carbonates are closer to the surface in Ida soils than in the other soils.

Relief affects the color of the subsoil through its effect on drainage and soil aeration. In well drained soils, such as Galva soils, the subsoil generally is brown because iron compounds are well distributed and are oxidized. In poorly drained, poorly aerated soils, such as Marcus soils, the subsoil generally is gray because iron compounds are reduced. Somewhat poorly drained soils, such as Primghar soils, have color characteristics intermediate between those of Galva and Marcus soils.

Time

The passage of time enables relief, climate, and plant and animal life to change the parent material into a soil. Topsoil forms in a few hundred years, and 8 to 10 times longer than that is required for the subsoil to become well developed. Similar soils form in different kinds of parent material if the other factors of soil formation are active for long periods. Over time, however, geologic events expose new parent material and generally interrupt soil formation.

During the pre-Illinoian (Kansan and Nebraskan) episodes, glacial drift generally covered the bedrock in Sioux County. In addition, Wisconsinan drift covered a small area in the northeastern part of the county. Wisconsinan loess covered the entire county. Except for the soils that formed in Wisconsinan loess, the soils that formed in these materials have been eroded away or have been buried by more recent material.

Radiocarbon dating has determined the age of wood, bones, and other organic carbon materials in Wisconsinan loess. The loess was deposited about 29,000 to 14,000 years ago. On the basis of these dates, the surface of a stable, loess-covered divide in Iowa is about 14,000 years old. Examples of these stable areas in Sioux County are the areas of Galva, Marcus, and Primghar soils on uplands.

In the central and northeastern parts of Iowa, erosion was considerable from 8,000 to 3,000 years ago *(4, 15)*. Material eroded from sloping areas and was deposited as sediment in the lower areas. The surface of these sloping areas, therefore, is thought to be less than 14,000 years old and may be no more than 3,000 years old.

The youngest surfaces in Sioux County are those of Ackmore soils on nearly level bottom land. The sediment in these areas is considered to be postsettlement alluvium overlying older, buried soils.

Human Activities

When Sioux County was settled, breaking the prairie sod and clearing the timber removed and changed the protective plant cover. Water erosion generally caused the most significant changes. 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, in many of the more sloping areas accelerated erosion removed part of the original surface layer.

Cultivation and erosion also changed the structure and consistence of the surface layer in some soils and the content of organic matter and level of fertility. In eroded areas the plow layer commonly includes the upper part of the subsoil, which is less friable than the original surface layer. Even in areas that are not subject to erosion, use of heavy machinery compacts the surface layer and changes the soil structure. Intensive cropping breaks down the granular structure of the surface layer of native grassland.

Erosion is the main cause of a decrease in the content of organic matter in soils. Erosion-control measures cannot increase the organic matter content to the level characteristic of native grassland, but they can keep the content at the level needed for crops.

Processes of Horizon Development

Horizon differentiation is the result of four basic processes. These processes are additions, removals, transfers, and transformations *(10)*. 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 in soils in Sioux County ranges from low to high. It is low in the surface layer of Ida soils and high in the surface layer of Colo soils. The removal of substances from parts of the profile is important in the development of soil horizons. An example is the downward movement of calcium carbonates and bases. Free carbonates have been leached from the upper part of most of the soils in the county. Exceptions include Calco, Crofton, Ida, Spicer, and Steinauer soils, which are calcareous throughout.

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 is transferred to the part of the plant growing above ground. It is then returned to the surface layer in the plant residue. This process affects the form and distribution of phosphorus in the profile.

The translocation of silicate clay minerals has an important effect on horizon differentiation. Clay minerals are carried downward by percolating water in the A horizon and accumulate in the lower part of the A horizon and in the B horizon. In Sioux County clay movement is minimal in comparison with some soils in other areas.

Transformations are physical and chemical. The weathering of soil particles to smaller sizes is an example of a transformation. Another example is the chemical reduction of iron in a process called gleying. Soils that are saturated for long periods are gleyed; they have ferrous iron and gray colors. Gleying is characteristic of poorly drained soils, such as Marcus soils.

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Glossary

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.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

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.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

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 meltwater.

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.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Large stones (in tables). Rock fragments 3 inches (7.6 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.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

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.

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.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

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.

Second bottom. The first terrace above the normal flood plain of a stream.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stream bench. A loess-covered landform in a stream valley, flanking and more or less paralleling the stream channel. Sometimes considered to be a loess-covered stream terrace.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind erosion and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

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.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Hawarden, 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-----	26.2	5.2	15.7	52	1	0	0.45	0.17	0.69	2	5.4
February----	33.2	12.4	22.8	61	1	0	.90	.29	.39	2	7.4
March-------	43.3	22.7	33.0	76	1	24	1.54	.64	2.29	4	8.3
April-------	61.0	36.6	48.8	89	16	96	2.43	1.05	3.59	6	1.5
May---------	73.0	48.0	60.5	92	25	334	3.49	1.80	4.95	7	.0
June--------	82.0	58.6	70.3	99	40	609	4.48	2.02	6.59	7	.0
July--------	86.5	63.4	75.0	100	46	775	3.52	1.82	5.00	6	.0
August------	84.5	61.4	73.0	99	44	713	3.37	1.45	4.99	6	.0
September---	75.5	50.5	63.0	96	29	390	2.67	1.12	3.98	5	.0
October-----	64.3	39.0	51.7	88	17	147	1.91	.54	3.02	4	.7
November----	46.1	24.8	35.5	72	17	6	1.06	.22	1.71	2	3.9
December----	31.7	12.1	21.9	58	17	0	.81	.33	1.21	3	7.4
Yearly:											
Average----	58.9	36.2	47.6	---	---	---	---	---	---	---	---
Extreme----	---	---	---	101	17	---	---	---	---	---	---
Total------	---	---	---	---	---	3,094	26.63	20.27	32.57	54	34.6

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Hawarden, Iowa)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 24	May 13	May 17
2 years in 10 later than--	Apr. 20	May 7	May 13
5 years in 10 later than--	Apr. 11	Apr. 26	May 5
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 6	Sept. 26	Sept. 15
2 years in 10 earlier than--	Oct. 11	Oct. 1	Sept. 20
5 years in 10 earlier than--	Oct. 20	Oct. 10	Sept. 30

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Hawarden, Iowa)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	174	147	128
8 years in 10	180	154	134
5 years in 10	191	166	146
2 years in 10	202	178	159
1 year in 10	208	185	165

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1B3	Ida silt loam, 2 to 5 percent slopes, severely eroded	1,075	0.2
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded	5,225	1.1
1D3	Ida silt loam, 9 to 14 percent slopes, severely eroded	2,705	0.6
8B	Judson silty clay loam, 2 to 5 percent slopes	6,900	1.4
11B	Radford-Judson complex, 0 to 5 percent slopes	9,915	2.0
26	Kennebec silty clay loam, 0 to 2 percent slopes	1,890	0.4
27B	Terril loam, 2 to 5 percent slopes	1,810	0.4
28B	Dickman sandy loam, 2 to 5 percent slopes	725	0.1
28C2	Dickman sandy loam, 5 to 9 percent slopes, moderately eroded	875	0.2
28D2	Dickman sandy loam, 9 to 14 percent slopes, moderately eroded	305	0.1
31	Afton silty clay loam, 0 to 2 percent slopes	7,990	1.6
32	Spicer silty clay loam, 0 to 2 percent slopes	630	0.1
33C2	Steinauer clay loam, 5 to 9 percent slopes, moderately eroded	355	0.1
33D2	Steinauer clay loam, 9 to 14 percent slopes, moderately eroded	680	0.1
33E2	Steinauer clay loam, 14 to 18 percent slopes, moderately eroded	685	0.1
33G	Steinauer clay loam, 18 to 40 percent slopes	2,520	0.5
54	Zook silty clay loam, 0 to 2 percent slopes	340	0.1
72	Estherville loam, 0 to 2 percent slopes	165	*
72B	Estherville loam, 2 to 5 percent slopes	375	0.1
72D2	Estherville loam, 5 to 12 percent slopes, moderately eroded	555	0.1
78B2	Sac silty clay loam, 2 to 5 percent slopes, moderately eroded	910	0.2
78C2	Sac silty clay loam, 5 to 9 percent slopes, moderately eroded	1,630	0.3
78D2	Sac silty clay loam, 9 to 14 percent slopes, moderately eroded	440	0.1
91	Primghar silty clay loam, 0 to 2 percent slopes	40,045	8.2
91B	Primghar silty clay loam, 2 to 5 percent slopes	27,465	5.6
92	Marcus silty clay loam, 0 to 2 percent slopes	12,730	2.6
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	2,510	0.5
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	600	0.1
116	Graceville silty clay loam, 0 to 2 percent slopes	3,180	0.6
133	Colo silty clay loam, 0 to 2 percent slopes	20,030	4.1
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	490	0.1
259	Biscay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	550	0.1
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,750	0.8
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	420	0.1
309	Allendorf silty clay loam, 0 to 2 percent slopes	795	0.2
309B	Allendorf silty clay loam, 2 to 5 percent slopes	430	0.1
309B2	Allendorf silty clay loam, 2 to 5 percent slopes, moderately eroded	300	0.1
309C2	Allendorf silty clay loam, 5 to 9 percent slopes, moderately eroded	300	0.1
310	Galva silty clay loam, 0 to 2 percent slopes	19,475	4.0
310B	Galva silty clay loam, 2 to 5 percent slopes	71,015	14.4
310B2	Galva silty clay loam, 2 to 5 percent slopes, moderately eroded	108,900	22.1
310C2	Galva silty clay loam, 5 to 9 percent slopes, moderately eroded	34,620	7.1
310D2	Galva silty clay loam, 9 to 14 percent slopes, moderately eroded	810	0.2
401B3	Crofton silt loam, 2 to 5 percent slopes, severely eroded	260	0.1
401C3	Crofton silt loam, 5 to 9 percent slopes, severely eroded	830	0.2
401D3	Crofton silt loam, 9 to 14 percent slopes, severely eroded	960	0.2
401E3	Crofton silt loam, 14 to 18 percent slopes, severely eroded	145	*
410	Moody silty clay loam, 0 to 2 percent slopes	435	0.1
410B	Moody silty clay loam, 2 to 5 percent slopes	2,565	0.5
410B2	Moody silty clay loam, 2 to 5 percent slopes, moderately eroded	9,695	2.0
410C2	Moody silty clay loam, 5 to 9 percent slopes, moderately eroded	5,690	1.2
410D2	Moody silty clay loam, 9 to 14 percent slopes, moderately eroded	250	0.1
428B	Ely silty clay loam, 2 to 5 percent slopes	6,145	1.3
467	Radford silt loam, 0 to 2 percent slopes	14,455	2.9
474	Bolan loam, 0 to 2 percent slopes	485	0.1
474B	Bolan loam, 2 to 5 percent slopes	1,645	0.3
474B2	Bolan loam, 2 to 5 percent slopes, moderately eroded	705	0.1
474C2	Bolan loam, 5 to 9 percent slopes, moderately eroded	990	0.2
474D2	Bolan loam, 9 to 14 percent slopes, moderately eroded	405	0.1
485	Spillville loam, 0 to 2 percent slopes	3,505	0.7
486	Davis loam, 0 to 2 percent slopes	4,495	0.9
615	Colo-Spillville complex, channeled, 0 to 2 percent slopes	650	0.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
670	Rawles silt loam, 0 to 2 percent slopes	875	0.2
733	Calco silty clay loam, 0 to 2 percent slopes	5,005	1.0
785	Spillco loam, 0 to 2 percent slopes	730	0.1
801B2	Bolan Variant loam, 2 to 5 percent slopes, moderately eroded	230	*
801C2	Bolan Variant loam, 5 to 9 percent slopes, moderately eroded	1,015	0.2
801D2	Bolan Variant loam, 9 to 14 percent slopes, moderately eroded	600	0.1
801F	Bolan Variant loam, 14 to 25 percent slopes, bouldery	135	*
810	Galva silty clay loam, benches, 0 to 2 percent slopes	10,625	2.2
810B	Galva silty clay loam, benches, 2 to 5 percent slopes	6,770	1.4
810B2	Galva silty clay loam, benches, 2 to 5 percent slopes, moderately eroded	2,685	0.5
812	Moody silty clay loam, benches, 0 to 2 percent slopes	980	0.2
812B	Moody silty clay loam, benches, 2 to 5 percent slopes	510	0.1
812B2	Moody silty clay loam, benches, 2 to 5 percent slopes, moderately eroded	485	0.1
878B	Ocheyedan loam, 2 to 5 percent slopes	340	0.1
878B2	Ocheyedan loam, 2 to 5 percent slopes, moderately eroded	275	0.1
878C2	Ocheyedan loam, 5 to 9 percent slopes, moderately eroded	925	0.2
5010	Pits, sand and gravel	990	0.2
5040	Orthents, loamy	810	0.2
5044	Fluvaquents, 0 to 2 percent slopes	3,505	0.7
	Water	1,325	0.3
	Total	490,240	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
1B3	Ida silt loam, 2 to 5 percent slopes, severely eroded
8B	Judson silty clay loam, 2 to 5 percent slopes
11B	Radford-Judson complex, 0 to 5 percent slopes
26	Kennebec silty clay loam, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
31	Afton silty clay loam, 0 to 2 percent slopes (where drained)
32	Spicer silty clay loam, 0 to 2 percent slopes (where drained)
54	Zook silty clay loam, 0 to 2 percent slopes (where drained)
78B2	Sac silty clay loam, 2 to 5 percent slopes, moderately eroded
91	Primghar silty clay loam, 0 to 2 percent slopes
91B	Primghar silty clay loam, 2 to 5 percent slopes
92	Marcus silty clay loam, 0 to 2 percent slopes (where drained)
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
116	Graceville silty clay loam, 0 to 2 percent slopes
133	Colo silty clay loam, 0 to 2 percent slopes (where drained)
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
259	Biscay 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
309	Allendorf silty clay loam, 0 to 2 percent slopes
309B	Allendorf silty clay loam, 2 to 5 percent slopes
309B2	Allendorf silty clay loam, 2 to 5 percent slopes, moderately eroded
310	Galva silty clay loam, 0 to 2 percent slopes
310B	Galva silty clay loam, 2 to 5 percent slopes
310B2	Galva silty clay loam, 2 to 5 percent slopes, moderately eroded
401B3	Crofton silt loam, 2 to 5 percent slopes, severely eroded
410	Moody silty clay loam, 0 to 2 percent slopes
410B	Moody silty clay loam, 2 to 5 percent slopes
410B2	Moody silty clay loam, 2 to 5 percent slopes, moderately eroded
428B	Ely silty clay loam, 2 to 5 percent slopes
467	Radford silt loam, 0 to 2 percent slopes
474	Bolan loam, 0 to 2 percent slopes
474B	Bolan loam, 2 to 5 percent slopes
474B2	Bolan loam, 2 to 5 percent slopes, moderately eroded
485	Spillville loam, 0 to 2 percent slopes
486	Davis loam, 0 to 2 percent slopes
670	Rawles silt loam, 0 to 2 percent slopes
733	Calco silty clay loam, 0 to 2 percent slopes (where drained)
785	Spillco loam, 0 to 2 percent slopes
801B2	Bolan Variant loam, 2 to 5 percent slopes, moderately eroded
810	Galva silty clay loam, benches, 0 to 2 percent slopes
810B	Galva silty clay loam, benches, 2 to 5 percent slopes
810B2	Galva silty clay loam, benches, 2 to 5 percent slopes, moderately eroded
812	Moody silty clay loam, benches, 0 to 2 percent slopes
812B	Moody silty clay loam, benches, 2 to 5 percent slopes
812B2	Moody silty clay loam, benches, 2 to 5 percent slopes, moderately eroded
878B	Ocheyedan loam, 2 to 5 percent slopes
878B2	Ocheyedan loam, 2 to 5 percent slopes, moderately eroded

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
1B3------------- Ida	IIe	103	37	77	4.3	2.5	5.3	7.2
1C3------------- Ida	IIIe	96	36	72	4.0	2.3	5.0	6.7
1D3------------- Ida	IIIe	87	33	63	3.6	2.4	4.5	6.0
8B-------------- Judson	IIe	126	47	95	5.2	3.1	7.3	8.6
11B------------- Radford-Judson	IIw	115	44	86	3.4	2.8	---	5.7
26-------------- Kennebec	I	115	43	86	4.8	2.8	7.1	8.0
27B------------- Terril	IIe	123	42	84	4.7	2.7	7.0	7.8
28B------------- Dickman	IIIe	61	21	46	2.5	1.5	3.6	4.2
28C2------------ Dickman	IVe	53	19	40	2.2	1.3	3.0	3.7
28D2------------ Dickman	IVe	44	15	33	1.8	1.8	2.8	3.0
31-------------- Afton	IIw	125	49	94	3.9	3.7	4.8	5.1
32-------------- Spicer	IIw	123	48	92	3.6	3.0	6.0	6.6
33C2------------ Steinauer	IIIe	96	36	72	4.8	2.3	5.0	6.7
33D2------------ Steinauer	IVe	87	38	65	3.6	2.1	4.8	6.1
33E2------------ Steinauer	IVe	70	26	53	2.9	1.7	3.8	4.9
33G------------- Steinauer	VIIe	---	---	---	---	1.4	2.4	4.1
54-------------- Zook	IIw	108	42	81	3.2	2.6	4.0	5.4
72-------------- Estherville	IIs	82	24	62	3.4	2.0	3.0	5.7
72B------------- Estherville	IIIs	79	28	59	3.3	2.0	3.0	5.5

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
72D2------------ Estherville	IVs	62	20	47	2.6	1.2	1.8	4.3
78B2------------ Sac	IIe	115	42	89	4.7	2.7	5.5	7.9
78C2------------ Sac	IIIe	110	40	85	4.5	2.6	5.1	7.5
78D2------------ Sac	IIIe	100	38	76	4.1	2.4	5.1	6.9
91-------------- Primghar	I	140	53	105	5.6	3.8	5.8	9.0
91B------------- Primghar	IIe	139	51	103	5.5	3.7	5.7	8.8
92-------------- Marcus	IIw	130	51	101	4.1	3.2	6.0	6.5
108------------- Wadena	IIs	85	31	64	3.5	2.6	4.8	5.9
108B------------ Wadena	IIe	78	30	59	3.2	1.9	4.6	5.4
116------------- Graceville	I	124	47	93	5.2	2.9	6.0	8.4
133------------- Colo	IIw	120	46	90	3.6	4.2	5.5	6.0
203------------- Cylinder	IIs	114	44	86	4.5	2.8	6.2	7.6
259------------- Biscay	IIw	108	42	81	3.9	2.6	6.6	5.4
308------------- Wadena	IIs	93	37	70	3.9	2.2	6.1	6.2
308B------------ Wadena	IIe	86	36	65	3.6	2.1	6.0	6.0
309------------- Allendorf	IIs	93	35	70	3.9	2.3	6.3	7.2
309B------------ Allendorf	IIe	90	34	68	3.8	2.2	6.1	6.3
309B2----------- Allendorf	IIe	86	32	65	3.6	2.1	6.0	6.8
309C2----------- Allendorf	IIIe	81	30	61	3.4	1.9	5.8	5.6
310------------- Galva	I	127	50	99	5.5	3.7	5.8	8.9

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
310B------------ Galva	IIe	124	48	97	5.4	3.0	5.7	8.7
310B2----------- Galva	IIe	120	47	94	5.3	2.9	5.5	8.4
310C2----------- Galva	IIIe	115	45	90	5.0	3.3	5.3	8.0
310D2----------- Galva	IIIe	106	42	83	4.7	2.7	4.7	7.4
401B3----------- Crofton	IIe	99	37	74	4.2	2.4	4.6	6.9
401C3----------- Crofton	IIIe	90	34	68	3.8	2.3	4.3	6.4
401D3----------- Crofton	IIIe	83	29	62	3.2	2.1	4.0	5.8
401E3----------- Crofton	IVe	66	23	45	2.5	1.6	3.0	4.6
410------------- Moody	I	120	45	90	5.0	3.3	5.5	6.7
410B------------ Moody	IIe	117	44	88	4.9	3.3	5.3	6.5
410B2----------- Moody	IIe	113	42	85	4.8	3.3	5.1	5.5
410C2----------- Moody	IIIe	108	41	81	4.5	2.6	4.8	5.0
410D2----------- Moody	IIIe	99	37	74	4.2	2.3	4.3	---
428B------------ Ely	IIe	128	48	95	5.1	3.1	7.5	8.8
467------------- Radford	IIw	127	48	95	3.8	3.1	---	6.3
474------------- Bolan	IIs	74	28	56	3.1	1.8	5.3	5.1
474B------------ Bolan	IIe	71	27	53	2.9	1.6	2.9	4.9
474B2----------- Bolan	IIe	67	25	50	2.8	1.5	2.7	4.7
474C2----------- Bolan	IIIe	62	21	43	2.3	1.4	2.3	4.0
474D2----------- Bolan	IIIe	53	20	40	2.2	1.3	2.1	3.7

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
485------------- Spillville	IIw	106	37	80	4.2	2.6	4.3	7.0
486------------- Davis	I	120	45	90	5.0	3.5	5.5	8.5
615------------- Colo-Spillville	Vw	---	---	---	---	4.2	6.5	7.8
670------------- Rawles	IIw	134	50	101	5.6	3.3	5.1	9.1
733------------- Calco	IIw	125	44	94	3.9	4.2	5.3	6.2
785------------- Spillco	IIw	102	38	77	4.1	2.5	5.5	6.8
801B2----------- Bolan Variant	IIe	64	24	48	2.7	2.7	4.0	5.0
801C2----------- Bolan Variant	IIIe	59	22	44	2.4	2.6	3.8	4.6
801D2----------- Bolan Variant	IIIe	50	20	37	2.1	2.5	3.6	4.4
801F------------ Bolan Variant	VIe	---	---	---	---	2.0	2.5	3.0
810------------- Galva	I	123	46	92	5.5	3.7	5.8	8.6
810B------------ Galva	IIe	120	48	90	5.4	2.9	5.7	8.4
810B2----------- Galva	IIe	116	47	87	4.8	2.8	5.5	8.1
812------------- Moody	I	118	44	89	5.0	2.9	5.3	8.3
812B------------ Moody	IIe	115	43	86	4.8	2.5	5.2	7.8
812B2----------- Moody	IIe	110	40	82	4.6	3.0	5.0	7.3
878B------------ Ocheyedan	IIe	104	39	78	4.6	3.3	5.0	7.2
878B2----------- Ocheyedan	IIe	100	38	75	4.4	2.7	4.8	7.0
878C2----------- Ocheyedan	IIIe	95	36	71	4.2	2.3	4.5	6.6

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1B3, 1C3, 1D3: Ida	American plum, lilac.	Rocky Mountain juniper, Russian olive, hackberry, Siberian peashrub, eastern redcedar.	Siberian elm, green ash, ponderosa pine, honeylocust, black locust.	---	---
8B: Judson	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Bur oak, hackberry, eastern redcedar, blue spruce, Russian olive.	Ponderosa pine, honeylocust, green ash.	---
11B*:					
Radford	Peking cotoneaster	Redosier dogwood, lilac, Amur maple.	Blue spruce	Hackberry, green ash, Austrian pine, Norway spruce, Scotch pine.	Silver maple, eastern cottonwood.
Judson	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Bur oak, hackberry, eastern redcedar, blue spruce, Russian olive.	Ponderosa pine, honeylocust, green ash.	---
26: Kennebec	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Ponderosa pine, Manchurian crabapple, eastern redcedar.	Golden willow, honeylocust, hackberry, green ash.	Eastern cottonwood.
27B: Terril	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Russian olive, hackberry, blue spruce, bur oak, eastern redcedar.	Ponderosa pine, honeylocust, green ash.	---
28B, 28C2, 28D2: Dickman	Lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, Russian olive, hackberry, black locust, ponderosa pine.	Bur oak, green ash, honeylocust, Siberian elm.	---	---
31: Afton	Lilac	Siberian peashrub, common chokecherry.	Eastern redcedar, hackberry, Russian olive, ponderosa pine, blue spruce.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
32: Spicer	Lilac	Siberian peashrub, common chokecherry.	Hackberry, ponderosa pine, blue spruce, Russian olive, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
33C2, 33D2: Steinauer	American plum, lilac.	Eastern redcedar, Siberian peashrub, Russian olive, Rocky Mountain juniper, hackberry.	Ponderosa pine, green ash, Siberian elm, honeylocust, black locust.	---	---
33E2, 33G. Steinauer					
54: Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry, Scotch pine.	Honeylocust, golden willow, green ash, silver maple, Austrian pine.	Eastern cottonwood.
72, 72B, 72D2: Estherville	Lilac, Peking cotoneaster, Siberian peashrub.	Black locust, eastern redcedar, hackberry, ponderosa pine, Russian olive.	Siberian elm, bur oak, green ash, honeylocust.	---	---
78B2, 78C2, 78D2: Sac	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian olive.	Ponderosa pine, honeylocust, green ash.	---
91, 91B: Primghar	Peking cotoneaster	American plum, lilac, Siberian peashrub.	Eastern redcedar, ponderosa pine, Manchurian crabapple.	Golden willow, honeylocust, green ash, hackberry.	Eastern cottonwood.
92: Marcus	Lilac	Siberian peashrub, common chokecherry.	Eastern redcedar, blue spruce, ponderosa pine, hackberry.	Green ash, honeylocust, golden willow, silver maple.	Eastern cottonwood.
108, 108B: Wadena	Siberian peashrub, lilac, Peking cotoneaster.	Eastern redcedar, Russian olive, hackberry, black locust, ponderosa pine.	Bur oak, green ash, honeylocust, Siberian elm.	---	---
116: Graceville	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Bur oak, Russian olive, hackberry, blue spruce, eastern redcedar.	Honeylocust, green ash, ponderosa pine.	---
133: Colo	Lilac	Redosier dogwood, American plum.	Black Hills spruce, blue spruce, hackberry, Amur maple, Scotch pine.	Green ash, golden willow.	Silver maple, eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
203. Cylinder	Peking cotoneaster	American plum, Siberian peashrub, lilac.	Eastern redcedar, Manchurian crabapple, ponderosa pine.	Hackberry, honeylocust, golden willow, green ash.	Eastern cottonwood.
259. Biscay	Lilac	Siberian peashrub, cotoneaster.	Hackberry, ponderosa pine, blue spruce, eastern redcedar.	Golden willow, silver maple, honeylocust, green ash.	Eastern cottonwood.
308, 308B. Wadena	Siberian peashrub, lilac, Peking cotoneaster.	Eastern redcedar, Russian olive, hackberry, black locust, Ponderosa pine.	Bur oak, green ash, honeylocust, Siberian elm.	---	---
309, 309B, 309B2, 309C2. Allendorf	Peking cotoneaster	American plum, Siberian peashrub, lilac.	Eastern redcedar, Russian olive, blue spruce, bur oak, hackberry.	Honeylocust, ponderosa pine, green ash.	---
310, 310B, 310B2, 310C2, 310D2. Galva	Peking cotoneaster	American plum, Siberian peashrub, lilac.	Eastern redcedar, Russian olive, blue spruce, bur oak, hackberry.	Honeylocust, ponderosa pine, green ash.	---
401B3, 401C3, 401D3. Crofton	American plum, lilac.	Eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Russian olive, hackberry.	Ponderosa pine, honeylocust, Siberian elm, green ash, black locust.	---	---
401E3. Crofton					
410, 410B, 410B2, 410C2, 410D2. Moody	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Blue spruce, hackberry, Russian olive, bur oak, eastern redcedar.	Ponderosa pine, green ash, honeylocust.	---
428B. Ely	Peking cotoneaster	Lilac, Amur maple, American plum.	Eastern redcedar, blue spruce.	Scotch pine, Austrian pine, green ash, hackberry, honeylocust.	Eastern cottonwood.
467. Radford	Peking cotoneaster	Redosier dogwood, lilac, Amur maple.	Blue spruce	Hackberry, green ash, Austrian pine, Norway spruce, Scotch pine.	Silver maple, eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
474, 474B, 474B2, 474C2, 474D2----- Bolan	Lilac, Siberian peashrub, Peking cotoneaster.	Russian olive, eastern redcedar, hackberry, Manchurian crabapple, black locust.	Honeylocust, green ash, bur oak, Siberian elm.	---	---
485--------------- Spillville	Peking cotoneaster	Redosier dogwood, lilac, Amur maple.	Blue spruce, eastern redcedar.	Hackberry, Austrian pine, green ash, Scotch pine.	Silver maple, eastern cottonwood.
486--------------- Davis	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Ponderosa pine, Manchurian crabapple, eastern redcedar.	Honeylocust, golden willow, green ash, hackberry.	Eastern cottonwood.
615*:					
Colo-------------	Lilac-------------	Redosier dogwood, American plum.	Black Hills spruce, blue spruce, hackberry, Amur maple, Scotch pine.	Green ash, golden willow.	Silver maple, eastern cottonwood.
Spillville-------	Peking cotoneaster	Redosier dogwood, lilac, Amur maple.	Blue spruce, eastern redcedar.	Hackberry, Austrian pine, green ash, Scotch pine.	Silver maple, eastern cottonwood.
670--------------- Rawles	American plum, lilac.	Siberian peashrub, common chokecherry.	Russian olive, eastern redcedar.	Bur oak, honeylocust, green ash, hackberry.	Eastern cottonwood, Siberian elm.
733--------------- Calco	Lilac, American plum.	Siberian peashrub, common chokecherry.	Hackberry, ponderosa pine, eastern redcedar, Russian olive.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
785--------------- Spillco	---	American plum, lilac, Siberian peashrub, common chokecherry.	Eastern redcedar, Manchurian crabapple, ponderosa pine.	Hackberry green ash, honeylocust, golden willow.	Eastern cottonwood.
801B2, 801C2, 801D2------------ Bolan Variant	Lilac, Siberian peashrub, American plum.	Eastern redcedar, hackberry.	Honeylocust, green ash, ponderosa pine, Russian olive, black locust.	Siberian elm------	---
801F. Bolan Variant	---	---	---	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
810, 810B, 810B2-- Galva	Peking cotoneaster	American plum, Siberian peashrub, lilac.	Eastern redcedar, Russian olive, blue spruce, bur oak, hackberry.	Honeylocust, ponderosa pine, green ash.	---
812, 812B, 812B2-- Moody	Peking cotoneaster	Siberian peashrub, American plum, lilac.	Blue spruce, hackberry, Russian olive, bur oak, eastern redcedar.	Ponderosa pine, green ash, honeylocust.	---
878B, 878B2, 878C2------------ Ocheyedan	Peking cotoneaster	American plum, lilac, Siberian peashrub.	Eastern redcedar, bur oak, blue spruce, Russian olive, hackberry.	Honeylocust, green ash, ponderosa pine.	---
5010*. Pits					
5040. Orthents					
5044. Fluvaquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1B3 Ida	Slight	Slight	Moderate: slope.	Slight	Slight.
1C3 Ida	Slight	Slight	Severe: slope.	Slight	Slight.
1D3 Ida	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
8B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
11B*:					
Radford	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
26 Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
27B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
28B Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
28C2 Dickman	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
28D2 Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
31 Afton	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
32 Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
33C2 Steinauer	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
33D2 Steinauer	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
33E2 Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
33G Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
54 Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
72 Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
72B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
72D2 Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
78B2 Sac	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
78C2 Sac	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
78D2 Sac	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
91 Primghar	Slight	Slight	Slight	Slight	Slight.
91B Primghar	Slight	Slight	Moderate: slope.	Slight	Slight.
92 Marcus	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
108 Wadena	Slight	Slight	Slight	Slight	Slight.
108B Wadena	Slight	Slight	Moderate: slope.	Slight	Slight.
116 Graceville	Slight	Slight	Slight	Slight	Slight.
133 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
203 Cylinder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
259 Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
308 Wadena	Slight	Slight	Slight	Slight	Slight.
308B Wadena	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
309 Allendorf	Slight	Slight	Slight	Slight	Slight.
309B, 309B2 Allendorf	Slight	Slight	Moderate: slope.	Slight	Slight.
309C2 Allendorf	Slight	Slight	Severe: slope.	Slight	Slight.
310 Galva	Slight	Slight	Slight	Slight	Slight.
310B, 310B2 Galva	Slight	Slight	Moderate: slope.	Slight	Slight.
310C2 Galva	Slight	Slight	Severe: slope.	Slight	Slight.
310D2 Galva	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
401B3 Crofton	Slight	Slight	Moderate: slope.	Slight	Slight.
401C3 Crofton	Slight	Slight	Severe: slope.	Slight	Slight.
401D3 Crofton	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
401E3 Crofton	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
410 Moody	Slight	Slight	Slight	Slight	Slight.
410B, 410B2 Moody	Slight	Slight	Moderate: slope.	Slight	Slight.
410C2 Moody	Slight	Slight	Severe: slope.	Slight	Slight.
410D2 Moody	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
428B Ely	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
467 Radford	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
474 Bolan	Slight	Slight	Slight	Slight	Slight.
474B, 474B2 Bolan	Slight	Slight	Moderate: slope.	Slight	Slight.
474C2 Bolan	Slight	Slight	Severe: slope.	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
474D2: Bolan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
485: Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
486: Davis	Severe: flooding.	Slight	Slight	Slight	Slight.
615*:					
Colo	Severe: flooding, wetness.	Moderate: wetness, flooding.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
Spillville	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
670: Rawles	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
733: Calco	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
785: Spillco	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
801B2: Bolan Variant	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
801C2: Bolan Variant	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
801D2: Bolan Variant	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
801F: Bolan Variant	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
810: Galva	Slight	Slight	Slight	Slight	Slight.
810B, 810B2: Galva	Slight	Slight	Moderate: slope.	Slight	Slight.
812: Moody	Slight	Slight	Slight	Slight	Slight.
812B, 812B2: Moody	Slight	Slight	Moderate: slope.	Slight	Slight.
878B, 878B2: Ocheyedan	Slight	Slight	Moderate: slope.	Slight	Slight.
878C2: Ocheyedan	Slight	Slight	Severe: slope.	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1B3 Ida	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1C3, 1D3 Ida	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
8B Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B*:										
Radford	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
26 Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
27B Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
28B, 28C2, 28D2 Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
31 Afton	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
32 Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
33C2, 33D2 Steinauer	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
33E2 Steinauer	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
33G Steinauer	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
54 Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
72, 72B, 72D2 Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
78B2 Sac	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
78C2, 78D2 Sac	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
91, 91B Primghar	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
92 Marcus	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
108, 108B Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
116 Graceville	Good	Good	Good	---	---	Very poor.	Very poor.	Good	---	Very poor.
133 Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
203 Cylinder	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	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.
309, 309B, 309B2 Allendorf	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
309C2 Allendorf	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
310, 310B, 310B2 Galva	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
310C2, 310D2 Galva	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
401B3, 401C3, 401D3 Crofton	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
401E3 Crofton	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
410, 410B, 410B2 Moody	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
410C2 Moody	Fair	Good	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
410D2 Moody	Fair	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
428B Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
467 Radford	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
474, 474B, 474B2 Bolan	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
474C2, 474D2 Bolan	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
485 Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
486----------------- Davis	Good	Good	Fair	Good	Poor	Very poor.	Very poor.	Good	Poor	Very poor.
615*:										
Colo---------------	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Spillville---------	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
670----------------- Rawles	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
733----------------- Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
785----------------- Spillco	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
801B2--------------- Bolan Variant	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Poor	Very poor.
801C2, 801D2------- Bolan Variant	Fair	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Poor	Very poor.
801F---------------- Bolan Variant	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.
810, 810B, 810B2--- Galva	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
812, 812B, 812B2--- Moody	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
878B, 878B2-------- Ocheyedan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
878C2--------------- Ocheyedan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
5010*. Pits										
5040. Orthents										
5044. Fluvaquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1B3 Ida	Slight	Slight	Slight	Slight	Severe: frost action, low strength.	Slight.
1C3 Ida	Slight	Slight	Slight	Moderate: slope.	Severe: frost action, low strength.	Slight.
1D3 Ida	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
8B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
11B*:						
Radford	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
26 Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
27B Terril	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
28B Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
28C2 Dickman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
28D2 Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
31 Afton	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
32 Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
33C2: Steinauer	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
33D2: Steinauer	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
33E2, 33G: Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
54: Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
72, 72B: Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
72D2: Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
78B2: Sac	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
78C2: Sac	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
78D2: Sac	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
91, 91B: Primghar	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
92: Marcus	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
108, 108B: Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
116: Graceville	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
133: Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
203: Cylinder	Severe: cutbanks cave, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
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.
309, 309B, 309B2 Allendorf	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
309C2 Allendorf	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
310, 310B, 310B2 Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
310C2 Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
310D2 Galva	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
401B3 Crofton	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
401C3 Crofton	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
401D3 Crofton	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
401E3 Crofton	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
410, 410B, 410B2 Moody	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
410C2 Moody	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
410D2 Moody	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
428B Ely	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
467 Radford	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
474, 474B, 474B2-- Bolan	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
474C2------------ Bolan	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
474D2------------ Bolan	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: frost action, slope.	Moderate: slope.
485-------------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
486-------------- Davis	Slight---------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.	Slight.
615*:						
Colo------------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Spillville-------	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
670-------------- Rawles	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
733-------------- Calco	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
785-------------- Spillco	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
801B2------------ Bolan Variant	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Moderate: droughty.
801C2------------ Bolan Variant	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Moderate: droughty.
801D2------------ Bolan Variant	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: droughty, slope.
801F------------- Bolan Variant	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
810, 810B, 810B2-- Galva	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
812, 812B, 812B2-- Moody	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
878B, 878B2------- Ocheyedan	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
878C2------------- Ocheyedan	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
5010*. Pits						
5040. Orthents						
5044. Fluvaquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1B3----------------- Ida	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
1C3----------------- Ida	Slight-----------	Severe: slope.	Slight-----------	Slight-----------	Good.
1D3----------------- Ida	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
8B------------------ Judson	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
11B*:					
Radford------------	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Judson-------------	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
26------------------ Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
27B----------------- Terril	Slight-----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
28B----------------- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
28C2, 28D2---------- Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31------------------ Afton	Severe: percs slowly, wetness, flooding.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
32------------------ Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
33C2---------------- Steinauer	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
33D2---------------- Steinauer	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Poor: hard to pack.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
33E2, 33G----------- Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: hard to pack, slope.
54----------------- Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
72, 72B------------ Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
72D2--------------- Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
78B2--------------- Sac	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
78C2--------------- Sac	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
78D2--------------- Sac	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
91, 91B------------ Primghar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
92----------------- Marcus	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
108, 108B---------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
116---------------- Graceville	Slight-----------	Severe: seepage.	Severe: seepage.	Slight-----------	Fair: too clayey, thin layer.
133---------------- Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
203---------------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
259---------------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
308, 308B: Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
309, 309B, 309B2: Allendorf	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
309C2: Allendorf	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
310: Galva	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
310B, 310B2: Galva	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
310C2: Galva	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
310D2: Galva	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
401B3: Crofton	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
401C3: Crofton	Slight	Severe: slope.	Slight	Slight	Good.
401D3: Crofton	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
401E3: Crofton	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
410: Moody	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
410B, 410B2: Moody	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
410C2: Moody	Moderate: percs slowly.	Severe: slope.	Slight	Slight	Good.
410D2: Moody	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
428B: Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
467----------------- Radford	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
474, 474B, 474B2---- Bolan	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
474C2, 474D2-------- Bolan	Severe: poor filter.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
485----------------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
486----------------- Davis	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
615*:					
Colo---------------	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Spillville---------	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
670----------------- Rawles	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
733----------------- Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
785----------------- Spillco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness.	Fair: wetness.
801B2--------------- Bolan Variant	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
801C2--------------- Bolan Variant	Slight-----------	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Good.
801D2--------------- Bolan Variant	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
801F---------------- Bolan Variant	Severe: slope.	Severe: seepage, slope.	Severe: slope, seepage.	Severe: seepage, slope.	Poor: slope.
810----------------- Galva	Slight-----------	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
810B, 810B2: Galva	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
812: Moody	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
812B, 812B2: Moody	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
878B, 878B2: Ocheyedan	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
878C2: Ocheyedan	Slight	Severe: slope.	Slight	Slight	Good.
5010*. Pits					
5040. Orthents					
5044. Fluvaquents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1B3, 1C3: Ida	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1D3: Ida	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
8B: Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11B*:				
Radford	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
26: Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
27B: Terril	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
28B, 28C2, 28D2: Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
31: Afton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
32: Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
33C2: Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, large stones.
33D2: Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, large stones, slope.
33E2: Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
33G: Steinauer	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
54: Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
72, 72B, 72D2: Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
78B2, 78C2 Sac	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
78D2 Sac	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
91, 91B Primghar	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
92 Marcus	Fair: low strength, shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
108, 108B Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
116 Graceville	Good	Probable	Probable	Good.
133 Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
203 Cylinder	Fair: wetness.	Probable	Probable	Poor: small stones.
259 Biscay	Fair: wetness.	Probable	Probable	Poor: area reclaim.
308, 308B Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
309, 309B, 309B2, 309C2 Allendorf	Good	Probable	Probable	Poor: area reclaim.
310, 310B, 310B2, 310C2 Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
310D2 Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
401B3, 401C3 Crofton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
401D3 Crofton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
401E3 Crofton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
410, 410B, 410B2, 410C2 Moody	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
410D2 Moody	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
428B Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
467 Radford	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
474, 474B, 474B2, 474C2 Bolan	Good	Probable	Improbable: too sandy.	Good.
474D2 Bolan	Good	Probable	Improbable: too sandy.	Fair: slope.
485 Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
486 Davis	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
615*:				
Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
670 Rawles	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
733 Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
785 Spillco	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
801B2, 801C2 Bolan Variant	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
801D2 Bolan Variant	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
801F Bolan Variant	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
810, 810B, 810B2 Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
812, 812B, 812B2 Moody	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
878B, 878B2, 878C2 Ocheyedan	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--			Features affecting--		
	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
1B3, 1C3---------- Ida	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
1D3--------------- Ida	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
8B---------------- Judson	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
11B*:						
Radford-----------	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness---------	Wetness.
Judson-----------	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
26---------------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable------	Favorable.
27B--------------- Terril	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
28B, 28C2--------- Dickman	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
28D2-------------- Dickman	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
31---------------- Afton	Slight---------	Severe: wetness.	Severe: slow refill.	Flooding, frost action.	Wetness, erodes easily.	Wetness, erodes easily.
32---------------- Spicer	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Frost action---	Wetness, erodes easily.	Wetness, erodes easily.
33C2-------------- Steinauer	Moderate: slope.	Moderate: piping, hard to pack.	Severe: no water.	Deep to water	Favorable------	Rooting depth.
33D2, 33E2, 33G--- Steinauer	Severe: slope.	Moderate: piping, hard to pack.	Severe: no water.	Deep to water	Slope-----------	Slope, rooting depth.
54---------------- Zook	Slight---------	Severe: hard to pack, wetness.	Severe: slow refill.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.
72, 72B----------- Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy------	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
72D2--------------- Estherville	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy.	Slope, droughty.
78B2, 78C2-------- Sac	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily, rooting depth.
78D2-------------- Sac	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily, rooting depth.
91---------------- Primghar	Moderate: seepage.	Moderate: hard to pack, wetness.	Moderate: deep to water, slow refill.	Deep to water	Erodes easily	Erodes easily.
91B--------------- Primghar	Moderate: seepage, slope.	Moderate: hard to pack, wetness.	Moderate: deep to water, slow refill.	Deep to water	Erodes easily	Erodes easily.
92---------------- Marcus	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action---	Wetness, erodes easily.	Wetness, erodes easily.
108, 108B--------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
116--------------- Graceville	Severe: seepage.	Moderate: thin layer, piping.	Severe: no water.	Deep to water	Favorable------	Favorable.
133--------------- Colo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness--------	Wetness.
203--------------- Cylinder	Severe: seepage.	Severe: seepage, piping.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Favorable.
259--------------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Severe: cutbanks cave.	Frost action, cutbanks cave.	Wetness, too sandy.	Wetness.
308, 308B--------- Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy------	Favorable.
309, 309B, 309B2, 309C2------------ Allendorf	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Erodes easily, too sandy.	Erodes easily.
310--------------- Galva	Moderate: seepage.	Slight---------	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
310B, 310B2, 310C2------------ Galva	Moderate: seepage, slope.	Slight---------	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
310D2------------- Galva	Severe: slope.	Slight---------	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
401B3, 401C3: Crofton	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
401D3, 401E3: Crofton	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
410: Moody	Moderate: seepage.	Moderate: thin layer, piping, hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
410B, 410B2, 410C2: Moody	Moderate: seepage, slope.	Moderate: thin layer, piping, hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
410D2: Moody	Severe: slope.	Moderate: thin layer, piping, hard to pack.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
428B: Ely	Moderate: slope, seepage.	Moderate: wetness, piping.	Moderate: deep to water, slow refill.	Slope, frost action.	Erodes easily, wetness.	Erodes easily.
467: Radford	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
474, 474B, 474B2, 474C2: Bolan	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Favorable.
474D2: Bolan	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy.	Slope.
485: Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
486: Davis	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
615*:						
Colo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
670: Rawles	Moderate: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
733: Calco	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
785 Spillco	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
801B2, 801C2 Bolan Variant	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing	Droughty.
801D2, 801F Bolan Variant	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Slope, droughty.
810 Galva	Moderate: seepage.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
810B, 810B2 Galva	Moderate: seepage, slope.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
812 Moody	Moderate: seepage.	Moderate: thin layer, piping, hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
812B, 812B2 Moody	Moderate: seepage, slope.	Moderate: thin layer, piping, hard to pack.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
878B, 878B2, 878C2 Ocheyedan	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
5010*. Pits						
5040. Orthents						
5044. Fluvaquents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1B3, 1C3, 1D3----Ida	0-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
8B---------------Judson	0-30	Silty clay loam	CL, ML	A-6, A-7	0	100	100	100	95-100	35-50	10-25
	30-46	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	46-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
11B*:											
Radford---------	0-31	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	80-100	30-40	5-15
	31-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	80-95	35-50	15-25
Judson----------	0-30	Silty clay loam	CL, ML	A-6, A-7	0	100	100	100	95-100	35-50	10-25
	30-46	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	46-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
26---------------Kennebec	0-47	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-20
	47-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
27B--------------Terril	0-25	Loam-------------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	25-60	Clay loam, loam, sandy loam.	CL, SC, SM-SC, CL-ML	A-6, A-4	0-5	95-100	90-100	65-95	35-85	20-40	5-20
28B, 28C2, 28D2--Dickman	0-17	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	17-39	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	39-60	Stratified coarse sand to loamy sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
31---------------Afton	0-31	Silty clay loam	MH, CH	A-7	0	100	100	100	95-100	50-65	20-35
	31-44	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	100	95-100	40-60	20-35
	44-60	Clay loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	95-100	80-100	60-90	35-50	20-30
32---------------Spicer	0-18	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	18-38	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	38-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
33C2, 33D2, 33E2, 33G-------------Steinauer	0-6	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	6-14	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	14-60	Loam, clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	60-75	25-55	10-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
54--------------- Zook	0-9	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	9-38	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	38-60	Silty clay loam, silty clay, silt loam.	CH, CL	A-7, A-6	0	100	100	95-100	95-100	35-80	10-50
72, 72B, 72D2---- Estherville	0-14	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	80-100	50-75	50-60	25-40	4-15
	14-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Gravelly sand, gravelly coarse sand, gravelly loamy sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
78B2, 78C2, 78D2- Sac	0-8	Silty clay loam	CL, ML, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	8-28	Silty clay loam, silt loam.	CL, ML, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	28-60	Clay loam, loam	CL	A-6, A-7	2-5	95-100	90-100	75-95	65-80	35-50	15-30
91, 91B---------- Primghar	0-20	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-60	20-30
	20-33	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	20-30
	33-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	95-100	90-100	30-40	11-20
92--------------- Marcus	0-19	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-65	20-35
	19-41	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	20-35
	41-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	95-100	85-95	30-40	15-25
108, 108B-------- Wadena	0-17	Loam-------------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	17-27	Loam, sandy loam, sandy clay loam.	SM, ML, SM-SC, CL-ML	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	27-60	Stratified gravelly coarse sand to loamy sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
116-------------- Graceville	0-38	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	35-45	11-20
	38-45	Silty clay loam, silt loam, loam.	CL	A-4, A-6, A-7	0	100	100	90-100	70-90	30-45	8-20
	45-60	Gravelly sand, gravelly loamy sand, very gravelly sand.	SM, GW-GM, SW-SM, GM	A-1, A-2	0	40-80	30-70	20-50	5-30	<25	NP-4
133-------------- Colo	0-24	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	24-38	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	38-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
203-------------- Cylinder	0-20	Loam-------------	CL	A-6	0	100	90-100	80-100	50-75	30-40	10-20
	20-35	Loam, clay loam	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	35-60	Gravelly coarse sand, sand, gravelly sandy loam.	SP-SM, SM	A-1, A-2, A-3	0-10	65-95	65-95	20-55	5-25	---	NP
259-------------- Biscay	0-17	Loam-------------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	35-50	10-25
	17-25	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	25-35	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	35-60	Loamy sand, sand	SP, SP-SM	A-1	0-5	85-95	75-95	20-45	2-10	---	NP
308, 308B-------- Wadena	0-16	Loam-------------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	16-36	Loam, sandy loam, sandy clay loam.	SM, ML, SC-SM, ML-CL	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	36-60	Stratified gravelly coarse sand to gravelly sandy loam.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
309, 309B, 309B2, 309C2----------- Allendorf	0-15	Silty clay loam	CL	A-6	0	95-100	95-100	95-100	85-95	30-40	10-20
	15-30	Silty clay loam, silt loam.	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	80-95	25-40	5-20
	30-35	Loam, sandy loam	ML, SM	A-4	0-5	85-100	85-100	65-90	40-60	25-35	3-10
	35-60	Very gravelly loamy coarse sand, gravelly sand, sand.	SW, SM, SP-SM, SP	A-1	2-10	60-95	40-95	20-40	3-25	---	NP
310, 310B, 310B2, 310C2, 310D2---- Galva	0-14	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	14-43	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	43-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	85-100	35-50	15-25
401B3, 401C3, 401D3, 401E3---- Crofton	0-7	Silt loam--------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	7-60	Silt loam--------	CL	A-6, A-7	0	100	95-100	95-100	95-100	32-50	10-25
410, 410B, 410B2, 410C2, 410D2---- Moody	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	13-25
	17-39	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	95-100	85-100	32-55	11-33
	39-60	Silt loam, silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-45	3-20
428B------------- Ely	0-28	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	28-56	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
	56-60	Silt loam, silty clay loam, loam.	CL	A-6	0	100	100	90-100	85-100	25-40	10-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
467--------------- Radford	0-31	Silt loam---------	ML, CL	A-4, A-6	0	100	100	95-100	80-100	30-40	5-15
	31-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	95-100	80-95	35-50	15-25
474, 474B, 474B2, 474C2, 474D2---- Bolan	0-17	Loam-------------	CL, ML	A-4, A-6	0	100	100	85-95	50-70	30-40	5-15
	17-27	Loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	100	80-90	40-55	25-35	5-15
	27-60	Loamy fine sand, fine sand, sand.	SM, SP-SM	A-2	0	100	100	70-85	10-30	---	NP
485--------------- Spillville	0-45	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	45-60	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
486--------------- Davis	0-8	Loam-------------	CL, ML	A-4, A-6, A-7	0	100	90-100	80-100	60-85	30-45	5-20
	8-46	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	90-100	80-100	60-85	30-45	5-20
	46-60	Loam, clay loam, silt loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	85-100	55-90	30-45	5-20
615*:											
Colo------------	0-9	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	9-47	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	47-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Spillville------	0-45	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	45-60	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
670--------------- Rawles	0-32	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	100	90-100	25-40	5-15
	32-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	100	90-100	30-45	10-20
733--------------- Calco	0-16	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	16-45	Silty clay loam	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
	45-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
785--------------- Spillco	0-60	Loam-------------	CL	A-6	0	100	95-100	85-95	55-80	25-40	11-20
801B2, 801C2, 801D2, 801F----- Bolan Variant	0-7	Loam-------------	CL, SM-SC, SC, CL-ML	A-4, A-6	0	100	100	75-90	40-60	20-30	5-15
	7-35	Sandy loam, loam, loamy sand.	SC, SM-SC, CL, CL-ML	A-4, A-6	0	100	100	75-90	40-60	20-30	5-15
	35-60	Stratified sandy loam to loam.	SM, ML	A-4	0	100	100	75-90	40-60	20-35	2-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
810, 810B, 810B2-- Galva	0-18	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	18-48	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	48-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	85-100	35-50	15-25
812, 812B, 812B2-- Moody	0-19	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	13-25
	19-41	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	95-100	85-100	32-55	11-33
	41-60	Silt loam, silty clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-45	3-20
878B, 878B2, 878C2----------- Ocheyedan	0-20	Loam-------------	CL	A-6	0	100	100	75-90	65-80	30-40	10-15
	20-40	Sandy loam, loam	SC, CL, SM-SC, CL-ML	A-4, A-6	0	100	100	60-80	35-55	25-40	5-15
	40-60	Sandy loam, sandy clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	100	100	85-95	50-90	25-40	5-15
5010*. Pits											
5040. Orthents											
5044. Fluvaquents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
1B3, 1C3, 1D3----- Ida	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	Low-----------	0.43	4	4L
8B--------------- Judson	0-30	27-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	30-46	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43		
	46-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.43		
11B*:										
Radford----------	0-31	18-27	1.40-1.60	0.6-2.0	0.22-0.24	5.6-7.8	Low-----------	0.28	5	6
	31-60	24-35	1.35-1.55	0.6-2.0	0.18-0.20	6.6-7.8	Moderate-----	0.28		
Judson-----------	0-30	27-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	30-46	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43		
	46-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.43		
26--------------- Kennebec	0-47	27-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	7
	47-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43		
27B-------------- Terril	0-25	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6
	25-60	15-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32		
28B, 28C2, 28D2-- Dickman	0-17	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-7.3	Low-----------	0.20	3	3
	17-39	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low-----------	0.20		
	39-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low-----------	0.15		
31--------------- Afton	0-31	33-38	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High----------	0.28	5	4
	31-44	25-35	1.25-1.30	0.2-0.6	0.18-0.20	6.1-8.4	High----------	0.43		
	44-60	25-30	1.30-1.45	0.2-2.0	0.14-0.16	6.6-8.4	Moderate-----	0.43		
32--------------- Spicer	0-18	29-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L
	18-38	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37		
	38-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low-----------	0.37		
33C2, 33D2, 33E2, 33G------------- Steinauer	0-6	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32	5	4L
	6-14	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	Moderate-----	0.32		
	14-60	24-35	1.50-1.80	0.2-0.6	0.14-0.19	7.9-8.4	Moderate-----	0.32		
54--------------- Zook	0-9	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7
	9-38	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28		
	38-60	20-45	1.30-1.45	0.06-0.6	0.11-0.22	5.6-7.8	High----------	0.28		
72, 72B, 72D2---- Estherville	0-14	10-18	1.35-1.45	2.0-6.0	0.19-0.22	5.6-7.3	Low-----------	0.20	3	5
	14-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low-----------	0.20		
	18-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low-----------	0.10		
78B2, 78C2, 78D2- Sac	0-8	27-35	1.20-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7
	8-28	20-35	1.20-1.30	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	28-60	20-32	1.65-1.80	0.2-0.6	0.14-0.16	6.6-8.4	Moderate-----	0.32		
91, 91B---------- Primghar	0-20	35-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	High----------	0.28	5	4
	20-33	30-35	1.30-1.35	0.6-2.0	0.18-0.20	6.1-8.4	High----------	0.43		
	33-60	25-30	1.35-1.40	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
92---------------- Marcus	0-19	36-40	1.30-1.35	0.2-0.6	0.21-0.23	6.1-7.8	High---------	0.28	5	4
	19-41	30-35	1.35-1.40	0.2-0.6	0.18-0.20	6.1-8.4	High---------	0.43		
	41-60	22-30	1.35-1.45	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.43		
108, 108B-------- Wadena	0-17	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	6
	17-27	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	27-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
116--------------- Graceville	0-38	27-34	1.15-1.25	0.6-2.0	0.19-0.22	5.6-7.3	Moderate-----	0.32	5	7
	38-45	25-34	1.20-1.35	0.6-2.0	0.17-0.22	5.6-7.3	Moderate-----	0.32		
	45-60	2-10	1.50-1.70	6.0-20	0.03-0.06	6.1-7.8	Low----------	0.10		
133--------------- Colo	0-24	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	24-38	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28		
	38-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28		
203--------------- Cylinder	0-20	22-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.24	4	6
	20-35	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.8	Moderate-----	0.32		
	35-60	2-12	1.60-1.70	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
259--------------- Biscay	0-17	18-27	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6
	17-25	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28		
	25-35	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-8.4	Low----------	0.28		
	35-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10		
308, 308B-------- Wadena	0-16	18-27	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	6
	16-36	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	36-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
309, 309B, 309B2, 309C2----------- Allendorf	0-15	27-32	1.25-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	4	7
	15-30	24-32	1.25-1.40	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.43		
	30-35	18-24	1.40-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Low----------	0.24		
	35-60	2-8	1.50-1.70	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
310, 310B, 310B2, 310C2, 310D2---- Galva	0-14	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
	14-43	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	43-60	25-30	1.35-1.45	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.43		
401B3, 401C3, 401D3, 401E3---- Crofton	0-7	20-27	1.20-1.30	0.6-2.0	0.21-0.24	7.4-8.4	Low----------	0.43	5	4L
	7-60	15-27	1.10-1.20	0.6-2.0	0.18-0.22	7.4-8.4	Low----------	0.43		
410, 410B, 410B2, 410C2, 410D2---- Moody	0-17	27-35	1.25-1.30	0.6-2.0	0.19-0.22	5.6-7.3	Moderate-----	0.32	5	7
	17-39	24-35	1.20-1.30	0.6-2.0	0.17-0.20	6.1-7.8	Moderate-----	0.43		
	39-60	20-30	1.30-1.45	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.43		
428B------------- Ely	0-28	27-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7
	28-56	28-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	56-60	20-30	1.40-1.45	0.6-2.0	0.18-0.20	6.6-8.4	Moderate-----	0.43		
467--------------- Radford	0-31	18-27	1.40-1.60	0.6-2.0	0.22-0.24	5.6-7.8	Low----------	0.28	5	6
	31-60	24-35	1.35-1.55	0.6-2.0	0.18-0.20	6.6-7.8	Moderate-----	0.28		
474, 474B, 474B2, 474C2, 474D2---- Bolan	0-17	20-26	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	4	6
	17-27	12-20	1.45-1.50	0.6-2.0	0.17-0.19	5.6-7.3	Low----------	0.28		
	27-60	2-8	1.60-1.70	6.0-20	0.08-0.10	5.6-7.8	Low----------	0.17		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
485-------------- Spillville	0-45	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	45-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
486-------------- Davis	0-8	18-27	1.20-1.30	0.6-2.0	0.18-0.22	6.1-7.3	Moderate-----	0.24	5	6
	8-46	18-30	1.20-1.35	0.6-2.0	0.18-0.22	6.1-7.8	Moderate-----	0.24		
	46-60	18-27	1.25-1.40	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.24		
615*:										
Colo------------	0-9	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	9-47	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28		
	47-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28		
Spillville------	0-45	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	45-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
670-------------- Rawles	0-32	18-27	1.25-1.35	0.6-2.0	0.21-0.23	6.6-8.4	Moderate-----	0.32	5	4L
	32-60	22-32	1.35-1.40	0.6-2.0	0.19-0.21	6.1-7.8	Moderate-----	0.32		
733-------------- Calco	0-16	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28	5	4L
	16-45	30-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High---------	0.28		
	45-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28		
785-------------- Spillco	0-60	18-26	1.45-1.55	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.24	5	6
801B2, 801C2, 801D2, 801F----- Bolan Variant	0-7	10-20	1.45-1.50	2.0-6.0	0.13-0.18	7.4-8.4	Low----------	0.20	4	3
	7-35	5-18	1.45-1.55	2.0-6.0	0.09-0.14	7.4-8.4	Low----------	0.20		
	35-60	5-20	1.45-1.55	2.0-6.0	0.09-0.14	7.4-8.4	Low----------	0.20		
810, 810B, 810B2- Galva	0-18	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
	18-48	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	48-60	25-30	1.35-1.45	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.43		
812, 812B, 812B2- Moody	0-19	27-35	1.25-1.30	0.6-2.0	0.19-0.22	5.6-7.3	Moderate-----	0.32	5	7
	19-41	24-35	1.20-1.30	0.6-2.0	0.17-0.20	6.1-7.8	Moderate-----	0.43		
	41-60	20-30	1.30-1.45	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.43		
878B, 878B2, 878C2----------- Ocheyedan	0-20	24-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	6
	20-40	14-24	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
	40-60	12-24	1.45-1.70	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.32		
5010*. Pits										
5040. Orthents										
5044. Fluvaquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1B3, 1C3, 1D3----- Ida	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
8B--------------- Judson	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
11B*:										
Radford----------	B	Occasional	Brief-----	Nov-Jul	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
Judson-----------	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
26--------------- Kennebec	B	Occasional	Brief-----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	High-----	Moderate	Low.
27B-------------- Terril	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
28B, 28C2, 28D2--- Dickman	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
31--------------- Afton	C/D	Occasional	Very brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
32--------------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
33C2, 33D2, 33E2, 33G-------------- Steinauer	B	None--------	---	---	>6.0	---	---	Moderate	High-----	Low.
54--------------- Zook	C/D	Occasional	Brief to long.	Feb-Nov	0-3.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
72, 72B, 72D2----- Estherville	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
78B2, 78C2, 78D2-- Sac	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
91, 91B---------- Primghar	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	High-----	Moderate	Moderate.
92--------------- Marcus	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
108, 108B--------- Wadena	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
116-------------- Graceville	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
133-------------- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
203---------------- Cylinder	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	Moderate	Low.
259---------------- Biscay	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	Moderate	Low.
308, 308B--------- Wadena	B	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
309, 309B, 309B2, 309C2------------ Allendorf	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
310, 310B, 310B2, 310C2, 310D2----- Galva	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
401B3, 401C3, 401D3, 401E3----- Crofton	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
410, 410B, 410B2, 410C2, 410D2----- Moody	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Low.
428B-------------- Ely	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
467---------------- Radford	B	Occasional	Brief-----	Mar-Jun	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
474, 474B, 474B2, 474C2, 474D2----- Bolan	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
485---------------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
486---------------- Davis	B	Rare---------	---	---	>6.0	---	---	Moderate	Moderate	Low.
615*: Colo--------------	B/D	Frequent----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
Spillville--------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
670---------------- Rawles	B	Occasional	Brief-----	Feb-Nov	>6.0	---	---	High-----	Moderate	Low.
733---------------- Calco	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
785---------------- Spillco	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	High-----	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
801B2, 801C2, 801D2, 801F------ Bolan Variant	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
810, 810B, 810B2-- Galva	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
812, 812B, 812B2-- Moody	B	None--------	---	---	>6.0	---	---	High-----	Moderate	Low.
878B, 878B2, 878C2------------ Ocheyedan	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
5010*. Pits										
5040. Orthents										
5044. Fluvaquents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Afton	Fine-silty, mixed, mesic Cumulic Haplaquolls
Allendorf	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
*Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Bolan	Coarse-loamy, mixed, mesic Typic Hapludolls
Bolan Variant	Coarse-loamy, mixed, mesic Typic Eutrochrepts
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Crofton	Fine-silty, mixed (calcareous), mesic Typic Ustorthents
*Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Davis	Fine-loamy, mixed, mesic Pachic Haplustolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fluvaquents	Loamy, mixed, mesic Fluvaquents
Galva	Fine-silty, mixed, mesic Typic Hapludolls
*Graceville	Fine-silty, mixed, mesic Pachic Haplustolls
Ida	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Marcus	Fine-silty, mixed, mesic Typic Haplaquolls
Moody	Fine-silty, mixed, mesic Udic Haplustolls
Ocheyedan	Fine-loamy, mixed, mesic Typic Hapludolls
Orthents	Loamy, mixed, mesic Typic Udorthents
Primghar	Fine-silty, mixed, mesic Aquic Hapludolls
Radford	Fine-silty, mixed, mesic Fluvaquentic Hapludolls
Rawles	Fine-silty, mixed (calcareous), mesic Mollic Udifluvents
*Sac	Fine-silty, mixed, mesic Typic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillco	Fine-loamy, mixed, mesic Cumulic Hapludolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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